WESTERN SYDNEY PLANNING PARTNERSHIP

NSW GOVERNMENT Transport for NSW

Western Sydney Smart Infrastructure Manual

DEOS DIGITAL

Prepared for WSPP by DEOS Digital

March 2023

Acknowledgement of Country

The Western Sydney Planning Partnership acknowledges more than 60,000 years of continuous Aboriginal connection to the land that makes up NSW.

We acknowledge and pay our respects to the traditional custodians of Country within Western Sydney. As part of the world's oldest living culture, the traditional Aboriginal owners and custodians share a unique bond to the Country – a bond forged through thousands of years of travelling across lands and waterways for ceremony, religion, trading, and seasonal migration.

We acknowledge that Western Sydney is home to the highest number of Aboriginal people of any region in Australia and that the primary Aboriginal custodians with obligations for Country and connection to the place for many generations including the Dharug/Darug, Dharawal/Tharawal, Gundungurra/Gandangara, and Darkinjung people.

Western Sydney Planning Partnership partner organisations:

Blacktown City Council, Blue Mountains City Council, Camden Council, Campbelltown City Council, City Of Liverpool, Fairfield City Council, Hawkesbury City Council, Penrith City Council, Wollondilly Shire Council, NSW Department of Planning and Environment, Greater Cities Commission, Transport for New South Wales, and Sydney Water.

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (10 March 2023) and may not be accurate, current, or complete.

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Readers should make their own inquiries and rely on their own advice when making decisions related to material contained in this publication.

Cover page Image (Liverpool City Council)

Table of Contents

1. Introduction

1.1 This document

The purpose of the Smart Infrastructure Manual is to help councils implement smart infrastructure solutions to support council objectives.

The manual is in five parts and two appendices:

Part A – What is Smart Infrastructure	Provides an overview of Smart Infrastructure and why councils would invest in it.
NSW Smart Places and Smart Infrastructure Strategies Over the past few years, the NSW Government has released a series of strategic documents regarding Smart Places and Smart Western Parkland City. A number of these documents are presented in Figure 2.6 below, demonstrating the level of progress and commitment on these programs to-date.  *Figure 2.6: NSW strategic documents supporting Smart Places and Smart Western Parkland City* It is noted that much of this work has been generally focussed on creating improvements for customers and communities. This is reflected in the number of NSW Smart Place publications such as: **Smart Places Playbook** – to help achieve the ambitions of a place and its people. **Smart Places Customer Charter** – to help deliver smart place outcomes that address customer concerns, have customer support and achieve great outcomes. **Smart Public Places Guide** – introduces the role of technology in delivering better public space outcomes for communities (see below figure).	Addresses internal capabilities needed by councils to implement and use SI effectively.

This work is commendable due to the relatively immediate impact it can deliver to communities and places throughout NSW. For example - the Smart Public Places Guide offers over 40 suggested improvements for public open spaces, public facilities and streets.

Figure 2.7: Smart places comprise public open spaces, public facilities and streets

NSW Roadmap for Digitalising Planning, Design, Construction and Operation of Infrastructure (Nov 2022) – This roadmap was published by Infrastructure NSW and sets out the NSW Government's strategic framework for achieving widespread adoption and application of digital technology throughout the infrastructure lifecycle for the NSW infrastructure sector. It aims to reduce complexity for industry working across multiple NSW Government agencies, by promoting and scaling up initiatives currently led by the NSW government, and eventually making these disparate initiatives business-as-usual.

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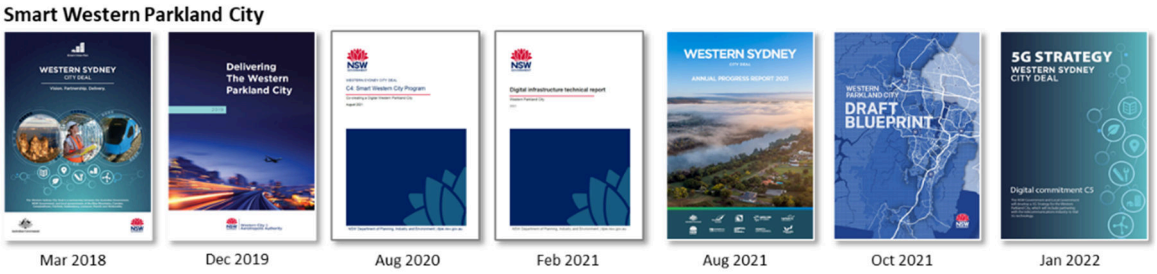

Figure 2.8: NSW strategic documents supporting Western Sydney

Part B – Building Capability

Part B – Building Capability	
Part C – Procurement Approach	Describes an approach to selection and procure Smart Infrastructure solutions.
. If replacement equipment is needed, then how will that be paid for and is their budget for it? • Potential data privacy risks and cybersecurity risks (as outlined elsewhere in this manual) • Being clear about responsibilities council has and which suppliers are expected to do. • Impact on digital infrastructure. For example, large numbers of IoT devices or users may place additional demands on operational support staff and infrastructure. • Including smart infrastructure in council's asset register and asset management programs Although listed here in Step 4 – these may have an impact on procurement and must be considered in the previous step. *Council Spotlight* *Resources* • NSW Smart Infrastructure Policy • Wollondilly "Wilton 2040" DCP Conditions of Consent for Smart Places • The "Smart Places" section of the Aerotropolis DCP (page 111) provides examples of Objectives and Design requirements.	Provides detail on specific types of Smart Infrastructure

Part D – Specific Smart Infrastructure	
Part D – Specific Smart Infrastructure	
Part E – Digital Infrastructure	Digital infrastructure is required to support the specific Smart Infrastructure solutions.
Appendix A: Smart Infrastructure Maturity Checklist	A checklist used to identify current maturity and how to progress to higher levels of maturity.
Appendix B: Pilot Evaluation Template	A template for evaluating smart infrastructure pilot projects.

1.2 Using this manual

This manual is intended for use by planners, asset managers, ICT personnel and others with an interest in implementing Smart Infrastructure in the communities.

The manual will help the reader:

- Get a basic understanding of smart infrastructure and why councils should invest in it.
- Understand the capabilities required to take advantage of Smart Infrastructure
- Undertake effective smart infrastructure procurement.

2. Part A – What is Smart Infrastructure

2.1 Smart Infrastructure

The NSW Smart Infrastructure Policy (SIP) defines Smart Infrastructure as "*the integration of smart technologies with physical infrastructure to optimise delivery, increase capacity and achieve a greater return-on-investment".*

Smart Infrastructure includes digital engineering processes and digital technologies such as data platforms, digital twins, modelling, sensing and monitoring, machine learning, analytics and business intelligence.

Smart infrastructure extends way beyond customer facing technologies, personalised services or point solutions with emerging technologies. This concept offers a new, end-to-end vision for the systems and services throughout the built environment that support and connect the general public, as represented below in Figure 2.1.

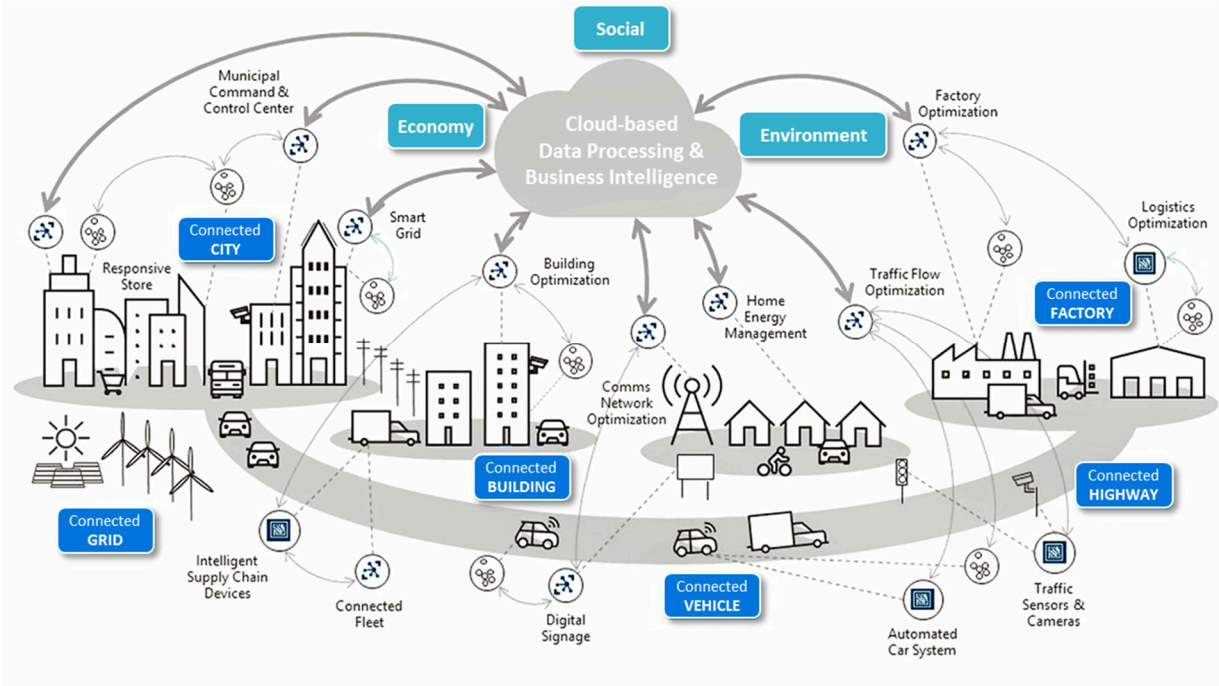

Figure 2.1: Conceptual representation of a smart city and smart infrastructure (source: Microsoft)

This vision forms a complete digital ecosystem, built on trusted and reliable data, that connects infrastructure organisations with their suppliers, stakeholders and customers. It also promotes cross-organisation cooperation, by actively supporting data sharing and digital collaboration, to re-invent how government organisations partner together to plan, deliver and operate public infrastructure.

This will mean holistic transformation of government organisations, enabled through emerging technologies and data management capabilities, to create new, connected and digitally optimised services over the complete lifecycle of public infrastructure.

Smart Infrastructure comprises three key elements including:

- **Digital Twins:** Virtual ecosystems of linked datasets, that collectively represent a physical entity.
- **Business Intelligence:** Strategies and technologies used at an enterprise level, for managing and analysing of business data.
- **Physical Entities:** A physical asset, or a group/system of assets, that is instrumented with Internet-of-Things (IoT) technologies.

A model of smart infrastructure is presented below in Figure 2.2, representing the key elements and their relationships. Note this diagram is focussed purely on the flow of data, (both structured and unstructured), and how data sources converge to create more advanced business intelligence. Additional details (such as business process, technologies, roles, etc.) has been intentionally filtered out of this model, focusing solely on data management requirements for smart infrastructure.

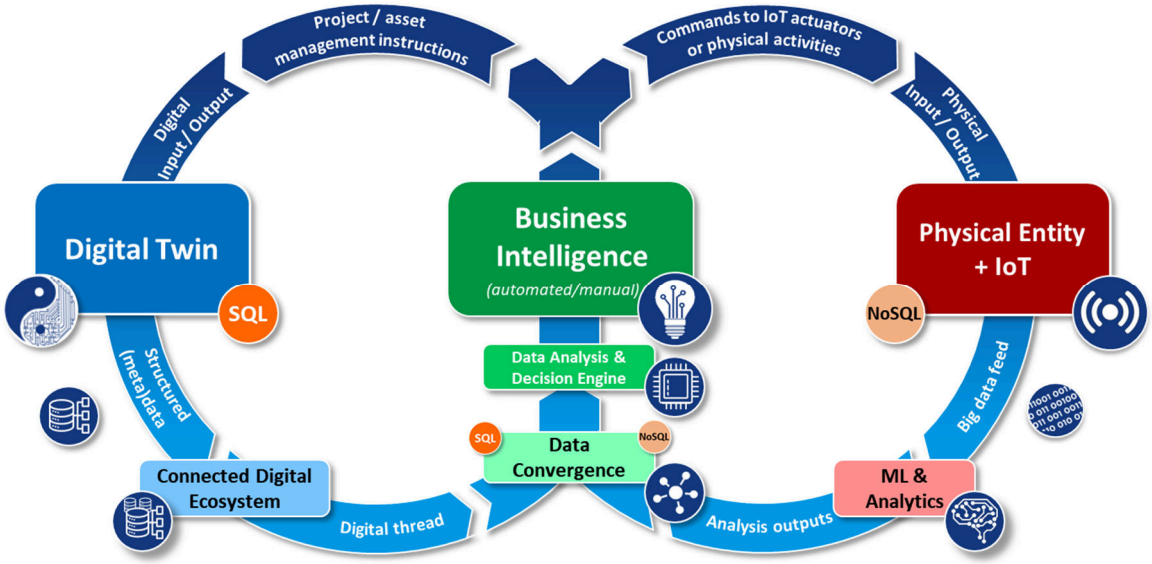

Figure 2.2: Data-centric model representing smart infrastructure (including digital twin)

Further details on the key elements, such as their characteristics and relevant examples, are provided below in Table 2-1.

Table 2-1: Smart Infrastructure key elements, characteristics and examples

Digital Twin	Business Intelligence	Physical Entity + IoT
• Combines structured datasets. • ACID transactions* • Recommended DBMS: SQL • Stored in a data warehouse	Determines business intelligence through convergence and analysis of structured & unstructured data	• Unstructured big data & analytics • BASE transactions* • Recommended DBMS: NoSQL • Stored in a data lake
Examples of Structured Datasets:	**Examples of BI Activities:**	**Examples of Big Data Feeds:**

CAD, BIM, GIS, schedule, cost, risk register, asset register, requirements, safety, environment, sustainability, contracts, records etc	Data science, data cleansing, regression, modelling, pattern detection, classification, dashboarding etc	Material stress/strain, movement, vibration, impact, weather, pollution, congestion, CCTV, patronage, biometrics, etc

*Note: *"ACID" and "BASE" transactions* are common terms used to compare properties of various forms of databases (e.g., consistency, reliability, availability, predictability etc.)

Smart Infrastructure Technologies

When considering smart infrastructure solutions, it is easy to focus on physical technologies (e.g., IoT sensors) - however these are just one part of the complete ecosystem.

The NSW SIP notes that, at the time of writing, there are no Australian standards that define a reference IoT ecosystem. In lieu of agreed standards, the next best thing is the 10-layer IoT Reference Framework, published by the IoT Alliance Australia (IOTAA) (Version 1 - dated Sept 2018), presented below in Figure 2.3.

