Digital Twin Ontario

Utility Manual

Data Sharing and Utility Coordination for Digital Twins of Ontario's Infrastructure

Revision 2025

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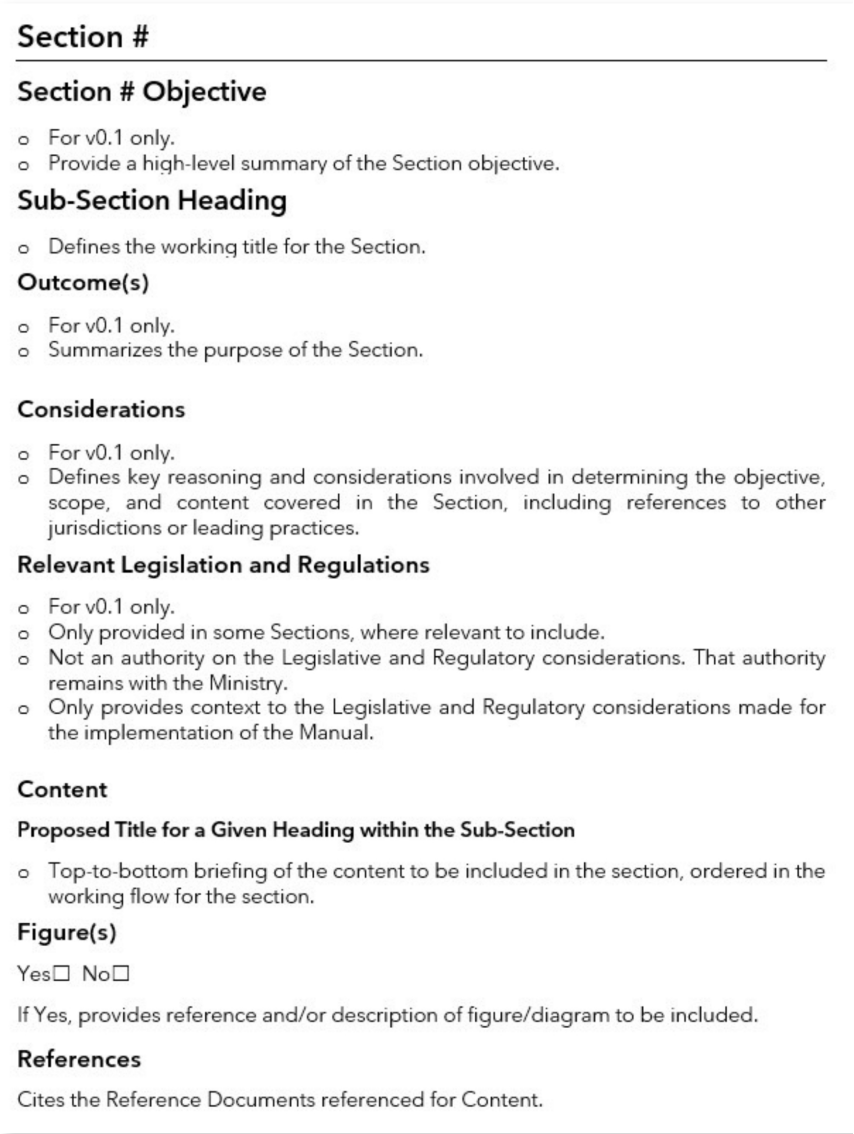


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Structure & Navigation

- **This document is v0.1 of the Manual, a working group version of the Manual, intended to be used for sector engagement to obtain input and formalize recommendations and content for v1.0.**
- **Each Section of this document is structured as a summary of the content and figure(s) to be included in v1.0. The Objective(s), Outcome(s), Considerations, Relevant Legislation and Regulations, and Reference(s) are included for additional context only and will not be featured in v1.0 of the Manual.**
- **The image below is for navigating each Section of the Manual.**