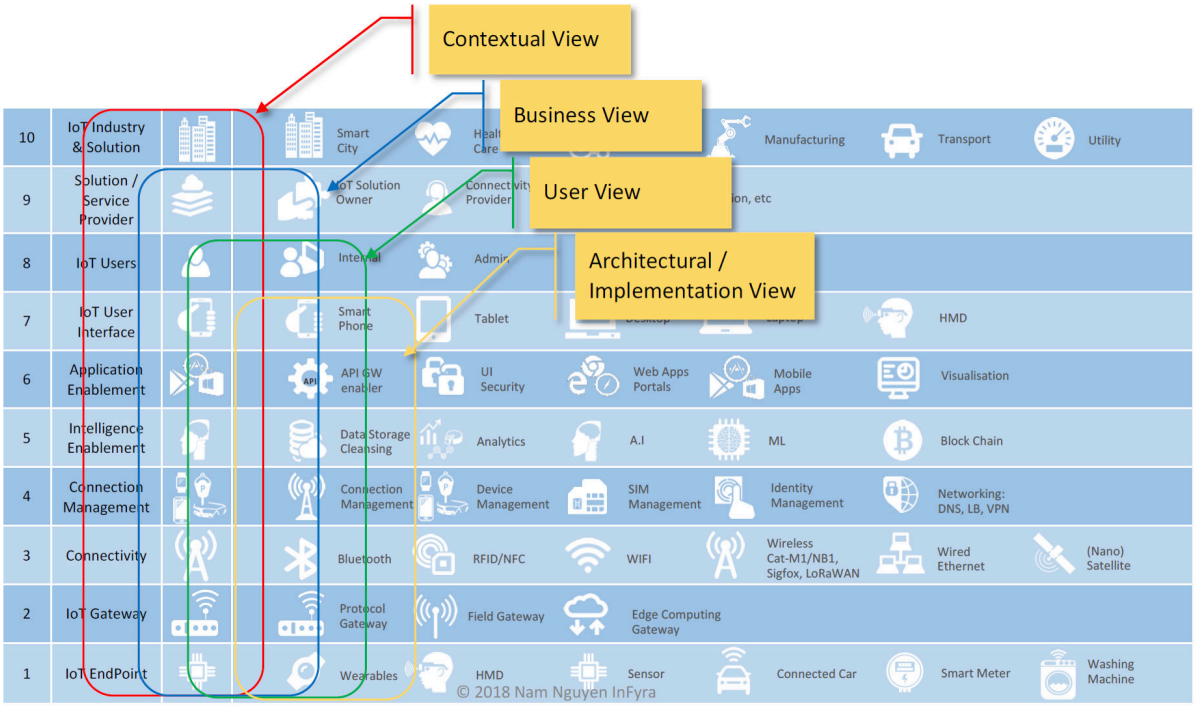

Figure 2.3: IoT Reference Framework, published by the IoT Alliance Australia (IOTAA)

The NSW SIP also specifies the building blocks of the smart infrastructure ecosystem, using a 5-layer reference model with the following components (represented below in Figure 2.4):

- **Security** – ensuring the safe and secure operations of SI solutions.
- **Application and Hosting layer** – for developing and operating SI solutions
- **Data and Intelligence layer** – enabling enable data management & analytics.
- **Connectivity layer** – including networks and related integration services.
- **Sensor layer** – including sensors, actuators, and devices.

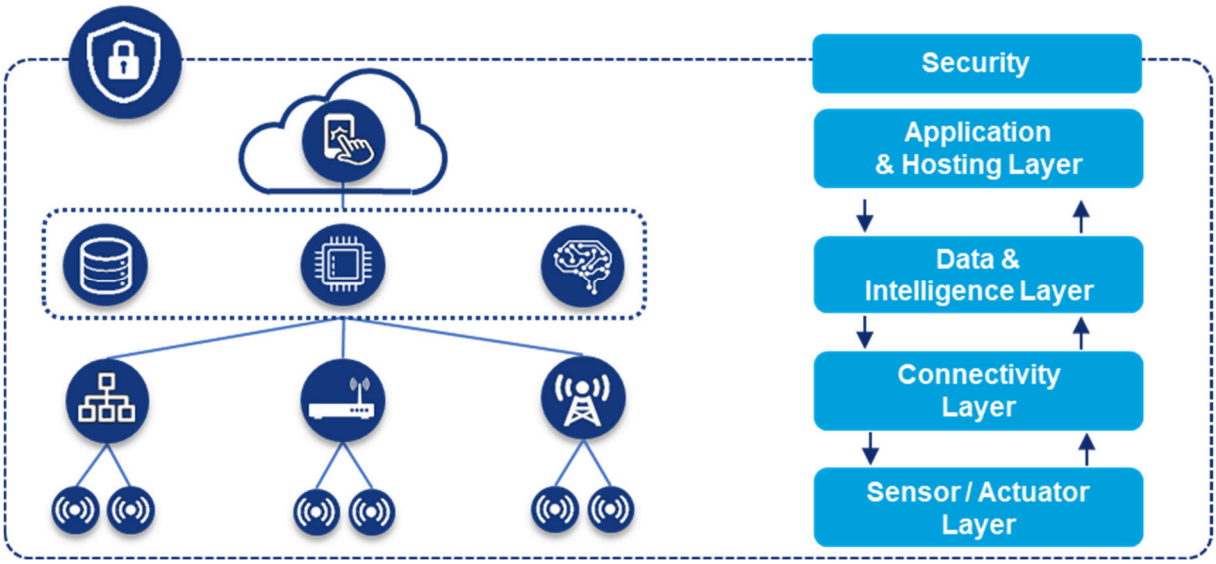

Figure 2.4: NSW Smart Infrastructure reference model (based on the NSW SIP)

In the context of smart infrastructure, this reference model highlights the importance of:

- Thinking beyond simple procurement and installation of IoT sensors; and
- Designing solutions that consider the overall end-to-end ecosystem.

In regard to government-led initiatives, government organisations require new business strategies, that are owned and sponsored by pioneering leaders who can think big and can recognise the significant opportunities of broadscale digital transformation. These strategies will help to navigate the journey, commit dedicated resources, coordinate initiatives, and build new digital business capabilities (such as improved data literacy and digital dexterity). Leading organisations need to become more agile, powered by a core that is end-to-end digital over the asset lifecycle – otherwise known as the "digital asset lifecycle" or the "digital thread".

2.2 Smart Infrastructure, Smart Cities and Smart Places

Smart Infrastructure and Smart Cities (or Smart Places) are closely related and many of the technologies and intended outcomes apply to both. A simple distinction is that:

- **Smart Infrastructure** is focused on the application of smart technologies to physical infrastructure, and is foundational for achieving Smart Places
- **Smart Places** (or Smart Cities) are broader in scope and include Smart Infrastructure, digital service delivery and customer engagement.

Figure 2.5 below shows a Venn Diagram representing the overlap between smart infrastructure and smart places. While this diagram is not exhaustive, it demonstrates how there are numerous similarities, along with subtle yet key differences, between these two concepts.

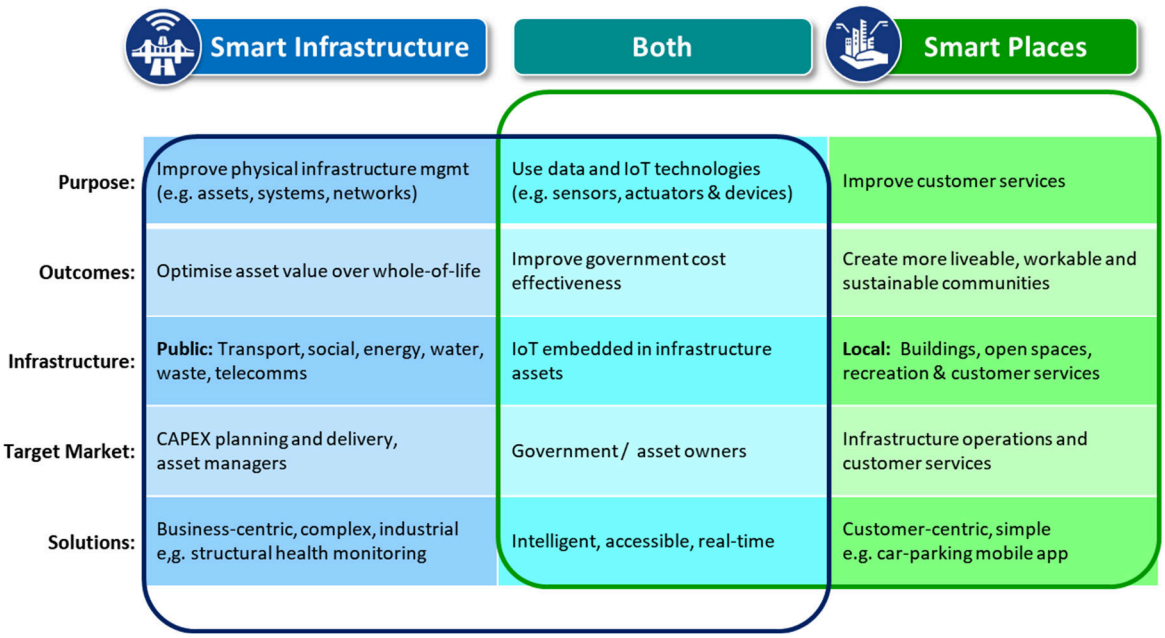

Figure 2.5: Venn Diagram of Smart Infrastructure and Smart Places

2.3 Why Would Local Government Invest in Smart Infrastructure?

Councils typically invest in smart infrastructure to support one or more of five Investment drivers, listed below in Table 2-2.

Table 2-2: Smart Infrastructure investment drivers

#	Investment Driver	Description
1	**Improve efficiency and reduce cost of council service delivery**	As with other services and council operations digital technologies are used to automate manual processes and enable new types of services to be developed.
2	**Improve data for council asset planning and management**	Councils have significant asset portfolios including buildings, roads, bridges, stormwater and other types of civil infrastructure. Smart technologies are used to enable more informed planning and support transition from reactive to condition based or predictive asset management.
3	**Improve resident and user experience (including digital equity)**	Safer, cleaner, healthier spaces and seamless service delivery all contribute to improved resident experience. Smart Infrastructure examples here include 24/7 access to council facilities, security cameras, wayfinding and information points.
4	**Environmental sustainability and resilience**	Environmental sustainability, urban heat, changing work patterns and digital inclusion are broader concerns that affect many Australians. Each has implications for how our communities will look in the future. Smart infrastructure technologies such as environmental sensing, electric vehicle charging, and public data communications infrastructure all help transition to that future.
5	**Data for improved decision making and planning**	Urban growth brings great opportunities to create well planned and designed localities with integrated transportation systems, safe spaces and environmental sustainability. Smart infrastructure technologies such as “digital twins” and using sensors to collect

#	Investment Driver	Description
		data allows more informed and effective planning. Digital Engineering approaches automate the “paper trail” for new developments from planning to design, construction and operation allows councils to cope with the portfolios of new projects.

2.3.1 Benefits of Smart Infrastructure

Many smart infrastructure investments support several of the drivers listed above. For example, video analytics can be used for public safety and to collect data about usage of public spaces that enables improved planning and more targeted investments.

Table 2-3 below shows examples of Smart Infrastructure and typical benefits from each. Shown in **bold** are examples of the primary benefits typically sought with others as secondary benefits. In practise each Council will identify the benefits that are important to them and their communities.

Table 2-3: Smart Infrastructure types and benefits

Infra Category	Smart Infrastructure	Improved Efficiency and Cost Reduction	Improved Asset Planning and Management	Improved Resident and User Experience	Environmental Sustainability and Resilience	Improved Decision Making and Planning
Digital Infrastructure	Data Sharing Portal			**public engagement, encourage innovation, digital inclusion**		
	Emergency Services Dashboard	**more effective disaster response and coordination**		safety and preparedness		
	Public Wi-Fi			**digital inclusion**		
Environment	Flood monitoring	**more effective disaster response and coordination**	asset protection	safety and preparedness		
	Monitoring of Green Corridors				**environmental sustainability and tourism**	
	Urban Heat Monitoring			**improved health and amenity**		
	Water Quality Monitoring	**automated environmental data collection using sensors**			environmental sustainability	
Planning and Development	Construction Site Dust Monitoring					**maintain air quality compliance for new development**
	Digital Twin					**improved planning**
Public Spaces	Facilities Booking and Access	increases utilisation, reduced energy cost, reduce physical visits to open facilities		**24/7 access to council facilities**		
	Pedestrian Counting					**planning**

Infra Category	Smart Infrastructure	Improved Efficiency and Cost Reduction	Improved Asset Planning and Management	Improved Resident and User Experience	Environmental Sustainability and Resilience	Improved Decision Making and Planning
	Smart Lighting / Multifunction Poles	**reduce lighting costs, reduce costs to deploy sensors and Wi-Fi access points**		safety		data collection from various sensors
	Video Analytics (fixed cameras)	inform utilisation of public spaces, inform transport planning	reduce cost of vandalism and graffiti	**public safety**		
	Soil Moisture Monitoring	**minimise costs to watering trees in town centres**				
	Smart Bus Shelter			**public engagement**		
Roads	**Bridge Condition Monitoring**		**condition based asset maintenance**			
	Automated Detection of Road Defects		**condition based asset maintenance**			
	TfNSW Smart Curbs					
Storm water	**Pipe Condition Assessment**		**condition based asset maintenance**			
	Pit Monitoring		**condition based asset maintenance**		improved water quality in rivers	
Transport	**EV Charging**				**climate change**	
	Smart Parking	**reduce congestion**				
Waste	**Smart Bins**	**reduce waste collection costs**		amenity		
Water	**Dams - Active management**	**optimise utilisation**				
	Recycling	**optimise operation, reduce water demand**			sustainability	

2.4 NSW Context

The NSW government has defined policies and strategies that relate to Smart Infrastructure. Much of this is relevant to councils. These include:

- The NSW Smart Places Strategy (2021)
- The NSW Government Smart Infrastructure Strategy (2020)
- NSW Govt Cybersecurity Policy
- NSW Roadmap for Digitalising Planning, Design, Construction and Operation of Infrastructure (Nov 2022)

NSW Smart Places and Smart Infrastructure Strategies

Over the past few years, the NSW Government has released a series of strategic documents regarding Smart Places and Smart Western Parkland City. A number of these documents are presented in Figure 2.6 below, demonstrating the level of progress and commitment on these programs to-date.

Figure 2.6: NSW strategic documents supporting Smart Places and Smart Western Parkland City

It is noted that much of this work has been generally focussed on creating improvements for customers and communities. This is reflected in the number of NSW Smart Place publications such as:

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3. Part B – Building Capability

This section describes the capabilities councils need to successfully take advantage of Smart Infrastructure technologies. These capabilities closely align with the capabilities needed to deliver on Smart Cities or Smart Places objectives.

These have been categorised into two areas:

- **Initial Target**: Building a minimum level of technology capability (See Section 3.2)
- **Longer-term target**: Maximising the Benefits of Smart Infrastructure Investments (See Section 3.3)

3.1 Smart Infrastructure Maturity Framework

It is helpful to thinking about Smart Infrastructure capabilities in terms of a Maturity Framework. A number of maturity frameworks have been developed over the past few years, that aim to help organisations identify capabilities that may need to be strengthened to achieve organisational objectives.

It is noted however that much of the effort in developing these frameworks has been focussed on smart cities and citizen-centric improvements. While these are important, much of the content is not relevant or appropriate for smart infrastructure objectives.

To fill the gap a new smart infrastructure maturity framework was developed that incorporates 7 main categories and 20 sub-categories, presented below in Table 3-1.

Table 3-1: Smart Infrastructure Maturity Framework

No.	Category	No.	Sub-Category
1	Smart City Vision & Strategy	1	Planned Outcomes
		2	Enablers
		3	Investment
2	Smart Infrastructure Vision & Strategy	4	Vision and Strategy
		5	Enablers
		6	Investment
3	Business Process	7	Procurement Specifications of Digital Deliverables or Smart Infrastructure Assets
		8	Collaborative Management of Infrastructure Assets
		9	Digital Asset Lifecycle (i.e., digital thread of data)
4	Data	10	Enterprise and Data Architecture
		11	Data Management Awareness and Interoperability
		12	Open Data Services
		13	Data Analytics and Insights
5	Technology	14	Technology Ecosystem (i.e., infrastructure and operational ICT technology)
		15	Uptake of IoT sensor Technologies, and Integration with Physical Infrastructure Assets
6	People	16	Staff Capability with Smart Infrastructure Technologies
		17	Data Literacy and Culture of Data Sharing
		18	Data Management Roles (for internal master data management for infrastructure assets)

7	**Overall Organisational Direction**	19	Team behaviours
		20	Accountability and Resourcing

3.1.1 Maturity Levels

The framework used to prepare this manual has been developed using five maturity levels based on the following international standards:

- ISO 37107:2019 - Sustainable cities and communities - Maturity model for smart sustainable communities, and
- ISO 37153:2017 - Smart community infrastructures - Maturity model for assessment and improvement.

The five maturity levels adopted for the SI Maturity Framework are listed below in Table 3-2.

Table 3-2: Maturity Levels

Level	Definition	Description
1	**Initial**	Not yet started
2	**Partially fulfilled**	Needs are identified but not yet started
3	**Fulfilled**	Satisfies current needs in a defined manner
4	**Improving**	Partially started towards future needs
5	**Sustainably optimizing**	Continually improving to satisfy future needs

As a priority, councils should expect to be at "Level 3 – Fulfilled" in order to take advantage of Smart Infrastructure capabilities. In the medium-term, councils should work towards "Level 4 – Improving" maturity, in order to maximise the value and ROI of Smart Infrastructure investments.

For full details on the business analysis completed using this framework please refer to the SIPA Project – Stage: 1 Initiation Report.

3.2 Initial Capability Target – "The Minimum Level of Capability" (Level 3 Maturity)

The capabilities described in this section are the minimum required to effectively undertake smart infrastructure projects and obtain lasting value from them.

This corresponds to "*Level 3 – Fulfilled*" in the Smart City Maturity Framework. These can be considered foundational capabilities and practises. Organisations have achieved the *Fulfilled* level of maturity when they can confidently say that they have the following in place:

Policies:

- ❑ Asset management
- ❑ Open data policy

- ❑ Interoperable technologies

Strategies:

- ❑ Smart infrastructure (SI) vision
- ❑ Enterprise architecture and data management

Documented:

- ❑ SI business case(s)
- ❑ Procurement specifications for SI deliverables
- ❑ Requirements for the digital thread of data
- ❑ In-house roles for dedicated smart infrastructure team

Culture that promotes:

- ❑ Opportunities for partnering and joint investment
- ❑ Data management, data literacy and/or data sharing
- ❑ Technological innovation and interoperability

Appendix A: Smart Infrastructure Maturity Checklist provides a useful to way to determine at what level councils currently are and what their next steps may be.

Several of the capabilities required for effective use of Smart Infrastructure are described in more detail below:

- Business case development
- Change Management
- Procurement
- Cybersecurity
- Data Privacy

3.2.1 Business Case Development

Introduction

All Smart Infrastructure projects should have a business case that describes both benefits and costs. Even pilot projects and technology trials need business cases to justify the resources, time and effort invested in them. When done well they focus on the ultimate outcomes being sought and take into account both direct and indirect costs over the total lifetime of the solution.

Best Practise Recommendations

- ❑ **"Business Needs First – Technology Second".** It is often easy to undertake a technology trial or pilot projects without considering how the technology will ultimately support business objectives. Being able to clearly define measurable primary and secondary benefits will help gain buy-in to commence a project. It will also enable objective measurement of the impact made over time.
- ❑ **Define pilot project objectives.** When embarking on a pilot project have clear objectives for the pilot and how you will know whether that pilot has been a success.

Develop a vision of how the Smart Infrastructure will be rolled out post-pilot and identify potential risks and uncertainties. The pilot project can then be designed to explore these and retire risks before committing to further investment.

- **Identify key performance indicators (KPIs)** that can be used to evaluate success of the investment. Some KPIs will relate directly to benefits while others will provide insight into usage or adoption that can be used to fine tune plans and inform future investments.
- **Establish "Why Now?"** Resources are often scarce. It is important to be clear why investment should be made now and not deferred. Often this is a combination of increased need, changing external conditions, council priorities and the availability of suitable solutions in the market.
- **Long Term Costs.** It is common to focus on upfront costs of new technology investments and neglect operational costs. The financial case should include the total cost of ownership of smart infrastructure solutions including acquisition costs, and ongoing costs for product maintenance, updating business processes and skills development.

Council Spotlight

Blacktown "Smart Bins" Pilot. Blacktown's Smart Bins pilot is a great example of a project where a business need was identified (overflowing bins) and smart technology trailed to provide information allowing bins to be emptied before they become full. This resulted in the business need being addressed (complaints to councillors about overflowing bins stopped) and there was a secondary benefit of reduced overtime paid for waste collection. The created a strong case to rollout smart bins in other locations.

3.2.2 Change Management

Introduction

Many smart infrastructure projects do not progress beyond pilot to larger scale rollout and thus fail to make a significant impact. As stated in the previous section having a clear purpose, business case and strategic alignment are crucial.

It is a truism that transformational solutions require some form of organisational transformation to take advantage of them. Organisational skills, roles, and business processes all need to be examined and changes identified to take advantage of new Smart Infrastructure. Change

management then goes hand in hand with project management to ensure that these changes are made.

Best Practise Recommendations

Change management approaches are widely available. The principles are applicable to many aspects of council operations. Best practise recommendations of particular relevance to smart infrastructure are:

- **Engage stakeholders early**, identify supporters and work with doubters to allay concerns. Stakeholders can and should be at all levels of the organisation. They may also be external to council – for example community and business representatives, state government agencies, other councils. When done well, smart infrastructure is driven by demand by those who benefit rather than being see as just another new time-consuming distraction thrust upon them.
- **Provide education and training** for both technical and non-technical staff to increase smart infrastructure understanding and literacy.
- **Review business processes, documents, job descriptions and service contracts** and update if necessary to accommodate changes in skills, roles and service expectations that come with smart infrastructure.
- **Update the asset register and asset management plan(s)** to accommodate smart technology. For IoT devices such as sensors, irrigation control systems, cameras and remote locking devices this includes recording metadata about IoT and other equipment including geolocation, type, installed data, last maintenance date, data access, site access details and the like.
- **Include Change Management Costs** in the business case. Changing processes, undertaking training require resource that should be acknowledged at the outset.

Council Spotlight

Spotlight your council's Change Management experiences and practises here!

Additional Resources

- LGNSW "Implementation and Change Management Guide" (2018) - https://lgnsw.org.au/common/Uploaded%20files/PDF/Capability_Framework_Implementation_and_Change_Management_Guide_Mar_2018.pdf
- The Change Management Institute (https://change-management-institute.com/) has helpful resources including a change management certification program.
- Many educational institutions offer training courses on change management. An online search will result a range of courses to consider.

3.2.3 Procurement

Introduction

Procuring smart infrastructure is similar to procuring other products and services there are some important differences. Firstly, smart infrastructure technology is often installed in public spaces. Secondly, data is at the core of smart infrastructure and brings with it some specific considerations.

This section describes best practices relating to smart infrastructure that are worth adopting even when councils are acquiring relatively simple smart infrastructure solutions.

Councils using local government procurement (www.lgp.org.au) may find that standard procurement templates do not address these topics. Councils should make the effort to include them in council procurement policies and practises.

Best Practise Recommendations

Update procurement policies and templates to include the following points, as applicable:

- **Ownership of smart infrastructure solutions.** Ownership should be transferred to council if council is expected to pay ongoing operational costs after an initial deployment phase. For example, a developer may be required to install smart irrigation in a development and operate it for some period of time. If the responsibility to operate this, then reverts to council then the developer should arrange for a suitable handover to council including transfer of ownership.
- **Providing access guarantees** to sensors, conduits and other smart infrastructure to enable installation and maintenance by council and those operating on its behalf. In the above example, the developer may need to guarantee access to communications infrastructure and power even if specific smart irrigation components have been transferred to council.
- **Clear responsibilities.** Be clear who will be responsible the installation, configuring and managing IoT devices in the field. Who will arrange site access and what insurances and work certifications are required?
- **Data ownership.** All data provided by a smart infrastructure solution should be owned by council. This includes “record level” or raw data as well as summarised data, reports and the like.
- **Data provision.** Solution providers should make data available to councils in an automated and straightforward manner that requires minimal council labour. This could for example be by uploading via API to a council operated data portal.
- **Metadata.** Data should be accompanied by metadata that provides additional context. Metadata is “data about data”. For example, sensors will generate data about what they are measuring (flood levels, video feeds etc). Metadata provides context such as details of the sensor used, its accuracy and resolution, configuration settings, latitude, longitude and altitude, when installed and when last calibrated should be made available. This may be accompanied by photographs showing the device in place and potentially information about site access and site contacts.

- **Service level agreements** stating what data will be provided, how often, how reliable, and in what format data.
- **Data formats** should be compatible with agreed standards to allow interoperability with other solutions that adhere to the same standards. The specific standards will depend on the smart infrastructure being procured.
- **Data Retention.** Ensure that data is retained at the completion or exit of solution delivery contract. Data may need to be extracted from third party systems before access is lost.

Part C – Procurement Approach for more detail on the overall procurement process.

Council Spotlight

Spotlight your council's Smart Infrastructure Procurement experiences and practises here!

3.2.4 Cybersecurity

Introduction

All councils should already have cybersecurity policy and operational practises to protect existing enterprise systems, data and digital infrastructure.

Smart Infrastructure brings with it some special considerations that must also be considered.

Best Practise Recommendations

- ❑ **Update Cybersecurity policy and practises** to include Smart Infrastructure technologies. This includes Internet of Things (IoT devices), wireless data communications networks and data sharing platforms.
- ❑ **Update IoT devices software** when vendors recommend they be updated. Sensors and remote actuators include small computers that have onboard software to process data and operate data communications. As with office computers, manufacturers may release software updates containing security updates and fixes from time to time. Operational practises should be updated to include this.
- ❑ **Undertake periodic risk assessments** and audits for Smart Infrastructure. Often these can be done using internal and external audits. They need to include wireless data infrastructure and other equipment in the field.
- ❑ **Procure Internet of Things devices and solutions** from vendors that adhere to the Federal government IoT Cybersecurity voluntary code of practise (reference below).

Council Spotlight

Spotlight your council's Cyber Security experiences and practises here!

Additional Resources

- The NSW Government Smart Infrastructure Strategy (2020) describes security challenges and solution requirements
- Digital.NSW (https://www.digital.nsw.gov.au/policy/cyber-security) has many resources including the NSWE Government Cyber Security policy and strategy and other useful documents and tools.
- Federal government IoT Cybersecurity voluntary code of practise outlines 13 principles representing the minimum level of security industry should provide with IoT devices - https://www.homeaffairs.gov.au/reports-and-pubs/files/code-of-practice.pdf
- Western Parkland City Cyber Uplift Initiative is developing guidelines and a self-assessment tool for councils.

3.2.5 Data Privacy

Introduction

Related to cyber security, data privacy has been increasingly an issue with several high-profile examples of citizen data being stolen by hackers. This data has included personal identity and other confidential information held in enterprise databases. "De-identifying" data sets by removing names and other personal information does not always eliminate the risk of "re-identification" of individuals. There are cases where a person's identity can be deduced based on the analysis of other data sets in combination with the de-identified data.

Smart Infrastructure collects data within the built environment. In many cases, such as structural monitoring of a bridge or a smart irrigation system, there is minimal or no data privacy risk. There are, however, some types of smart infrastructure that do present an inherent data privacy risk and must be managed accordingly.

One example is that of fixed CCTV cameras which in the past were closed, self-contained systems typically accessible only by selected council staff, security firms and police. Newer camera systems can perform automated image analysis such as facial recognition and license plate recognition. Councils may also wish to use data from these systems for other purposes – for example to better understand public space usage and pedestrian movement. Making this data available to an expanded group of users beyond the initial restricted group can increase data privacy risk if it's not done in a considered manner.

A second example is remote facilities booking and access systems. These systems allow citizens to book and obtain access to sporting facilities, meeting rooms and the like. The privacy risk here is that the location of individuals could be determined at specific times. An individual being at the tennis court at a certain time would imply that their home may be unattended and potentially a target for thieves.

In the first instance data privacy should be considered together with cyber security when securing data stored by council or others on its behalf. There are additional privacy considerations when sharing data – within council and particularly when sharing data externally. Refer section *3.3.3 - Data Sharing.*

Best Practise Recommendations

- ❑ **Ensure council follows the 12 NSW Information Protection Principles** and has a process to evaluate new initiatives and data sources for data privacy risks.
- ❑ **Undertake privacy risk assessments** of Smart Infrastructure data sets.

Council Spotlight

Spotlight your council's Data Privacy experiences and practises here!

Additional Resources

- The NSW Information and Privacy Commission has relevant resources specifically for public sector agencies - https://www.ipc.nsw.gov.au/privacy/agencies

3.3 Longer-term Capability Target – "Maximising the Benefits" (Level 4 Maturity)

The capabilities described in this section are capabilities that allow councils to go beyond initial smart infrastructure project and maximise the value of their smart infrastructure investments. They correspond to "*Level 4 – Improving*" in the Smart City Maturity Framework.

Organisations have achieved the *Level 4 - Improving* level of maturity when they can confidently say that they have the following in place in addition to those listed for *"Level 3 - Fulfilled":*

Documents:

- ❑ Data management framework, including processes to support digital thread.
- ❑ SI Implementation program, including operational funding that extends beyond trials.
- ❑ Broad deployment of remote sensors and connected infrastructure (for both new and existing assets)
- ❑ Roadmap for improved data science and business intelligence
- ❑ Performance benchmarks and KPIs for SI and asset management

Culture that promotes:

- ❑ Open data community with strong community interaction
- ❑ Data-driven decision making
- ❑ Continuous improvement, through feedback, knowledge capture and lessons learnt.

Refer also *Appendix A: Smart Infrastructure Maturity Checklist*, which provides a useful to way to determine at what level councils currently are and what their next steps may be.

The specific capabilities described in this section are:

- Whole of council “systems” approach
- Inhouse Resources
- Data Sharing
- Digital Engineering
- Communications Infrastructure
- Seeking External Perspectives and Input

3.3.1 Whole of Council “Systems” Approach

Introduction

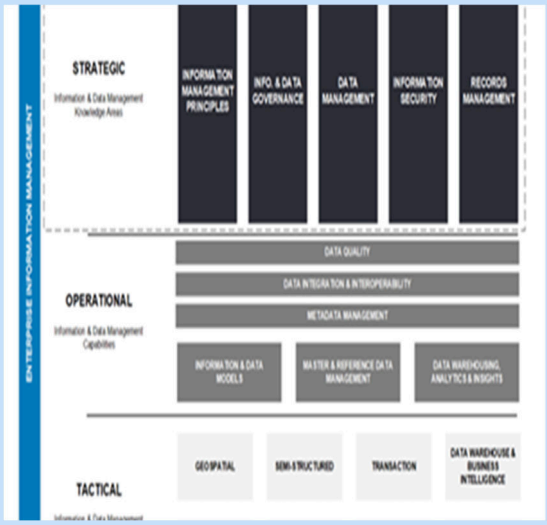
“Silos” within council are inevitable and understandable as various groups seek to achieve their individual objectives. The problem with siloed approaches to Smart Infrastructure and Smart City initiatives is opportunities to share data and adopt common practise are missed.

Best Practise Recommendations

- ❑ **Establish a smart infrastructure steering committee** to maintain overview of all SI projects and identify opportunities for re-use, sharing and consolidation. Membership should include people from across councils business units.
- ❑ **Establish common practises** across council for business case development and evaluation, development of KPIs and evaluation processes.
- ❑ **Undertake an audit of all SI projects** and evaluate opportunities to maximise value through data collection and sharing, transition to BAU, reduce risk.
- ❑ **Introduce a “Smart by Default” policy** for new infrastructure so that cases where smart technology will not be used must be justified.
- ❑ **Establish a Data Governance function** within council to coordinate a whole of council data catalogue, master data management processes, metadata, etc.

Council Spotlight

Camden City Council. Council established an Information & Data Governance Framework in December 2020 along with an Information & Data Governance Committee (IDGC) that oversees the overall governance of it's information assets. The IDGC is made of up of various managers/leaders across Council coming together regularly to work collaboratively on implementing innovative solutions while maintaining standards and eliminating silos. Council has also developed a draft Smart Community Framework which will also be maintained as smart infrastructure/technologies are rolled out and data is collected.