Notes for Internal Reviewers

General Notes

- **Please provide your comments directly in the Manual.** If preferred, feedback can also be sent to Digital Twin Ontario via email at info@digitaltwinontario.ca.
- The priority is to **focus review on the clarity of the content provided and identification of misaligned visions and/or content gaps.** Additionally, focus your review to **consider the flow and scope of the content provided.**
    - Additionally, any notes on the language used is appreciated; keeping us aligned on clarity of terminology and concepts.
- **Use of acronyms is limited wherever possible**, only used for:
    - Prevalent terms used throughout the document.
    - When the acronym is already predefined in Industry.
    - Referenced from Leading Practice Reference Documents.
- Notice **capitalization of terms** such as "Leading Practice" or "Reference Documents", this **indicates that there is a glossary definition attached to the term**. This will allow for ease of reference for the Utilities and Infrastructure Industry.
- **The Manual applies to Designated Priority Projects ("Projects") including but not limited to Utilities Infrastructure Projects**. We address Utilities Coordination in the Manual, as utilities engage across Infrastructure initiatives. The Manual applies to all Designated Priority Projects, and that is why the Manual includes BIM.
    - For example, the construction of a hospital is not a utility Project per se. However, there is a utilities component, as the relocation of underground/aboveground utilities is required, and a Manual would be able to provide the guidance/instruction to those working on those aspects of the Project(s).
- Note the RACI Matrix sections for Section 5, 6, and 8 are currently in non- tabular format **All RACI matrix descriptions will be converted to matrix tables in a subsequent version of the Manual. Please see Section 5.2 for an example of the tables to be provided.**
- The Information contained in the Manual is, draft and under development, should not be

relied on, is presumptive with respect to legislation and regulation which would need to be adopted by the Province, and is for authorized discussion purposes only to inform policy recommendations.

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Section Specific Notes

Section 5 and 6

- As a reminder, **Section 5 and 6 present the overall instructions and standards for the Manual as it relates to the four (4) Data Management Pillars**: Data Ingestion, Data Exploration, Data Sharing, and Data Collaboration, consolidated in one place of reference.
  - These instructions are referred to in Section 8, which instructs Delivery Partners on the step-by-step processes for the application of Manual standards during a Project.

Note that where possible, **a choice is made to prioritize the "Instructional" capacity of the Manual where possible**, whether that be Technology, platforms, templates, forms, or processes. These choices are drafts with the clear provision for Delivery Partners to "meet or beat" the indicated requirement(s). These requirements are subject to change based on review cycles and subsequent sector engagement.

Please note, this Manual provides **general requirements** for Utility Coordination and Data Sharing that can be applied to all Projects. **Use case-specific versions** (e.g., water, gas, etc.) will be subsequently developed in the **form of Bulletins.**

Section 7, 8, and 9

- As a reminder:
  - **Section 7** consolidates required BIM Processes in the Manual based on Leading Practice ISO 19650 series for Projects.

- **Section 8** instructs on required activities for Data Sharing and Utility Coordination in Project Stages.

- **Section 9** acts a summary of key takeaways from each Section of the Manual.

The "DTO AssetFlow Hub" name communicates to Delivery Partners that it is not a physical Data centre.

- Conveys the idea of a midway point for Asset Information to flow through while avoiding any connotations of a physical centre. Additionally, the word "hub" suggests a place where diverse sources of Information come together, which aligns with the DTO AssetFlow Hub's role in integrating Organizational Data Sources.

Generally, **"Data" should be understood as the source for "Information."** Therefore, BIM manages the Information (Information Management) from Data Sources.

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Version	Summary of Changes
0.1	Release of Mock-up Draft
Owner	Digital Twin Ontario

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Digital Twin Ontario Utility Manual – Value Associated with Adhering to Utility Manual Requirements

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Notice

The Manual presumes that the Digital Twin Ontario Act has been enacted, providing enabling legislation for legislative and regulatory measures. Including presumptive legislation in the Manual is intended to assist Industry consultations by building an understanding the expectations of Appointing Parties, Lead Appointed Parties, and other Appointed Parties in supporting Digital

Twins to accelerate Infrastructure deployment. Note that the Province of Ontario has yet to adopt any legislation or regulation officially, and any discussions regarding regulatory tools are solely for authorized discussion purposes to inform policy recommendations.

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Document Objective: The objective of this document is to detail the specific value associated with adhering to requirements for Delivery Partners as outlined in the Digital Twin Ontario (DTO) Utility Manual. The document highlights the potential value achieved as a result of Delivery Partners meeting these requirements.