Additional Resources

- The DAMA International – Data Management Body of Knowledge (DMBOK). Includes a dictionary of commonly used terms relating to data management. www.dama.org

3.3.2 Inhouse Resources

The availability of skilled people in technical areas is frequently an issue for councils. This is particularly true for digital skills such as data governance, security and newer smart technologies such as Internet of Things.

Councils can certainly get started with smart infrastructure by outsourcing "turnkey" solutions where vendors provide a package of products and services that deliver the required outcomes.

A certain amount of inhouse capability is required however to maximise the value of smart infrastructure investments beyond the minimum. The ability to "mine" data and extract more value from smart infrastructure investments is best done by inhouse people who are engaged across council.

In practise councils can use a combination of inhouse and outsourced resources. Inhouse resources responsible for more strategic technical work and outsourced resources to fill gaps and help with more "tactical" projects.

3.3.3 Data Sharing

Introduction

Many councils have multiple data stores – each established for different systems. Data in these stores are generally available only to a limited group of people within a department.

As a result, it is very difficult to find new uses for existing data and to coordinate data across "silos". Although data can be shared between systems and departments but this of often done manually and is time consuming.

Current Examples:

- Existing CCTV cameras – It is difficult to share on a common platform as they were typically installed and operated by different departments, different systems, etc.
- Existing asset management systems and GIS systems – Platforms are not integrated, so it's difficult to gain a complete view of infrastructure and how they relate to environmental, land use, and other factors.

Data can be shared internally (within council) and externally (with partner organisations or the community).

External data sharing may be to support inter-council collaborations, coordination with government agencies and emergency services or with the general public. Some councils will also consider sharing data to foster innovation and the development of new services by citizens, universities and companies in their communities.

Best Practise Recommendations

- ❑ **Establish enterprise data storage** (data warehouse, data lake or data "lakehouse") to enable data sharing within council. Data storage can be in-house, cloud based or a combination of these.
- ❑ **Establish master data management practices** (based on DAMA DMBOK), with appropriate data architecture to integrate asset management, GIS and other related systems.
- ❑ **Integrate external data feeds** (BoM, NSW government LandIQ, heat mapping, etc.) so that internal planning and decision support tools can take advantage of these data sources.
- ❑ **Establish an internal data catalogue** available to internal stakeholders with descriptions of data sources, their primary purpose, owners, etc.
- ❑ **Define access permissions** policy and administrative processes. In some cases, useful subsets or extracts of databases that contain confidential or personal information can be made available to internal users. Refer *3.2.5 – Data Privacy.*
- ❑ **Establish a data sharing policy** describing what data can be shared, the platforms required to enable this and how access permissions should be set. It is important to keep data current – the Data Governance function can monitor this
- ❑ **Procure external data sharing platforms** that support different levels of access to data such as open (for all to access) and restricted access for specified groups of users and organisations.

- ❑ Procure data sharing platforms that include **data transformation functionality** for example to achieve consistent representation of information regardless of how the data sources represent that information. A simple example is the ability to show dates in a consistent manner.

Council Spotlight

Camden City Council's Open Data Policy & Open Data Standard ensures that Privacy Impact Assessments are conducted as part of the process of approval a dataset to be published or made available to the community externally.

A five-step process is used to assess potential privacy impacts before publishing open data sets on council's publicly facing data portal.

Additional Resources

- The NSW Government has published data sharing principles, a data sharing agreement template and a data sharing checklist – https://data.nsw.gov.au/data-sharing-principles
- The Australian Computer Society's has numerous publications relating to data sharing including "Framework and Controls for Data Sharing", February 2023 discusses privacy and sensitive data in the context of data sharing. – https://www.acs.org.au/insightsandpublications/reports-publications/Industry_Insights_Frameworks_and_Controls_for_Data_Sharing.html

3.3.4 Digital Engineering

Introduction

All projects generate data as they progress from requirements to design, implementation and then to operations. These can be specifications, as-built documents and data about equipment installation and maintenance. Often this data is generated by and used by different organisations both internal to council and external.

To address the challenges associated with project data management, digital ways of working are now emerging in the construction sector that aim to improve project controls, enable greater cost certainty and deliver a step-change in project delivery. The most commonly

promoted solution has been the use of data-rich 3D models, otherwise known as Building Information Modelling (or BIM).

The emergence of BIM has provided new, more visual ways of working, that have significantly improved the design coordination and information management. BIM-centric concepts such as 4D BIM (i.e. 3D BIM Model + project schedule) or 5D BIM (3D BIM model + cost breakdown) have been adopted by industry to describe new capabilities, develop new methodologies and achieve smarter design outcomes.

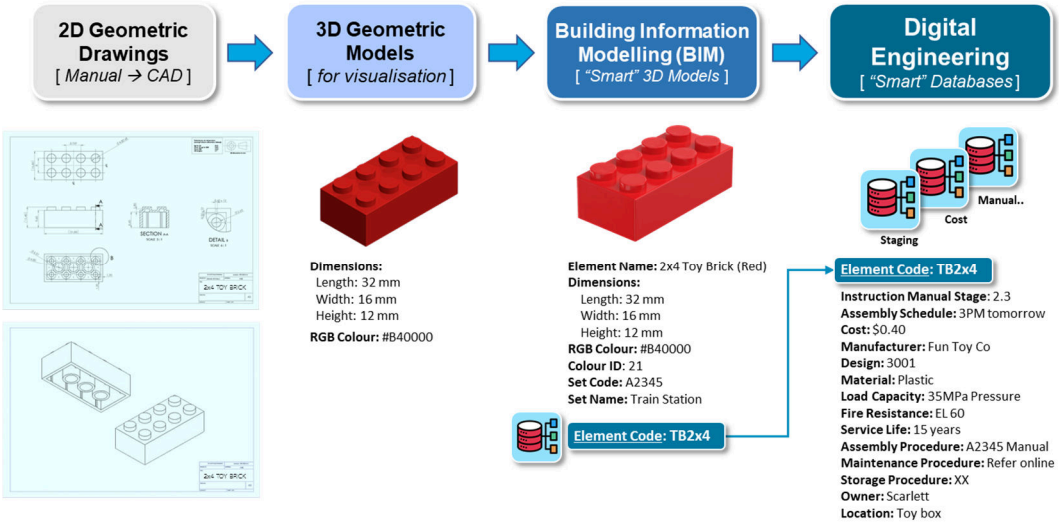


Figure 3.1: The evolution of design processes

While BIM has been a catalyst for change and improvement, the infrastructure sector is now looking at the next stage in the evolution of project/asset data management – that extends capabilities beyond BIM. As presented above in Figure 3.1, the next stage of development is known as Digital Engineering (or DE).

DE is defined as a collaborative way of working, using semantic data management, to enable more productive methods of project delivery and asset management.

DE relies on standardised data architecture, through the use of agreed data models (or entity-relationship diagrams), together with formally agreed data dictionaries, to represent all aspects of physical infrastructure and support all activities over the complete asset lifecycle. It is important to note that data modelling is not like other forms of digital deliverables such as laser scanning, GIS or BIM. These forms of models use consistent data architecture with semantic interoperability, to ensure all datasets are machine-readable, and can be managed, exchanged, federated, and re-used in an ecosystem of linked databases.

DE enables data integration across all stakeholders, creating a digital thread, supporting process automation, and allowing data to be managed more effectively as an asset. Referring below to Figure 3.2, this provides a high-level representation of the digital thread.

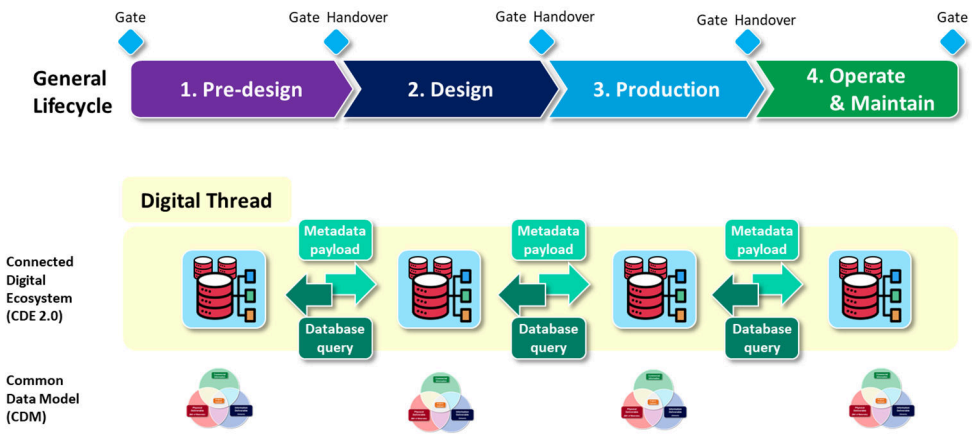


Figure 3.2: Building the digital thread over the complete asset lifecycle

The digital thread enables full traceability of data over the complete asset lifecycle – and provides the foundation for more advanced concepts such as the digital twin. The first essential step towards building the digital asset lifecycle is the establishment of consistent DE.

Best Practise Recommendations

DE can be implemented on a project-by-project basis; however this will most likely result in electronic deliverables that are interoperable and cannot be associated or queried without a considerable amount of time and effort. Most critically, the project-by-project approach will not resolve the greater data management challenges that most councils currently face.

Best practise DE is not achievable through quick fix, and may instead require a concerted efforted by councils to strategically improve internal business processes, data standards and related technology, digital literacy etc.

Council Spotlight

Spotlight your council's Digital Engineering experiences and practises here!

Additional Resources

- **Australian Standard AS 7739.1:2023 Digital engineering for fixed rail infrastructure Part 1: Concepts and Principles** – this new standard will be published in March 2023, and is the first in a suite to be released by RISSB. While the title refers to rail infrastructure, most of the contents is generic and may assist councils in developing their own DE strategies. The Part 2 standard is currently under development and once released will provide more specific details on how to create a common data model and associated data dictionary, which are essential components for enterprise DE strategies.

3.3.5 Seek External Perspectives and Input

Introduction

Most councils recognise the need to build expertise and knowledge in digital technologies and all at are different stages of their Smart Infrastructure journeys. In many cases a council may have relatively mature capabilities in some respects but less so in others.

Engaging with external organisations and experts brings new perspectives and knowledge that can benefit councils in all aspects of smart infrastructure.

Best Practise Recommendations

- **Build Communities of Practise.** In addition to internal groups and steering committees as described elsewhere it is important to engage with other councils and organisations. It is important to recognise that community of practise operate on the basis that the value one gets from it is proportional to the effort one puts into it.
- **Community Engagement**. Communities often will include people with knowledge and perspective they are willing to contribute if they see it will be benefiting their community. Direct engagement with communities or via organisations such as chambers of commerce are ways that councils can tap into this resource.
- **Establish a Smart Infrastructure Advisory Group**. Some organisations recognise the value in external perspectives and are beginning to establish advisory committees where external experts are invited to critique and provide constructive feedback on council smart city and digital strategies.

Council Spotlight

Parramatta Council has established an independent smart city advisory group to provide external perspectives and critique council's "smart" strategy and initiatives.

Advisory group members have complimentary skills and experience to council staff and act as a "sounding board" to council.

4. Part C – Procurement Approach

Smart infrastructure requires upfront and ongoing investment in technology, support and skills. It is important that these investments result in benefits for council and the community, and that the costs are well understood.

This section describes approaches that councils can use to plan for, pilot, procure and operate smart infrastructure.

4.1 Scope of Smart Infrastructure

New developments and precincts provide an opportunity for smart infrastructure to be designed and implemented or at least planned for during construction. Planning upfront is less disruptive and costly than retrofitting smart technology after development is complete.

Specific examples of smart infrastructure that should be considered for new developments include:

- Ensuring adequate underground conduit is in place to carry fibre and power ("pits and pipes")
- Installing fibre optic communications infrastructure
- Ensuring adequate power is planned for to cater for expected smart infrastructure developments, including IoT sensing, EV charging, stormwater recycling, etc.
- Installing wireless data communications transceivers and infrastructure for public Wi-Fi
- Installing internet of things data communications infrastructure (for example LoRaWAN)
- Installing multifunction "smart" light poles
- Installing smart irrigation – sensing and controls
- Installing environmental monitoring – air and water quality, heat
- Planning for current or future "microgrids" and neighbourhood power systems
- Planning for and installing stormwater water recycling.
- Installing parking sensors
- Planning for and installing EV chargers.
- Installing Smart Bins

4.2 Pilot Projects

Pilot projects are a common way to trial or evaluate new approaches. Although they are often positioned as "technology trials", the objectives of pilots should include the assessment of potential organisational impacts and retirement of some operational risks. If done well, then transitioning to business as usual (BAU), post pilot should be a relatively straightforward process with no major surprises.

Whether planning a new pilot project or evaluating an existing smart infrastructure pilot councils should consider:

- Expected, measurable benefits to council and the community.
- The questions the pilot should aim to answer – these may relate to the businesses case, operational impacts, or technology functionality.

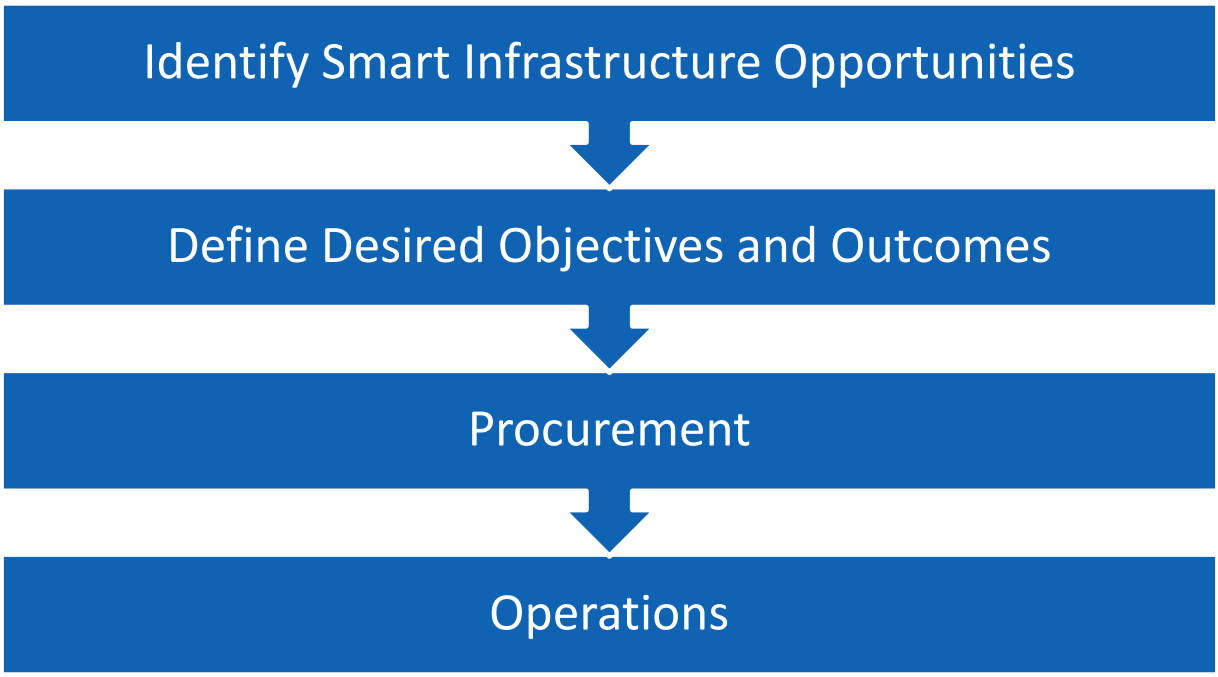
- How well the pilot objectives have been defined (and how well they have been met)
- Whether funding has been identified to operate the smart infrastructure solution post-pilot
- The key elements of a business case needed to expand beyond pilot to BAU.
- Whether council has the internal skills and resources to transition from pilot to BAU
- The likely scope of a change management program if transitioning to BAU

Appendix B: Smart Infrastructure Pilot Evaluation Template develops these points into an easy-to-use template for councils.

4.3 Procurement Approach

The overall approach described here applies whether procuring a specific type of smart infrastructure or smart infrastructure for an area such as park, neighbourhood, precinct or at broader scale such as across an LGA.

There are four key steps to this approach:



4.3.1 Step 1 - Identify Smart Infrastructure Opportunities

The first step is to identify the types of Smart Infrastructure to be considered. Consider the various types of existing physical infrastructure or physical infrastructure to be built, including roads, parks and buildings, which are all candidates for smart infrastructure.

Opportunities for smart infrastructure may be stated in council strategies or policies, specified in planning or design documents, or arise “organically” through innovation initiatives within council departments and with external collaborators.

Even if not stipulated in council strategy and objectives, smart infrastructure investment opportunities must be aligned with them.

In general, any given type of smart infrastructure aligns with one or more of the following five key investment drivers described in S*ection 0 –" Why Would Local Government Invest in Smart Infrastructure?:*

- Improved Efficiency and Cost Reduction
- Improved Asset Planning and Management
- Improved Resident and User Experience
- Environmental Sustainability and Resilience
- Improved Decision Making and Planning

4.3.2 Step 2 - Define Objectives and Outcomes

Regardless of how the smart infrastructure has been identified it is important to clearly define the expected outcomes of any smart infrastructure deployment.

In this step the broad benefits identified in Step 1 are defined in terms that are meaningful to the various stakeholders – both internal and external.

Initially these outcomes may be qualitative – for example "increase the frequency of roadside asset inspections". Before committing resources however, they should be quantified in measurable terms. For example: "increase the frequency of asset roadside inspections for all roads to monthly". These are sometimes referred to as "performance outcomes" and are included in procurement documents, pilot project documents and business cases.

This table lists examples of objectives and outcomes for different types of smart infrastructure:

Table 4-1: Smart infrastructure objectives and outcomes

Physical Infrastructure	Smart Infrastructure Type	Objectives	Example Performance Outcomes
Public Spaces	Public Wi-Fi	Enable digital inclusivity for residents	Wi-Fi services will be available at all locations in all public parks and urban centres.
Public Spaces	Multi-Function Poles	(1) Support safety and environmental outcomes (2) Sensors provide insights into use of public space (3) Smart lighting reduces energy consumption	All public spaces will have multi-function poles installed where light poles are required with provision for sensors that can be added in future
Public Spaces	EV Charging	Support environmental sustainability	10% of parking spaces in carparks will be equipped with EV chargers and the electrical infrastructure to support them.
Stormwater	Pit Monitoring	Minimise Asset management cost	Stormwater pits to be equipped with pit monitoring technology that provides hourly depth readings.
Road Pavement	Vehicle Mounted sensors	Minimise Asset management cost	All roads to be inspected at least monthly

4.3.3 Step 3 – Procurement

The Smart Infrastructure procurement step includes:

- Defining detailed requirements that may relate to council existing ICT polices and infrastructure,
- Ensuring that digital infrastructure will be in place to support the new smart infrastructure,
- Ensuring that data ownership, cybersecurity and other unique aspects of smart infrastructure described elsewhere in this manual are included in procurement documents.
- Procuring operational services such as solution maintenance and technical support
- Validating that what is delivered is acceptable and complies with requirements.

Direct vs Indirect Procurement

If council will be acquiring solutions directly, they can be specified at this step as part of a request for tender process. Refer *Part D – Specific Smart Infrastructure Types* for more detail on specific types of Smart Infrastructure. That section also provides some guidance on the various data and digital infrastructure required to support each type of smart infrastructure.

If council is not procuring the solution directly but is procuring "outcomes" then these should be written into Development Control Plan, Condition of Consent or other instrument. Developers are then expected to propose solutions that meet the performance outcomes and requirements defined in Step 2. It is up to the developer to find and propose suitable solutions.

Vendor Selection

As with other procurement there are many factors to take account when selecting vendors. As with other procurements product and service range, Experience, track record, reputation, ability to deliver and ability to respond to queries and issues are some of these factors. For smart infrastructure solutions councils should also question vendors about their approaches to data, privacy security and the unique aspects of smart infrastructure described in this manual.

Some councils are considering acquiring solutions from international firms. In these cases, councils should request that vendors clearly state:

- whether their products are compliant with relevant Australian Standards,
- where their solutions have been deployed in similar settings in Australia or other countries
- how are warranty claims made and what is the turnaround time if a faulty product has for example to be returned by council to a regional depot in (say) Singapore before a replacement is sent
- how the vendor proposes to provide technical support during Australian time zones particularly for solutions requiring high reliability
- are their local representatives to assist with demonstration, installation and operational support
- where data is hosted. Some organisations are uncomfortable having their data stored in a data centre in the USA as the US government can request access to any data

stored there. Some vendors allow the customer to choose which country data is stored in.

- can the vendor provide Australian pricing and fixed service pricing in Australian dollars, so council is not exposed to currency fluctuations

Being Informed

Whether council is procurement directly expecting others to do so it will benefit from staying abreast of the latest developments in smart infrastructure solutions and technology. Time spent doing research and attending information sessions and conferences is well spent. Collaborating with other councils is also a great way to share the load. The group can assign one or more aspects of smart infrastructure to each council. They then build their knowledge and report back to the group.

Solution Acceptance

Many aspects of smart infrastructure solutions are technical in nature. Much of the technology is also new and continually changing. For these reasons there are not the same trained certifiers available as there may be for existing when approving construction building works.

There is no simple answer as to how councils can be confident that they are getting what they asked for. Some approaches to be considered include:

- Ensure that acceptance plans refer back to the outcomes identified in step 2 and the specific requirements from this step.
- Request that suppliers provide suggested acceptance test plans and have those plans reviewed by an independent body or third party with experience in that field.
- Find an independent company able to undertake an acceptance test on behalf of council. This may be via a request for proposal process.
- Discuss with other councils to identify how others have addressed this need.

4.3.4 Step 4 – Operations

Smart Infrastructure has many of the same operational considerations as enterprise IT systems. Technical support, ongoing configuration management, system updates and training are all required and must be specified and procured in Step 3. Often these are framed as service levels and Service Level Agreements (SLAs) are put in place with providers to ensure that operational services are delivered with the required scope, quality and timeliness.

Unlike enterprise IT systems, however there are components of smart infrastructure that are deployed in the field. This brings with it other considerations including:

- Exposure of equipment to the weather, accidental damage, flooding, fire and vandalism. If replacement equipment is needed, then how will that be paid for and is their budget for it?
- Potential data privacy risks and cybersecurity risks (as outlined elsewhere in this manual)
- Being clear about responsibilities council has and which suppliers are expected to do.

- Impact on digital infrastructure. For example, large numbers of IoT devices or users may place additional demands on operational support staff and infrastructure.
- Including smart infrastructure in council's asset register and asset management programs

Although listed here in Step 4 – these may have an impact on procurement and must be considered in the previous step.

Council Spotlight

Spotlight your council's smart infrastructure procurement experiences and practises here!

Resources

- NSW Smart Infrastructure Policy
- Wollondilly "Wilton 2040" DCP Conditions of Consent for Smart Places
- The "Smart Places" section of the Aerotropolis DCP (page 111) provides examples of Objectives and Design requirements.

5. Part D – Specific Smart Infrastructure Types

This section provides information and guidance on several types of Smart Infrastructure:

- Smart Bins
- Automated Detection of Road Defects
- Electric Vehicle Charging
- Smart Buildings
- Environmental Monitoring

5.1 Smart Bins

5.1.1 Description

"Smart Bins" contain a sensor to detect the level of rubbish within them and often include a mechanism to automatically compact the rubbish in the bin to increase time between collections.

They monitor their capacity and will transmit that wirelessly to an app or website.

They are generally intended to be used in public spaces such as parks and town centres.

5.1.2 Benefits

Smart Bins are primarily used to reduce waste collection costs and improve amenity in public spaces.

Smart Infrastructure Drivers				
Improved Efficiency and Cost Reduction	**Improved Asset Planning and Management**	**Improved Resident and User Experience**	**Environmental Sustainability and Resilience**	**Improved Decision Making and Planning**
Reduce waste collection costs		**Reduce overflowing garbage in busy public space**		

Waste collection costs are reduced in two ways. Firstly, many bins contain an automatic mechanism that compacts rubbish thus increasing the volume of rubbish collected between collections. Secondly, the bins provide data about how full they are that enables waste to be collected only when bins need emptying. In some cases, unnecessary overtime can be reduced through more efficient waste collection scheduling.

Amenity of public spaces is increased by reducing the number of overflowing bins. This is particularly the case when public usage of a space may be unusually high due to an event and bins may need emptying more frequently.

5.1.3 Digital Infrastructure Requirements

Smart bins communicate data back to council using wireless data networks. LoRaWAN, cellular (4G or NB-IoT) and Wi-Fi are all suitable. Actual wireless communications options will vary by solution provider. Refer *section 6.2- Wireless Data Communications* for more information.

Smart Bins are designed to be self-contained units and are typically solar powered, so no external electricity supply is needed.

5.1.4 Procurement

When procuring smart bin solutions consider:

- **Data Ownership**. The data provided by bins is useful to inform waste collection operations on a day-to-day basis, it can also be used for historical analysis to aid in planning future services. Procurement should ensure that vendors agree that councils own the data and that vendors will make it easily available. Ideally it would be made available via an API so that data transfer can automated.

5.1.5 Creating Impact

As with other examples of smart infrastructure fully realising the benefits of smart bins requires a change in business processes.

In the case of smart bins, councils should consider:

- **Updating waste collection scheduling** and rostering to use smart bin information. They should take into account whether bins actually need emptying, including considering active scheduling of bin collection via mobile apps.
- **Waste collection service agreements** with contractors should be updated at renewal to discourage unnecessary collections (i.e.: when the amount of rubbish in a bin is less than an agreed amount).
- **Monitoring waste collection services** for example by alerting when bins are emptied unnecessarily (and potentially at unnecessary cost).
- **Adding smart bins to the council's asset register** and ensure that periodic maintenance is undertaken according to manufacturer recommendations.

In addition to their basic functionality Smart Bins can add additional value in several ways:

- Some councils use bins as a canvas to display community created art.
- Bin monitoring data can be analysed to provide insights into when and where people are using public spaces.
- Include Bluetooth Receivers. Some smart bins include additional functionality such as included Bluetooth receivers that can provide useful information about pedestrian traffic in the vicinity of the bin. This works by detecting and reporting the presence of nearby smartphones. Note that roadside bins may count people in vehicles as well as pedestrians.

5.1.6 Council Spotlight

Blacktown Council has undertaken a successful smart bin pilot. The pilot was initially in response to community complaints to a councillor about overflowing bins. A small pilot was undertaken involving 6 bins. Not only have customer complaints stopped but the council has saved money in waste collection costs. Council is now deploying more smart bins.

5.1.7 Additional Resources

Many other councils in Australia have implemented smart bins include Campbelltown and Ryde councils.

5.2 Automated Detection of Road Defects

5.2.1 Description

This technology uses cameras (like a GoPro or a mobile phone) and/or other sensors, that are mounted onto the front of council vehicles that drive the local road network on a frequent and regular basis (e.g., garbage collection trucks, inspector or ranger vehicles etc)

The solution then combines the video footage with Artificial Intelligence (AI) (using machine learning (ML)), to automatically identify road defects and assess road condition in accordance with standards.

The resulting road condition surveys are relatively cheap, automated, frequent and replace the need for less frequent manual visual inspections.

5.2.2 Benefits

- Reduce the need for manual road defect identification and measurement.
- Reduce risk of poor-quality inspections due to human error or oversight
- Increase frequency of asset condition assessment (weeks instead of years)

- Early detection of potholes and other road surface issues
- Improve movement and place infrastructure to the community.

Smart Infrastructure Drivers				
Improved Efficiency and Cost Reduction	Improved Asset Planning and Management	Improved Resident and User Experience	Environmental Sustainability and Resilience	Improved Decision Making and Planning
	condition based asset maintenance			

5.2.3 Digital Infrastructure Requirements

5.2.4 Procurement

- contracted as a service by providers with council received road condition reports.
- technology purchased by council and installed on council owned or sub-contracted garbage trucks.
- Ensure council owns and stores both the raw video and the condition assessment data to enable future data analysis (even if the provider is no longer engaged by council)
- Data should be automatically uploaded to data storage.
- Data provided to council in a geotagged format to be compatible with council's GIS system.
- Conduct a data privacy assessment as image-based systems may collect images of individual people and personal information such as vehicle licence plates.

5.2.5 Creating Impact

- Providers should provide a mechanism for seamless and automated data transfer to council.
- Data to be stored in council enterprise data store for internal data sharing.
- Update road inspection and maintenance procedures to take advantage of the new technology.
- Include a commitment to measuring and reporting KPIs in the business case - reduced customer complaints, fewer serious defects repair, less overtime for reactive repairs.
- Integrate data from road condition assessment with customer reports and complimentary services such as Google's "Waze for Cities" program.
- Plan for future data analysis such as development of predictive/optimised road maintenance approaches
- Ensure solution is capable of "scanning" roadside furniture and other assets.

5.2.6 Additional Resources

- Asset AI – This NSW Government is expected to be available to all LGAs in late 2023
- IPWEA Paper - Automated Detection of Road Defects (July 2021)
- Moreton Council have recent experience with this type of smart infrastructure

5.3 Electric Vehicle Charging

5.3.1 Description

Electric Vehicles (EVs) will play a critical role in halving NSW's emissions by 2030 and achieving net-zero emissions by 2050. The NSW Government's EV Strategy is aiming to drive sales of EVs to more than 50% of new car sales by 2030-31 and to prepare the NSW road network for a low-emissions future. With the increasing number of EVs on the roads a key concern for potential EV owners is the availability of EV charging. There is an overwhelming preference to charge at home overnight or at workplaces during the day because this is where cars are already parked.

Electric Vehicle Supply Equipment (EVSE) is the hardware that delivers energy, from an electricity source, to charge an EV battery. It is often referred to as the charging station and sits outside of the car, or as part of a charging cable. The charger in the car converts power entering the car from AC to DC. Faster EVSE that use DC power do not require an internal charger as the power is directly fed into the battery without requiring conversion.

There are different charging levels, which refers to the amount of power delivered to a vehicle. Level one is the lowest and Level four & ultra-fast charge is the highest. The table below outlines the different levels of vehicle charging[1]:

Level	Power	Range added / hour	Charging time	Typical application
Level 1 – single phase (domestic)	2.4-3.7kW	10-20km	5-16 hrs	Home
Level 2 slow – single phase (domestic or public)	7kW	30-45km	2-5 hrs	Home, work, shopping centres, car parks
Level 2 fast – three-phase (private or public)	11-22kW	50-130km	30 mins-2 hrs	Home, work, shopping centres, car parks, Urban roadside
Level 3 – fast charge (public)	50kW	250-300km	20-60 mins	Regional near highways, motorways and key routes
Level 4 – super-fast charge* (public)	120kW	400-500km	20-40 mins	Regional near highways, motorways and key routes

Level	Power	Range added / hour	Charging time	Typical application
Ultra-fast charge (public)	250kW	1000+km	10-15 mins	Highways and motorways

Note: Level 4 super-fast charging is also commonly referred to as rapid charging. In terms of the types of charging connections, most car companies with EVs provide the standard 10-Amp plug (a standard home plug) as a minimum charging option. However, there are different types of plugs being adopted by different manufacturers. In Australia the standard plugs that are used are Type 2 (Mennekes) plug for AC charging, and both the Combined Charging System (CSS) and Charge de Move (CHAdeMO) for DC charging. Note that the Tesla supercharge stations only service Tesla vehicles due to a Tesla proprietary plug.