Table 1: Summary of Associated Value from Adhering to the Digital Twin Ontario Utility Manual:[1]

Value Added / Manual Requirements	Enhanced collaboration and coordination	Improved Data accuracy and quality	Streamlined processes and increased efficiency	Cost savings in asset management	Increased safety and risk reduction	Operational sustainability and technology compatibility	Improved Data management	Enhanced accuracy and damage prevention	Enhanced transparency	Better asset management and maintenance	Digital visualization and simulations	Ease of Regulatory compliance
Adhere to construction and Data standards	✓	✓		✓								
Comply with relevant guidelines for the four Data Pillars	✓	✓		✓	✓	✓				✓	✓	
Notify the Infrastructure Owner when subsurface Infrastructure is located	✓		✓		✓							
Create a Digital Asset after being notified that Infrastructure is located		✓			✓					✓	✓	
Installed or repaired Infrastructure must include RFID technology					✓	✓		✓				
Provide Digital Assets and records to Appointing Parties				✓				✓				✓
Maintain Digital Assets of Infrastructure where required				✓			✓					✓
Make Digital Assets available through the AssetFlow Hub		✓	✓									

[1] Refer to Table 2 for additional details on specific requirements and their associated value added to Delivery Partners

Value Added / Manual Requirements	Enhanced collaboration and coordination	Improved Data accuracy and quality	Streamlined processes and increased efficiency	Cost savings in asset management	Increased safety and risk reduction	Operational sustainability and technology compatibility	Improved Data management	Enhanced accuracy and damage prevention	Enhanced transparency	Better asset management and maintenance	Digital visualization and simulations	Ease of Regulatory compliance
Submit all permits through the E-Permitting Platform	✓		✓	✓					✓			
Prohibit Infrastructure Owners from charging for a Locate Request			✓	✓								
Submit Data related to any investigations upon request from DTO					✓			✓				
Use the Common Data Environment to manage Project information	✓	✓	✓				✓					
Adopt standards for representing power system components	✓					✓	✓					
Follow the DTO Data Sharing Process			✓				✓					
Submit Deliverables in the Manual through the DTO AssetFlow Hub									✓			
Comply with Data security measures outlined by DTO	✓											
Use digital tools and platforms to enhance Data sharing		✓	✓	✓		✓						
Track and measure specific Key Performance Indicators		✓	✓						✓			
Acquire the appropriate tools for Data quality as part of BIM integration	✓	✓										

Table 2: Detailed Requirements and Associated Value from Adhering to the Digital Twin Ontario Utility Manual

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
Adhere to the DTO Utility Manual, including the current version of construction and Data standards referenced in the Manual.	As Infrastructure Owners and Project Proponents, the province will be required to comply with the standards. DTO will work with partner Ministries to update existing construction and Data- related regulations to apply standards. Examples of relevant legislation include: • Building Code Act, 1992. • Ontario Energy Board Act, 1998. • Technical Standards and Safety Act, 2000. • Ontario Underground Infrastructure Notification System Act, 2012.	• **Enhanced collaboration and coordination:** Adhering to standards in the Manual improves collaboration between Infrastructure Owners and Delivery Partners by providing a common framework. Clarifying requirements in one place will save time and resources between different parties in a Project, while also reducing errors. • **Improved Data accuracy and quality:** Adherence to standards in the Manual helps to ensure accuracy and easily integrate drawings across different Delivery Partners, improving Data quality. This will save time negotiating between parties and mitigate the costs of adhering to different standards and processes across Projects due to fewer inconsistencies and errors. • **Cost savings in asset management:** Long-term maintenance costs will be reduced by minimizing errors and avoiding rework through adherence to these standards. Accurate and reliable drawings enable efficient asset management, reducing the need for costly corrective measures.
Comply with relevant standards and guidelines for the four Data Pillars: Data Ingestion, Data Exploration, Data Sharing, and Data Collaboration. All Data Pillars have specific requirements pertaining to UIE (Utility Infrastructure Engineering) for Horizontal Structures[2] and BIM (Building Information Modeling) for Vertical Structures.[3]	The province will be required to adhere to relevant standards and guidelines as Infrastructure Owners and Project Proponents. DTO defines key roles involved in the Data Sharing and Data Collaboration processes, such as Assets Manager, Data Custodians, Project Managers, and Data Liaisons through the Manual and additional tactical guidance.	• **Improved Data accuracy and quality:** Following standards and guidelines help to ensure accurate, reliable, and high-quality utility Infrastructure Data, enabling informed decision-making and better asset management. • **Increased safety and risk reduction:** Enhances safety by mitigating the risk of strikes and minimizing rework through improved asset coordination. Additionally, fostering alignment on common standards helps prevent duplication of data collection and storage processes. • **Enhanced collaboration and coordination**: Adhering to standards promotes consistency in Data exchange, facilitating better collaboration and coordination among Delivery Partners for efficient Project by fostering alignment to help prevent duplication of data collection and storage processes.