For NSW Government the provision of fast charging stations at prioritised locations across NSW is a key action under the NSW Electric Vehicle Strategy.

[1] https://www.transport.nsw.gov.au/projects/electric-vehicles/charging-an-electric-vehicle

5.3.2 Benefits

The aim of the NSW Government EV Strategy is to increase sales of EVs to more than 50% of new car sales by 2030-31, which means that the demand for EV charging will increase significantly over the next 10 years. Councils need to be prepared to deal with the introduction of EV charging stations in a managed and consistent manner.

Smart Infrastructure Drivers				
Improved Efficiency and Cost Reduction	**Improved Asset Planning and Management**	**Improved Resident and User Experience**	**Environmental Sustainability and Resilience**	**Improved Decision Making and Planning**
Optimised installation and ongoing management cost of EV Charging Stations	**Appropriate decisions on EV Charging infrastructure (type, location, etc.)**	**Accessibility to EV Charging Stations**		**Informed decision making on type, location and lifecycle cost (value for money) of EV Charging Stations**

5.3.3 Digital Infrastructure Requirements

As more EV charging stations options are available, choosing the right option is becoming increasingly difficult. The many features and options can make the idea of installing EV charging challenging.

The simplest and most cost-efficient solution is the installation of a “dumb” station. A “dumb” EV charging station is a non-networked device that only serves as a power source. These stations lack the hardware and software needed to connect to the internet. This means that they can’t process credit card payments or communicate with tracking software and mobile apps, etc.

In most cases, the better option is to install networked, or “smart,” EV charging stations. Unlike “dumb” stations, smart chargers can connect to a cloud-based network and charging software. This gives station owners access to advanced tracking and access control, etc.

To assist with these decisions on charging, NSW Government provides two guides on how to prepare facilities for EV Charging:

- Preparing a commercial building for EV charging (weblink)
- Preparing a residential strata building for EV charging (weblink)

These guides provide information on the proposed approach to assess the infrastructure requirements of the site or building, with a key focus on the supply of electricity. In addition, these guides also provide guidance on engagement of stakeholders, charging station options, as well as funding and cost recovery mechanisms.

5.3.4 Procurement

Procurement can be classified into two main categories:

- Standalone charging stations (roadside, carparks, etc); and
- Integrated charging stations (installed into commercial or residential buildings).

Many sites and buildings are not yet ready for EV charging and will need to install appropriate infrastructure to deliver the most convenient and practical charging option. NSW Government provides guidance information on the best approach to adopt EV Charging for residential and commercial buildings. Both types of buildings can be adopted through either an individual or collective approach, where:

- An individual approach follows an incremental approach driven by individuals / single entities to establish charging facilities, or
- A collective approach follows a more integrated approach to gain approval from all building owners and/ or users, to establish charging facilities to the benefit of all building users.

NSW Government created a tool to help interested parties understand the cost of retrofitting electric vehicle (EV) infrastructure into buildings. Its aim is to help define the cost of the charging equipment, as well as the related infrastructure upgrades that may be necessary. Following confirmation of the charging requirements, suppliers can be engaged through an approach to the market. To effectively use the costing tool the following site-specific information (including measurements) is required:

- carpark floor plans,
- number of carpark spaces in the building / at the location,
- trenching requirements (metres),
- cable trays required (metres),
- sub-mains required (metres), and
- final circuits required (metres).

Based on the outcomes from the cost estimating process, councils have two main options to engage with suppliers in relation to the supply of EVSE:

- Obtain quotes for turnkey solutions from EV charging operators (a single party is awarded the entire contract, usually with affiliated subcontractors). NSW Government provides a list of prequalified suppliers - https://www.transport.nsw.gov.au/projects/electric-vehicles/charging-an-electric-vehicle/providers; or
- Appoint independent electricians or contractors to install the necessary EVSE (multiple vendors are appointed to carry out different project tasks).

There are advantages and disadvantages to both these options, as outlined in the table below.

Suppliers	Advantages	Disadvantages
EV charging operators	• There is only one accountable party to manage. • EV charging operators are more likely to have experience in EV-specific design and construction, especially on complex projects, involving concrete trenching, coring, and repair work. • EV operators will often offer preliminary advice and even a quote as complementary service. • They may offer billing and charging management services as part of their package.	• Expect to pay a premium for this service.
Independent electrical contractors	• Incumbent electricians are familiar with the building. • Potentially more cost-effective. • Greater contracting flexibility without being locked into a single vendor. • Allows the use of contractors that are a known entity. • Ability to select the best vendor for a given project component, including a higher level of control over the solution.	• Increased responsible entities (and points of contact) may lead to risks in the integration and maintenance of the separate systems. • Additional time required to become familiar with the technology. • Challenge of balancing availability and decision making amongst multiple contractors.

As more electrical contractors become familiar with EV charging technology, the risks of appointing non-specialist independent contractors will reduce.

To make the process of engaging suitable suppliers easier, NSW Government has established a prequalification scheme for NSW Government Electric Vehicle Fleet Charging Infrastructure (SCM13381). The scheme can be used by:

- Agencies and NSW state-owned corporations,
- Local and federal government entities, and
- Eligible non-NSW Government buyers (eligibility can be confirmed on the buy.nsw.au website).

The prequalification scheme provides a range of documentation to assist with engaging a supplier, including:

- a list of prequalified EVSE suppliers,
- the Scheme Conditions,
- a standard form agreement template, and
- an EVSE Specification template, which covers standard requirements for the provision of:
    - EVSE Goods
    - EVSE Works
    - EVSE Services (Maintenance Services)

Note that the scheme also provides for the option of Charging-as-a-Service (CaaS), which is where an EV Charging Service Provider is paid for the use of an EVSE installed, operated and maintained by the Service Provider.

5.3.5 Creating Impact

To get the maximum benefit from EV Charging, it is important for councils to understand the role that they can play, including:

- ❑ Improving awareness and local leadership on EV charging within local council areas
- ❑ Improving capacity and capability on EV charging within local councils
- ❑ Implement mechanisms for sharing knowledge and materials on EV charging (including lessons learned) across local councils.
- ❑ Exploring what role councils can play in providing on-street charging, including being clear on funding options, etc.
- ❑ What role councils can play in transition their own fleet of vehicles to set the example in the local community.

Typically, local councils require support and guidance on the following topics, including on:

- ❑ Procurement, including best practice and template documents (see other sections for supporting information)
- ❑ Use of data, including sharing of demand models and existing local council data sources that can be used.

- ❑ Training and education of local council and the community on issues relating to EV (including charging requirements and options).

5.3.6 Additional Resources

- NSW Electric Vehicle Strategy - https://www.nsw.gov.au/initiative/nsw-governments-electric-vehicle-strategy
- Electric Vehicle Fleet Charging Infrastructure Scheme (SCM13381) - https://info.buy.nsw.gov.au/schemes/ev-charging-infrastructure-scheme
- Australian Charging Station Suppliers - https://www.transport.nsw.gov.au/projects/electric-vehicles/charging-an-electric-vehicle/providers

5.4 Smart Buildings

5.4.1 Description

Smart buildings use Internet of Things (IoT) devices including sensors, software, online connectivity to monitor various building characteristics, analyse the data, and generate insights around usage patterns and trends that can be used to optimise the building's environment and operations. While smart technology provides greater control over a building, smart building technology is much more than just advanced "command and control" mechanisms, such as building management systems (BMS). Typical components that are found in smart buildings include:

- Smart heating, ventilation, and cooling
- Smart lighting systems
- Smart security
- Air quality monitoring and control
- Occupancy monitoring, and
- Virtual assistants

It's also worth understanding the difference between smart building technology and a traditional BMS:

- BMS can typically be programmed to control a building's HVAC system at specific times daily (turn on and off) based on predefined temperature levels.

- Smart building technology provides more control over the operation of the HVAC system. For example, it can direct the BMS to turn the HVAC on and off as needed throughout the day, by measuring CO2 levels in real time. If CO2 levels are in line with building guidelines, the system automatically reduces the outside air intake. If CO2 levels are approaching the limit, it brings in additional outside air. Smart building analytics platforms can also factor in data from utility companies and weather data along with the building's HVAC operating data to help define ways to reduce operating costs on a hot day. Having this degree of control over a building's HVAC system results in saving energy and money, while still maintaining a comfortable environment for occupants.

Smart building technology does not replace a building's existing BMS. Smart building systems work in conjunction with a BMS, allowing the owner to better understand and control the building by monitoring building functions in real time, analysing building data, and automating operations more strategically to optimise operating a building.

5.4.2 Benefits

Smart buildings go beyond the concept of automation, which is a key feature of IoT. A smart building system must be able to evaluate the data it gathers from sensors and automatically be able to act on the data, for example being able to activate a sprinkler system without human intervention if there is a fire or automatically adjusting window blinds when the temperature and / or lighting levels exceed comfortable levels.

Smart Infrastructure Drivers				
Improved Efficiency and Cost Reduction	**Improved Asset Planning and Management**	**Improved Resident and User Experience**	**Environmental Sustainability and Resilience**	**Improved Decision Making and Planning**
Optimised building operation reducing energy consumption and operating costs	**Optimised asset management, through predictive maintenance**	**Improved building environment and user experience to create a comfortable living or working environment**	**Optimised energy consumption and passive building management resulting in more sustainable and resilient buildings**	**Access to data and analytics support more strategic decision making on building operation and ownership**

Benefits of smart buildings include:

- Lower operational costs:
    - A smart building can, for example, leverage data it collects to reduce use of electric lighting by adjusting shades to let in more natural light. Such lighting management has been proven to lower power usage. It also helps buildings become more energy-efficient to meet greenhouse-gas emission targets.
    - Smart-building data can also support automated scheduling, from parking-space allocation, workspace assignment to conference room reservation.
    - Wireless technologies can reduce personnel costs in commercial buildings, for example sensors can activate lighting and sprinklers instead of needing to be turned on or off by a building manager. In smart buildings, safety equipment such as fire extinguishers and CCTV cameras can be monitored remotely.
- Energy efficiency - lower energy costs:
    - Similar to installation of green roofs and use of sustainable construction materials the use of digital technologies that intelligently regulate how energy is (and isn't) used can go a long way toward decarbonising buildings. For example, a recent study found that buildings with green HVAC systems

managed by a smart building energy management system resulted in an average 7.7% reduction in power consumption.

    - Connecting lighting, shades, and HVAC systems enables building operators to automatically adjust temperature, shades, and lighting based on time of day and occupancy.

- Greater flexibility – increased liveability:

    - Smart-building data can be used, for example, to detect changes in occupancy density. The building's HVAC systems can then adjust airflow, humidity, and temperature appropriately, or based on exceeding occupancy thresholds, lighting colour could change to indicate too many people in a conference room, workspace, or building.

- Improved building condition monitoring - predictive maintenance:

    - Building condition monitoring generates insights into the health of a building and how it is used, which can be used to optimise building operations, improve the living environment for residents, and reduce the operating cost for the building owner.

    - Data captured by the building's IoT sensor arrays can be transformed into actionable information about the performance of a structure's various systems and when they require maintenance. The majority of a building's vital functions are invisible to the occupants, be it the HVAC ducts, plumbing, or electrical lines. In a smart building, every component within these systems can be monitored remotely and flagged when there's a problem.

    - Smart building monitoring tracks building assets, records resource consumption, identifies unexpected damages and equipment failures, maintains optimised maintenance schedules, and alerts relevant authorities about problems in and around a building.

- Increased resale value:

    - By utilising smart technologies, the resale value of smart buildings and properties can be increased.

5.4.3 Digital Infrastructure Requirements

While there is no strict criteria or established checklist for what makes a building smart, the following digital infrastructure components typically make up a modern smart building:

- **Sensors** - technology hardware in the form of sensors, which is embedded into the physical environment of the building. These sensors can be used for everything from security, lighting, and temperature control to actionable data capture.

- **IoT Connectivity** - every key building system, from heating and cooling to lighting and security, is part of a local IoT network that can be accessed and controlled remotely (via wi-fi in many cases) on a single, centralised, and cloud-based digital platform.

- **Data** - buildings generate lots of data, and in standard buildings this data is untapped, evaporating as soon as it is produced. In smart buildings, however, this data can be captured with in-house information and communication technology (ICT) and used to extract valuable insights that guide decision-making. Machine learning algorithms may also be used to track and analyse big data, analysing through datasets that might otherwise go unnoticed.

- **Visualisation** - cloud-based platforms like Building Information Modelling (BIM) software can be deployed in smart buildings to visualise and monitor the building's vital functions through the course of its life cycle. The 3D models can be used to identify, track and optimise a building's carbon footprint.

- **Automation** - automation is the key to "smartness", i.e., the programmable IoT systems of a smart building have the ability to function at least somewhat independently of human intervention, making automatic adjustments to heating, cooling, lighting, ventilation, and security within a range of dynamic settings.

More technical details of some of the key technologies used in smart buildings include:

- **IoT devices:** An IoT device has the capability to connect to the internet, either wirelessly or using a wired connection. In smart buildings IoT devices are usually, but not always, wireless. IoT devices integrates with technology that supports network connections, with functional software like APIs, and with sensors and actuators.

- **Smart building communications:** The communication layer in a smart building technology stack includes connectivity technologies such as cellular or Low Power Wide Area Network (LPWAN) and also communication protocols such as Zigbee or Message Queuing Telemetry Transport (MQTT). Zigbee and MQTT are data protocols:

    - Zigbee is a short-range, low-power, wireless standard used in mesh topology to relay sensor data over multiple sensor nodes. Zigbee is often used in smart homes and for remote equipment management in buildings.

    - MQTT is the de facto standard for IoT communications to ensure that all data communication between devices is encrypted and secure. MQTT is commonly used for connections to remote locations where network bandwidth is at a premium.

- **IoT connectivity technologies:** Smart buildings use various connectivity technologies like radio frequency identification (RFID), cellular, or LPWAN. These technologies are also referred to as transport or communication protocols. Different applications may use different connectivity technologies. While LPWANs are cheap and provide long-range communication for all types of IoT sensors, they only send small blocks of data at a low rate. LPWANs are often used for smart lighting, asset

monitoring and tracking, and energy management. Cellular networks offer reliable but expensive broadband communication and are often used in video streaming applications, automated cars, connected health, and industrial applications.

5.4.4 Procurement

It is important to have a clear strategy for the procurement of smart buildings, whether development of a new smart building or upgrading an existing building to become smarter. The strategy is important because it should be used to inform the overarching systems to be used in the building. For example, if sustainability and cost-effectiveness are important then it will guide which lighting and HVAC system to use, inform the goals for water conservation technologies, the architectural layout of the building, etc.

An effective strategy should define a holistic set of requirements that spans across functional areas such as IT, operations, human resources, real estate, and security. It should also identify the local council team of key stakeholders based on these requirements. This will help to define and prioritise use cases from the requirements to establish realistic time frames and to make the right investments in proof-of-concepts and full-scale implementations. This is especially important when considering the impact of smart buildings across the council's building portfolio.

Key steps in the procurement process are to:

- Define the overall smart building objectives
- Understand the role that technology plays
- Select the team
- Adopt a project-based approach for smart buildings, including:
    - Understand the current state of the buildings in the council's portfolio
    - Conduct a gap analysis relative to future opportunity (based on strategy and smart building objectives)
    - Implement a PoC (could be a building or part of a building, e.g., focus on a specific system such as smart lighting or smart HVAC)
    - Identify benefits to confirm overall opportunity
- Launch at-scale implementation

Note that at-scale implementation may mean the implementation of a program over a number of years to achieve the overall objective of improving council's building portfolio.