[2]Horizontal Structures refer to Network Assets, including road, rail, water, power, and communications distribution systems.

[3] Vertical Structures refer to Infrastructure that runs vertically, such as power lines and transmission towers, cell phone towers, and water towers. Structures located above ground are more visible and vulnerable to damage from weather and other environmental factors.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
		• **Cost savings in asset management:** Standardized processes across Projects streamlines workflows, improves operational efficiency, reduces Data processing time, which results in cost and time savings for Delivery Partners. • **Better asset management and maintenance**: Improved integration of utility Data with other relevant information as a result of standardization enables proactive maintenance planning and asset condition monitoring. • **Operational sustainability and technology compatibility:** Adhering to a set of common standards helps to ensure compatibility with emerging technologies, allowing for seamless integration with digital twin technologies and advanced analytics to enhance utility operations and decision-making.
Notify the appropriate Infrastructure Owner when subsurface Infrastructure has been located during an excavation and respond to locate requests as an Infrastructure Owner.	N/A	• **Increased safety and risk reduction:** Ensuring utility Infrastructure is properly identified prevents accidents and reduces the risk of utility damage. Proactively notifying Infrastructure Owners when a utility has been located helps maintain a safe working environment and mitigates potential liabilities for Delivery Partners. • **Streamlined processes and increased efficiency:** Promptly notifying the Infrastructure Owner avoids construction delays and conflicts caused by utilities that are unexpectedly uncovered in the future. Consequentially, accurate utility information enables more efficient repairs and maintenance, which saves time and effort. • **Enhanced collaboration and coordination**: Adhering to the requirement promotes collaboration with Infrastructure Owners, leading to improved efficiency and reduced costs. In turn, this optimizes planning efforts and identifies opportunities for process improvements.
Create a Digital Asset and record as per standards outlined in the Manual and in regulation, after being notified that subsurface Infrastructure has been located.	DTO will be required to regularly review and update the Manual to include the most up-to-date standards to which drawings must be completed.	• **Better asset management and maintenance:** Digital Assets enable Delivery Partners to monitor and manage Infrastructure more efficiently. It provides a real- time view of the assets, allowing for proactive decision-making and optimized maintenance and repair schedules. • **Increased safety and risk reduction:** Digital Assets help Delivery Partners identify areas where maintenance is required, or safety hazards exist and schedule repairs before problems occur.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
		• **Improved reliability and reduced downtime:** The Digital Asset enables Delivery Partners to identify potential issues before they become major problems. This proactive approach helps increase the reliability of Infrastructure, reduces downtime, and ensures uninterrupted service for end-users.
Ensure that Subsurface Utilities installed, repaired, or altered after a specified date include radio frequency identification (RFID) technology or a suitable alternative: • Suitable alternatives to be specifically defined in regulations. • Examples include a Global Positioning System (GPS) with sub- hectometer level accuracy and the ability to provide latitude, longitude, and elevation information.	DTO will provide details on suitable alternatives where RFID technology is not feasible through regulation and examples in the Manual.	• **Enhanced accuracy and damage prevention:** RFID technology and suitable alternatives enhance the accuracy of locating Subsurface Utilities, reducing future utility locate efforts and minimizing errors or delays. • **Increased safety and risk reduction:** Ensuring Infrastructure is easily locatable significantly reduces the risk of utility damages during construction or excavation. Accurate identification and tracking help to ensure a safer working environment and minimize accidents or injuries. • **Costs savings in asset management:** Implementing RFID technology and suitable alternatives provides access to accurate and up-to-date Data, reducing manual Data collection efforts during construction. This improves efficiency and lowers costs associated with Data collection. • **Digital visualization and simulations:** Integrating RFID technology and suitable alternatives is integral to creating a Digital visualization of Subsurface Utilities. This enables simulation of scenarios, allowing partners to identify potential issues proactively and enhance planning and decision-making. • **Operational sustainability and technology compatibility:** Investing in electronically locatable technology helps to sustain operations over the long term by more easily being able to locate Infrastructure when required. RFID technology is becoming increasingly prevalent in utility Infrastructure management across various jurisdictions and has demonstrated the ability to keep Infrastructure owners ahead of industry trends.