5.4.5 Creating Impact

Deciding to build or upgrade a building to be a smart building comes with a range of challenges. None of these challenges should prevent councils from adopting smart technology but should

be considered as part of the development and procurement process. Common challenges or concerns include:

- **Privacy concerns:** Tracking and monitoring employees in workplaces involves privacy and data issues that many organisations have not faced before and may need specific advice (HR and Legal) to address.
- **Cyber security concerns:** Being entirely reliant on online digital infrastructure makes smart buildings uniquely vulnerable to cyber-attacks. Every interconnected IoT device represents a potential attack surface that hackers can exploit to gain entry into an organisation's networks.
- **Funding:** Smart buildings may need a capital investment in technology, for example enhancing a building management system (BMS) to act as a digital hub to manage the devices and applications that control the building.
- **Smart Technology overload:** For some people, smart technologies may be intimidating, particularly when things go wrong, for example a failed sensor or unintelligible error message from a connected device.
- **Connectivity:** Smart buildings are reliant on persistent internet connections and connectivity.
- **Hype:** Technology can be seen as a silver bullet for building management problems. Sometimes it can be difficult to separate the hype from reality, e.g., there are publications that suggest smart buildings can save as much as 20% in energy costs, however reputable sources estimate energy savings from smart buildings more in the range of 7-8%.

Smart buildings have the potential to improve the built environment. At the same time, it's important to be pragmatic and not allow technology to override the human factor. It is important to remember that buildings are for people. A smart building's true intelligence lies not in the sophistication of its gadgetry but in its overall capacity to improve the lives of its occupants, reduce harmful effects on the natural world, and empower building owners and operators to make informed decisions.

5.4.6 Additional Resources

NSW Government has developed various resources that can assist with the implementation of smart buildings, including:

- **NSW Smart Infrastructure Policy:** https://www.digital.nsw.gov.au/policy/smart-infrastructure-policy
- **NSW IoT Policy:** https://www.digital.nsw.gov.au/policy/internet-of-things

5.5 Environmental Monitoring

5.5.1 Description

Environmental Monitoring involves the use of sensors, data communication and related technologies to collect information about the environment and make it available for analysis and display. Environmental factors that can be monitored include air quality, heat, humidity, water level, water quality, noise, soil moisture and some aspects of biodiversity.

5.5.2 Benefits

Benefits from environmental monitoring include:

- Collecting data to enable informed policy and decision making
- Reducing costs of environmental compliance through automated data collection (as compared to manual data collection methods)
- Collecting data to inform engagement with external stakeholders including NSW Government agencies
- Communicating environmental quality to the community

Examples of environmental monitoring grouped by the five investment drivers described in *Section 0-*

Why Would Local Government Invest in Smart Infrastructure*"* are shown in the following table:

Smart Infrastructure Drivers				
Improved Efficiency and Cost Reduction	**Improved Asset Planning and Management**	**Improved Resident and User Experience**	**Environmental Sustainability and Resilience**	**Improved Decision Making and Planning**
Flood monitoring to minimise need for site visits when determining when to close and reopen roads and bridges	**Flood monitoring to allow closure of roads/bridges** **Soil moisture monitoring as part of automated smart irrigation systems** **Water quality monitoring of stormwater to**	**Air quality monitoring to better understand health (busy roads, urban heat, bushfire, wood heater usage etc)** **Noise monitoring in town centres to monitor impacts 24-hour economy, late night opening impacts**	**Water quality compliance monitoring** **Monitoring Dust from Construction Monitoring contaminated water runoff** **Koala and other species monitoring**	**Heat monitoring to inform heat mitigation strategies**

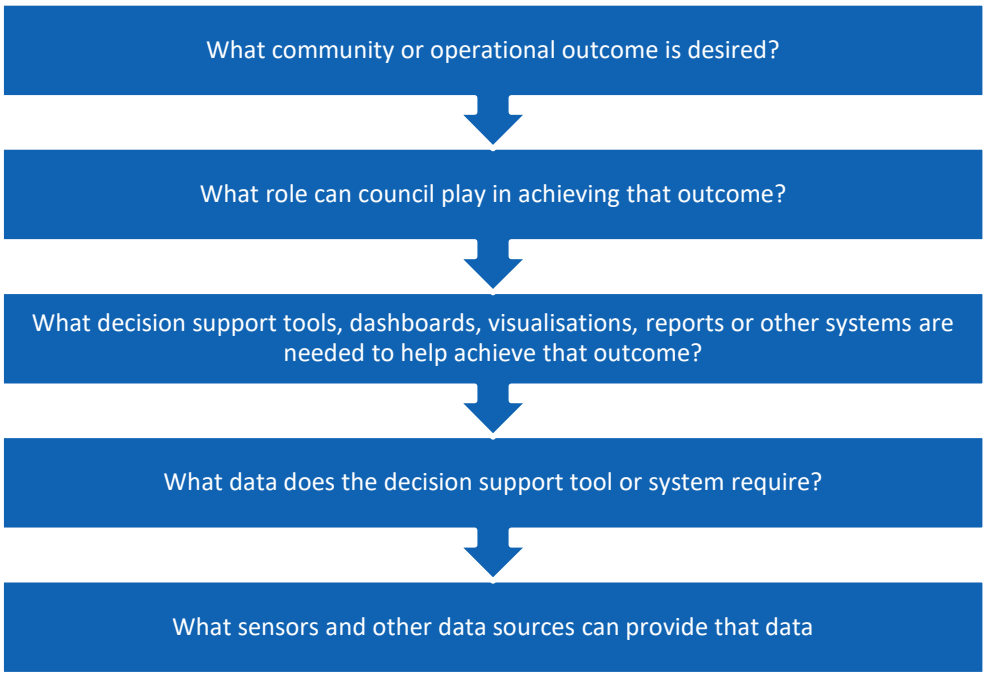
5.5.3 Procurement

Start with Business Requirements

When considering environmental monitoring it is essential that the reason for doing so is understood. The type, quantity, quality and placement of sensors depends on this. When

defining business requirements, it's important to identify what "agency" council has in relation to a particular environmental issue. When the data becomes available what can council do with that and what outcome is desired?

Rather than start with the sensing devices, a more effective approach is to work backward from the desired outcome:



Technology Components

All environmental monitoring systems include these technology components:

- Sensing Devices
- Data communications network
- IoT Platform
- Data Storage Platforms
- Data Visualisations
- Data Sharing

Sensors and Sensing Devices

Sensors are exposed to physical characteristics of the environment and represent those characteristics as data. One or more sensors are packaged into a *sensing device* that also includes weatherproof case and electronics to manage power, onboard data processing and communications. Although there is a distinction between them these terms are often used interchangeably.

Sensing devices vary widely with respect to manufacturer, capability, quality and cost. Specific considerations for procurement of sensing devices include:

- **Sensors.** Which sensors are included in the device. Temperature and relative humidity are needed for urban heat. Some devices will also include wind direction and strength which may be useful (but at a higher cost). Different sensors are used to measure water quality, water quantity, soil moisture and the various aspects of air quality.

- **Sensor Quality**. Assessing quality usually means understanding measurement accuracy and precision. Product technical information should specify this. Generally, higher quality sensors are more expensive than lower quality sensors. Depending on the objectives a lower cost sensor may be adequate, and the lower cost allows more sensors to be procured for the same budget. It's best to get expert advice on the data quality that is sufficient for the purposes the environmental data will be used.

- **Power**. Environmental sensors must be physically located where measurements are needed. In many cases there may not be power at these locations. If it is impractical to provide a fixed power source, then solar powered sensing devices are available. Alternatively, external solar powered battery packs are available to provide power.

- **Data Communications.** As for power the same is true for data communications. If an ethernet connection is not available at a specific location, then sensors can be purchased with wireless data communications capability. The type of wireless used must be matched to the available data communications network (see below). In some cases, a separate "dongle" can be sourced that allows a non-wireless sensor to use wireless communications.

Data Communications

If configured correctly, typical environmental sensing devices produce relatively small volumes of data and are not particularly demanding of data communications networks. Either wired or wireless data networks can be used.

Wired data networks may be appropriate for example when sensing devices are installed on multi-function poles.

Many environmental sensing devices use wireless data communications. All of the commonly available wireless data networks are suitable for carrying environmental sensing data. The following table summarises pros and cons of common wireless systems specifically with respect to environmental sensing.

Wireless Type	Pros	Cons
Wi-Fi	• Council buildings may already have Wi-Fi available • Low operating cost	• High power consumption – sensing devices require larger batteries and solar panels • Short range from sensing device to base station – coverage may be difficult across an entire LGA
Cellular (4G, NB-IoT)	• Coverage – available in most metro and regional locations	• High data costs with large numbers of IoT devices and

		depending on how devices configured
Low Power Wide Area Network (LoRaWAN, LPWAN)	• Low power consumption at sensor • Long range (from sensing device to base station)	• Wireless network infrastructure may not be available • Cost to establish and operate wireless network infrastructure

Refer *Section 6.2 – Wireless Data Communications* for more information.

IoT Platform

Environmental monitoring is an example of an "Internet of Things" (IoT) system consisting of connected devices deployed potentially in many locations throughout a local government area. *IoT Platforms* are used to manage and configure sensing devices. They are often provided by sensor manufacturers as part of a complete IoT solution. Refer *Section 6.3 - Internet of Things (IoT)* for more information.

Data Platforms

Data collected by the sensing devices is stored in databases located on data platforms. These may be operated by your organisation's IT department, or they may be operated externally "as a service" by IoT sensor vendors.

Data Visualisation, Analysis and Reporting

Sensor data is of little use if it cannot be used. Spatial maps, dashboards and other visualisation tools are common user interfaces. The right approach will depend on why the monitoring is being conducted, who will be using the data and their needs.

It is important to understand what it being measured and whether that is what should be displayed or whether some processing must be done first. For example, air quality monitoring can show detailed or "raw" air quality data or an "air quality index" which is derived from the raw data to be in a form that better represents air quality.

Data Sharing

Optionally a data sharing portal can be used for engaging with external stakeholders.

Insourced vs Outsourced Procurement

As with other smart infrastructure types, councils can choose to procure and operate all of the technology components, outsource them to an external provider or adopt a hybrid approach with elements of both. In some cases, providers will provide sensing devices, the IoT platform, data storage, data visualisation and technical support on an annual subscription basis.

When engaging providers, it is important to ensure that procurement contracts stipulate that:

1) Council owns or is licensed to be able to use the detailed environmental data collected (not just summary data or daily averages)
2) Vendors will make current and historical data available via an API so that data transfer can be automated

3) If council is outsourcing installation of equipment, then providers must have appropriate certifications and insurance.

5.5.4 Deployment and Operations

When deploying environmental monitoring solutions also consider:

- **Location**. When planning locations for sensors take local conditions into account, for example (1) check that wireless signal is available, (2) check that there is sufficient sunlight if solar powered, (3) heat sensors should not be in direct sun or mounted to north sides of buildings, (4) water volume and quality sensors are securely installed if in flood prone locations, (5) expect sensors near the ocean to be exposed to salt spray so should have plastic or marine grade stainless steel housings, (6) site should be accessible.

- **Installation**. Environmental sensors are often located in public spaces. This makes them vulnerable to vandalism or accidental damage. If locating air quality or heat sensors in public spaces, then installing them 3 to 3.5m above the ground is a good balance between keeping the sensors out of reach while collecting data near where people are.

- **Calibration.** Some sensor types such as some air quality sensors require field calibration before use. This requires co-locating the sensing device with a high-quality sensor for a period of time to determine whether a correction factor must be applied to the data the sensors produced. High quality environmental reference stations are operated by some NSW government departments and commercial operators.

- **Ongoing Operations.** Equipment installed in the field may need maintenance from time to time, periodic recalibration and replacement in the event of hardware failure. As with installation services, skilled people with appropriate site-specific certifications and insurances will be needed.

5.5.5 Creating Impact

In addition to the general recommendations covered elsewhere in this manual when deploying environmental monitoring solutions organisations should:

- ❑ Ensure that financial business cases include ongoing operational costs of all of the technology components – sensing devices, data communications and subscription services

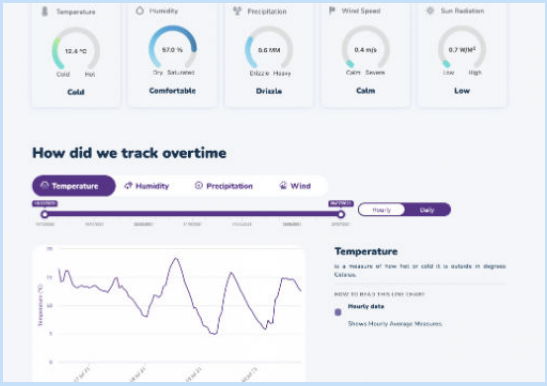
- ❑ Include sensor network equipment in council asset register and asset management plan

- ❑ For new developments update council policy to ensure that environmental factors are measured before (baselined) and after development

- ❑ For new capital works, renewals and developments assess whether environmental sensing should be included, and if so then what environmental information will be needed

5.5.6 Council Spotlight

Western Sydney Parkland Sensor Network. The Western Sydney Parkland Sensor Network is a joint collaboration lead by Sydney Water with the support of the eight western Sydney councils. It is a first of a kind in terms of scale with real time data generated from the network now feeding into multiple platforms including Sydney Water's, the Council internal and open data portals as well as the NSW Digital Twin.



5.5.7 Additional Resources

The NSW Government has expertise in environmental monitoring and has funded recent projects that include the use of environmental sensing:

- OPENAIR – developing best practises for council use of low-cost air quality sensors to address bushfires, wood smoke, heat, transportation and other environmental issues. www.openair.org.au
- SIMPACT – https://www.simpact-australia.com/

6. Part E – Digital Infrastructure

Digital Infrastructure is the “electronic plumbing” that supports Smart City solutions and Smart Infrastructure. In addition to the “Enterprise” ICT systems that councils use to operate existing services, smart infrastructure requires additional types of digital infrastructure:

- Inground Power and Data Communications
- Wireless Data Communications
- Internet of Things (IoT)

For new developments and greenfields it is better to plan for and deploy this infrastructure early.

6.1 Inground Power and Data Communications

Underground Conduit carries power and data.

Key requirements are that it:

- should be installed in all public spaces – capable of carrying fibre and power to all multi-function poles, etc.
- must be accessible to council and its subcontractors.
- Is planned to accommodate future needs.

6.1.1 Additional Resources

The *Digital Infrastructure Technical Report: Western Parkland City (2021)* – provides technical detail for planning, designing and constructing “in-ground” telecommunications pits and conduits.

6.2 Wireless Data Communications

Data communications and connectivity underpin most types of Smart Infrastructure. It enables the collection of data from places or infrastructure and the control of devices in the field.

6.2.1 Types of Wireless Data Communications

There are several types of wireless data communications networks, and most councils will have several in use, at least in some locations.

- **Cellular** - The ubiquity of cellular networks makes them an attractive option particularly for councils starting out with Smart Infrastructure. 4G and 5G (NB-IoT and Cat M1) are the most common options. Cellular data plans are similar to mobile phone plans with charges for data used and sometimes a monthly access fee. While cost effective for small deployments these operating costs can become expensive when the number of devices installed increases.

- **Wi-Fi** – Wi-Fi networks are commonly operated by councils and available in council buildings and in some cases in town centres. Wi-Fi supports high data volumes and there is no usage charge for council owned systems. The main issues with Wi-Fi are

coverage and cybersecurity. These are relevant both when considering offering "public Wi-Fi" to the general public and when using Wi-Fi to support smart infrastructure implementations.

- **LoRaWAN** – Long Range, Low Powered Wide Area Networks are ideally suited to Internet of Things (IoT) data communications where data volumes are low, and it is important to minimise power consumption of devices in the field. Sensor based solutions are ideal for LoRaWAN but data intensive systems such as CCTV are not suitable for LoRaWAN.