Provide the Digital Asset and record as per the standards required in the Manual. These should be provided to the Appointing Party acting as the Project Proponent through the DTO AssetFlow Hub within the time period mandated for a Locate Request as per the Ontario Underground Infrastructure Notification System Act, 2012 (One Call Act).	DTO will administer a single Data capture and sharing system (i.e., the AssetFlow Hub) that will allow for the issuance of digital locate records and facilitate the flow of Information between Infrastructure Owners using Building Information Modeling. DTO will create regulations that define the specific Data requirements to be shared with the AssetFlow Hub in accordance with the appropriate Data standards.	• **Cost savings in asset management:** Providing the Digital Asset and record as required by the Manual eliminates the need to physically mark underground Infrastructure during Locate Requests. This saves time and money by eliminating the need for locators to visit the field for marking. • **Ease of regulatory compliance:** The Digital Asset and record enable Delivery Partners to easily comply with timelines and regulatory requirements set by the One Call Act. Delivery Partners can respond faster and more efficiently to Locate Requests by eliminating field visits. • **Enhanced accuracy and damage prevention:** Digital Assets offer a more accurate representation of Infrastructure than physical locations, which helps prevent damage during construction or excavation. Contractors and excavators can rely on Digital Assets to understand the Infrastructure's location and characteristics, minimizing the risk of accidental damage.
Maintain a Digital Asset and record of the Infrastructure where legislation has required the digitization of Infrastructure. These should be maintained in a local repository internal to the Appointing Party for a defined period of time.	N/A	• **Ease of regulatory compliance:** Maintaining a Digital Asset and associated record supports better compliance with the Ontario One Call system, reducing the risk of fines while also promoting safety. • **Improved Data management:** The Digital Asset and integration with the AssetFlow Hub provide real-time Data and insights for optimized operations, proactive decision-making, and the efficient allocation of resources. • **Cost Savings in asset management:** Digital Assets and records reduce costs associated with manual record-keeping and Data collection, which minimizes errors, helps to avoid delays, and reduces the likelihood of potential damages. This improves Project timelines and reduces overall risks to Project completion.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
Make Digital Assets and records available through the AssetFlow Hub within a specific period of time following the identification of Infrastructure.	DTO will administer the AssetFlow Hub and provide the opportunity for Delivery Partners to offer Application Programming Interface (API) between the AssetFlow Hub and the Delivery Partners' local repository.	• **Enhanced collaboration and coordination:** Making Digital Assets available through the AssetFlow Hub enhances collaboration and communication with other Infrastructure Owners. Standardized Data sharing practices facilitate coordination, preventing damage during construction or excavation and ensuring a safer working environment. • **Streamlined processes and increased efficiency:** Providing Data through the AssetFlow Hub centralizes Data sharing in a system of reference with other Infrastructure Owners. This saves time and effort, streamlining the Data sharing process and reducing administrative burdens. • **Improved Data accuracy and quality:** Making Digital Assets available supports consistency in Data format and management. Infrastructure Owners will have access to accurate and up-to-date information, enabling informed decisions on maintenance, repairs, and upgrades. Improved decision-making enhances asset performance and operational efficiency. • **Digital visualization and simulations:** Data analytics and machine learning can leverage Digital Assets and records to provide insights into operations. Analyzing Data can identify areas for improvement, reduce costs and increase efficiency. Simultaneously, machine learning can support the scaling of digital twin models of Infrastructure.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