  As the amount of smart infrastructure and IoT increases councils should consider deploying LoRaWAN infrastructure using one of the following common approaches. Firstly, councils can procure and deploy LoRaWAN gateways in their LGAs. These are connected by fibre and there is design work required to identify how many gateways are required and where they should be located. The second approach is for council to engage with an IoT telecommunications provider who will implement and operate the LoRaWAN network on behalf of council.

The following table summarises the relevant strengths and procurement considerations for different types of wireless data infrastructure:

Wireless Type	Strengths	Procurement Considerations
Wi-Fi	• Likely to be already available in council buildings and some town centres. • Low operating cost	• High power consumption for IoT devices – they may require hardwired power or substantial solar panels. • Wi-Fi coverage may be lacking in areas where smart infrastructure is planned (additional cost to rectify)
Cellular (4G, NB-IoT)	• Available in most metro and regional locations	• Can be high opex costs when data volumes and numbers of devices are high
Low Power Wide Area Network (LoRaWAN, LPWAN)	• Low power consumption at end device • Long range (from sensor to base station)	• Council must organise LoRaWAN infrastructure network in their LGA

6.2.2 Adopt a Whole of Council Approach

It is recommended that councils develop policy and strategy for wireless communications infrastructure that is applicable to all smart city / smart infrastructure initiatives undertaken by council.

Many organisations undertake smart infrastructure and smart city pilots in isolation from each other. While it is appropriate to use multiple types of wireless communications there are good reason to adopting an organisational wide approach:

- To provide guidance to individual departments who wish to progress smart infrastructure initiatives.
- To realise economies of scale as use increases, for example, five projects each with five IoT sensors may determine that Nb-IoT is cost effective as volumes are small. In aggregate however it may be more cost effective to invest in deploying LoRaWAN infrastructure to support initially 25 devices with capacity to expand beyond that.
- To enable consistent approaches to procurement, management, cybersecurity, and data privacy to be formulated and applied.

6.3 Internet of Things (IoT)

The Internet of Things (IoT) is a broad group of technologies that include sensors, data communications and data management. Most examples of smart infrastructure involve the collection of data from devices installed in the field, transmitting that data to a central data platform and making that data available for analysis, automation or decision support.

Examples of IoT solutions include environmental monitoring, smart parking and automated irrigation systems. The specific IoT devices used (sensors and actuators) will vary according to their function, the data they are generating or the functions they perform.

To be useful, IoT devices are supported by an accompanying "IoT infrastructure". This includes the data communications network, systems to manage the maintain the devices, data management platform and data visualisers such as dashboards. The "IoT Reference Architecture" shown in Figure 2-3 illustrates the relationships between various components of an IoT solution. IoT devices or "endpoints" are shown at the bottom of the diagram.

6.3.1 Procurement

Turnkey Solutions

The simplest way to procure an IoT solution is to go to market for a complete solution. Vendors will provide everything needed including products and the services needed to configure, install and operate them. The big advantage of this approach is that councils need minimal internal expertise and can simply procure the outcome required.

Considerations with this approach:

- Council may still need to allocate resource to planning of IoT devices and potentially providing power and site access.
- The solution may be propriety and incompatible with other IoT systems that council may have now or in the future.
- As procurement is focused on outcomes (e.g.: parking system, road condition assessment reports, automated irrigation systems) there may be no expectation that vendors will make the underlying data available to council. Opportunities can be lost to "mine" this data and extract more value from it. An example is that imagery from road condition assessment systems may contain useful data relating to green spaces, and roadside furniture.
- Some solutions that do make the underlying data available will only do so for a limited time. Analysis of historical data is only then possible if council acquires and stores the data from the solution provider. An example here is that of some environmental

monitoring provides who will host a turnkey solution but only make available the most recent 6 months of data.

In House Solutions

Alternatively, councils can acquire the various components of an IoT solution and integrate them together into their desired solution. Councils seeking at some point to operate multiple IoT solutions using common IoT infrastructure should consider this approach.

Clearly this requires in-house expertise and a good understanding of the various components and how they can be used together.

Considerations when taking this approach include:

- Troubleshooting technical issues may require working with multiple suppliers – each providing a part of the solution.
- Establishing an overall IoT systems architecture and approach at the outset will allow devices and functionality to be added over time. If done correctly, then economies of scale can be achieved from the IoT Infrastructure and from internal resources such as people and processes.

6.3.2 Best Practise Recommendations

Assuming that Smart Infrastructure will be increasingly important in future councils should aim to over time to operate in-house IoT infrastructure:

- Procure solutions and components that ensure that council owns the IoT data generated by the system.
- Select vendors that will make this data in an automated and seamless manner. A common way to do this is to make available an “application programming interface” or “API.” Technical skills are required to use these APIs to ingest data into council’s own data management system.
- Expect that IoT devices in the field may have a limited lifetime as devices are exposed to the weather, vandalism, and accidental damage. Financial business cases should make allowances for device replacement as part of the operational costing.

6.3.3 Resources

- Internet of Things Alliance (IoTAA) – www.iotaa.org.au

Appendix A: Smart Infrastructure Maturity Checklist

This is a checklist showing what's needed to achieve the initial and medium-term target Smart Infrastructure Maturity levels. Refer Part B of this document for more information.

It is organised into 7 main categories:

- Smart City – Vision and Strategy
- Smart Infrastructure – Vision and Strategy
- Business Process
- Data
- Technology
- People
- Organisational Direction

No.	Category & Sub-category	Target 1 Level 3 - Fulfilled	Target 2 Level 4 – Improving
Smart City - Vision and Strategy			
1	**Planned Outcomes**	❑ Organisation has published its detailed vision and strategy for the city's future ❑ This provides details on planned improvements to economic, social and environmental outcomes, and how the strategy aligns with broader plans e.g. NSW Smart Places, Smart Western Parkland City, etc.	❑ The organisation's detailed vision and strategy also defines clear measures of success, ❑ Measures are being actively tracked by city leaders.
2	**Enablers**	❑ Organisation has published its detailed vision and strategy for the city's future. ❑ This clearly articulates plans to utilise smart enablers (e.g., technologies, data and collaboration).	❑ The organisation's detailed vision and strategy includes a detailed action plan, with clear milestones to establish smart enablers. ❑ This action plan is being actively tracked by city leaders.
3	**Investment**	❑ Organisation has published its detailed vision and strategy for the future. ❑ This includes business case(s) and shared investments, that will secure funding for initiatives to achieve targeted service outcomes.	❑ Implementation of the organisation's detailed strategy is underway. ❑ Funding secured of new initiatives and sufficient investment for ongoing operations beyond initial trials. ❑ These initiatives are delivering improved service outcomes, underpinning future service improvements at scale. ❑ City is considering regular budget to fund consistent pipeline of more long-term investment.
Smart Infrastructure - Vision and Strategy			
4	**Vision and Strategy**	❑ Organisation's executive leadership has published their detailed vision and strategy, demonstrating how the department or city will meet objectives of the Smart Infrastructure Policy.	❑ Organisation's vision is underpinned by an action plan with clear milestones to test implementation of smart infrastructure solutions, ❑ Progress is being tracked by executive leadership. This demonstrates clear alignment with the NSW Smart Infrastructure Policy.

No.	Category & Sub-category	Target 1 Level 3 - Fulfilled	Target 2 Level 4 – Improving
5	**Enablers**	❑ Organisation has published documentation for managing smart infrastructure technologies - that define consistent requirements across multiple use-cases. ❑ Smart infrastructure however is still delivered only through isolated projects, outside of a centrally governed framework (with funding for dedicated staff, data insights, business improvement, training, in-house technologies etc)	❑ Organisation has established an in-house smart infrastructure framework, ❑ This is centrally governed with dedicated staff, to ensure consistent and reliable outcomes across multiple use-cases. ❑ Work is also underway to expand beyond newly built assets, and to consider how to integrate new smart technologies for existing infrastructure assets.
6	**Investment**	❑ Business case(s) established to fund smart infrastructure solutions. Shared budget accountability for some discrete initiatives.	❑ Funding secured for pipeline of new initiatives and sufficient investment for ongoing operations beyond initial trials. ❑ Organisational budgets and structures adapt to ensure effective and transparent delivery of system-wide approach.
Business Process			
7	**Procurement Specs of Digital Deliverables or Smart Infrastructure Assets**	❑ Organisation has refined procurement documentation for digital engineering and/or smart infrastructure deliverables. ❑ This documentation has been repeated/improved on numerous projects. ❑ Organisation is working to standardise procurement documentation for all projects.	❑ Organisation has standardised procurement documentation for digital engineering and/or smart infrastructure deliverables. ❑ This documentation is now used in all procurement contracts where relevant. ❑ Organisation seeks feedback to build knowledge and lessons.
8	**Collaborative Management of Infra Assets**	❑ Organisation has clearly mapped its physical infrastructure assets and has common asset management policies in place to exploit asset synergies. ❑ However compliance with these policies is patchy, and the organisation lacks the governance structures and incentives to drive compliance.	❑ Physical infrastructure assets are mapped, and asset management policies are in place. ❑ Polices are underpinned by effective governance processes and benchmarking aimed at ensuring compliance and driving continuous improvement.
9	**Digital Asset Lifecycle**	❑ Enterprise architecture of organisation is well documented and informs the requirements for the digital thread of data. ❑ This enables design of more streamlined/automated data flow throughout the organisation and over the asset lifecycle.	❑ Digital asset lifecycle (i.e. digital thread of data over the asset lifecycle) is implemented for overall organisation, ❑ This is supported with well documented procedures and appropriate technologies.
Data			
10	**Enterprise and Data Architecture**	❑ Organisation has developed a comprehensive strategy for its enterprise architecture and data management, based on open standards, modular design and service-oriented architecture. ❑ A roadmap for transition towards new architecture has been established ❑ Strong leadership and collaborative governance arrangements have been established to manage the transition.	❑ Organisation manages all of its data on a platform basis, with either: • all its business units sharing an integrated data platform; or • widespread sharing and re-use of strategic data assets between different parts of the government and its suppliers, based on interoperable systems and open standards.

No.	Category & Sub-category	Target 1 Level 3 - Fulfilled	Target 2 Level 4 – Improving
11	**Data Management Awareness and Interoperability**	❑ Organisation is building its data management capability, with ongoing activities such as: • Identifying data assets; • Developing an in-house data management framework (e.g., policies, standards, processes etc); • Documenting requirements for data interoperability and reliable re-use. ❑ Initial compliance with the framework is however patchy, ❑ The organisation lacks the governance structures and incentives to drive compliance.	❑ Organisation has effective data management capability, due to implementation of its data management framework. ❑ The organisation now has clarity of its data assets, which are often shared with its suppliers. ❑ Clear leadership and collaborative governance processes work together, to support data quality and framework compliance on a systematic basis.
12	**Open Data Services**	❑ Organisation has published an open data policy and has begun to operate an open data portal. ❑ This portal shares a broad range of data assets online, with an aim to promote and leverage innovation. ❑ Members of public are also sharing data in key areas.	❑ Open data community continues to grow, building new services valued by users. ❑ Members of public show willingness to share data is becoming widespread.
13	**Data Analytics and Insights**	❑ Investing in more advanced data management, capture, analytics, big data applications and business intelligence platforms.	❑ Data assets used to provide actionable information. ❑ Extended data capture and analytics inform improved decision making and service design.
Technology			
14	**Technology Ecosystem (i.e., infra and op ICT technology)**	❑ Organisation is developing policies, processes and standards to encourage interoperability and re-use on a systematic basis. ❑ Compliance with these policies is patchy, however, and the organisation lacks the governance structures and incentives to drive compliance.	❑ Organisation and its suppliers have full transparency of the technology assets that exist in the organisation. ❑ Clear leadership and collaborative governance processes have been established across the organisation to encourage interoperability and re-use on a systematic basis.
15	**Uptake of IoT sensor Technologies, and Integration with Physical Infrastructure Assets**	❑ Clear policy and planning frameworks have been established to ensure that all major physical developments and infrastructure upgrades have digital technologies and communications networks built into them from the start. Joint investment plans in broad deployment of connected assets.	❑ Policies are underpinned by effective governance processes and benchmarking aimed to ensure compliance and drive continuous improvement. ❑ Broad deployment of connected assets. ❑ Work is also underway to expand beyond newly built assets, and to consider how to integrate new smart technologies for existing infrastructure assets.
People			
16	**Staff Capability with Smart Infrastructure Technologies**	❑ Organisation has completed recruitment process and has filled in-house roles for dedicated smart infrastructure team. ❑ New smart infrastructure team resources mobilised and working to deliver initial, short-term smart infrastructure objectives.	❑ Organisation is increasing capability, with smart infrastructure team providing training and expertise to other in-house teams. ❑ This is building general familiarity with smart infrastructure, promoting in-house collaboration, exposing broader organisation to new technologies and sparking new opportunities to utilise big data.

No.	Category & Sub-category	Target 1 Level 3 - Fulfilled	Target 2 Level 4 – Improving
17	**Data Literacy and Culture of Data Sharing**	❑ Organisation has commenced program to improve data literacy and/or data sharing culture, with leaders committing to improvements. ❑ Barriers to sharing data assets being discussed between partners and solutions emerging.	❑ Organisation has completed program for data literacy and data sharing improvements. ❑ Data sharing culture is becoming embedded in organisation. ❑ Efforts are underway to equip staff with new policies, procedures, champions, training and use-cases - with an aim to become part of business-as-usual operations.
18	**Data Management Roles**	❑ Dedicated data management established in organisation. Staff member(s) recruited, with responsibility for holistic improvements to organisational data management.	❑ Data management team delivering notable improvements including consistent data architecture, data modelling, data science, data management platforms, data reliability, digital asset lifecycle, staff training, etc.
Overall Organisational Direction			
19	**Team behaviours**	❑ Organisation promotes technological innovation and supports greater uptake of digital solutions with more long-term horizons and greater transformational outcomes.	❑ Organisation is committed to digital transformation and uptake of smart solutions. ❑ Business plans and public presentations make reference to support for smart/digital developments.
20	**Accountability and Resourcing**	❑ Organisational priorities begin to be influenced significantly, as teams have necessary authority, governance processes and resources.	❑ Leadership of smart/digital change is shared, with responsibility shared across senior managers. Sufficient resources committed to smart infrastructure initiatives. ❑ Clear programme management processes have been established to support the delivery of this shared agenda.

Appendix B: Smart Infrastructure Pilot Evaluation Template

This template can be used by councils to evaluate existing smart infrastructure pilots and plan new pilots. It is recommended that councils modify and adapt it to suit their own circumstances and processes. For example, the template could be converted to a checklist or even a slide presentation format for use in internal review meetings.

Overview	
Project Description *Include organisational info, contact name, dates and costs as appropriate*	
Rationale – *"What are the expected benefits of investing in this smart infrastructure?"*	
Investment Drivers - What are the types of benefits of the smart infrastructure solution?	❑ Efficiency and Cost Reduction ❑ Asset Planning and Management ❑ Resident and User Experience ❑ Sustainability and Resilience ❑ Decision Making and Planning
Benefits - Describe the benefits to internal and external stakeholder groups	
Strategic Fit – Which strategy documents does this initiative align with?	
Pilot Objectives – *"How clear are the pilot objectives?*	
What do you expect to learn from the pilot?	
What areas is the pilot exploring? E.g.: technology, business processes, business case, community response etc	
For each of these areas how will success of the pilot be measured?	
Transitioning to Business as Usual	
If the pilot is successful what commitments are there to transition beyond pilot?	
What business processes will need to be modified to take advantage of this smart infrastructure?	
What impact will there be on staffing. Does council have the required skills and roles?	
What is the total operational cost over the medium term? (e.g.: 3 to 5 years)	
Have data management and governance needs been identified?	
Are cyber security and privacy risk assessments and plans in place?	