Require all contractors, excavators, utilities, municipalities, provincial Ministries and Agencies, and third-party Delivery Partners to submit all municipal and provincial permits through the E-Permitting Platform. This requirement includes all permits for or in proximity to Designated Priority Projects.	The province of Ontario will be required to collaborate with municipalities to apply the Manual and relevant Data standards to municipal Rights-of-Way / non-provincially funded Projects. Financial investments from the Province of Ontario may be provided to integrate permitting processes from municipalities and provincial Ministries and Agencies into the DTO E-Permitting Platform. As noted in the Manual, the province may partially fund Delivery Partners' transition to full Manual integration in the Province's Infrastructure and Utilities Industry. Funding is dependent on the extent to which the Manual requires a Material increase in effort and/or investment beyond what would otherwise be expected.	• **Streamlined processes and increased efficiency:** The E-Permitting Platform provides a single point of entry for Delivery Partners to access permit approvals for Projects that have received provincial funding. This simplifies the application process and reduces administrative burden, as all permits can be submitted through one platform, streamlining the approval process. • **Cost savings in asset management:** The E-Permitting Platform consolidates permit-related information into a single repository, saving time and costs. Delivery Partners will no longer need to navigate multiple systems or engage with various agencies separately. This streamlined approach increases efficiency, helps to delays, and reduces costs. • **Enhanced transparency:** The E-Permitting Platform promotes transparency and accountability in permitting. It centralizes all required permits, ensuring all Delivery Partners have access to necessary information. This facilitates compliance with regulatory timelines and enables effective communication and coordination among Delivery Partners.
Infrastructure Owners are prohibited from charging for a Locate Request required under the Ontario One Call Act by an Appointing Party acting as a Project Proponent, in alignment with the Building Infrastructure Safely Act, 2023.	DTO clarifies through the Manual that municipalities will be permitted to charge fees for locates, despite the prohibition for other Infrastructure Owners.	• **Cost savings in asset management:** Digital Assets as locates provide long-term time and cost savings. They are more accurate than physical locates and eliminate the need for manual marking and field visits. By adhering to the prohibition on charging for Locate Requests, Delivery Partners are incentivized to use digital locates, saving time and reducing costs.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
		• **Streamlined processes and increased efficiency:** Digital locates minimize the risk of delays in construction processes. They can be accessed and reviewed more efficiently, allowing construction activities to proceed smoothly without interruptions. Embracing digital locates supports timely Project execution and minimizes potential delays.
Require all relevant parties, including but not limited to Appointing Parties and relevant subcontractors, must submit Data and Information related to any investigations upon request from DTO.	DTO will receive and review complaints that construction proponents submit in the event of inaccurate, incomplete, or delayed Data from Appointing Parties. Using the Ontario Dispute Adjudication for Construction Contracts (ODACC) as condition precedent, DTO will have the authority to appoint adjudicators, conduct adjudication hearings, issue binding decisions, and enforce those decisions. DTO will also have the authority to make rules and procedures for the adjudication process and to provide guidance to Parties on how to resolve their disputes. DTO will issue Administrative Monetary Penalties based on the specific circumstances of a violation of any legislative or regulatory requirements up to a maximum amount. The province of Ontario will empower municipalities to investigate complaints related to standards required under the Building Code Act, 1992.	• **Enhanced accuracy and damage prevention:** The requirement encourages Delivery Partners to provide accurate locates, improving process efficiency and workflow for all Delivery Partners. • **Increased safety and risk reduction:** Adhering to the requirement reduces the risk of liability for Project Proponents by minimizing the chances of encountering issues or damages due to inaccurate information.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
Use the Common Data Environment (CDE), a centralized digital platform, to share and manage Project information throughout its lifecycle. Delivery Partners will be required to use the CDE for collecting and importing Data from various sources, such as Geographical Information Systems (GIS), Asset Management systems, and construction documents.	N/A	• **Enhanced collaboration and coordination:** The CDE centralizes Project information, facilitating better collaboration and coordination among Delivery Partners. By consequence, the CDE enables easy exchange of information, progress tracking, and issue resolution. • **Improved Data accuracy and quality:** The CDE supports standardized storage and management of Project information to help maintain Data accuracy and consistency. As a result, the CDE reduces the likelihood of errors and discrepancies and supports version control of information. • **Streamlined processes and increased efficiency:** The CDE eliminates manual document handling, reducing administrative tasks and improving efficiency. Quick access to up-to-date information enables informed decision-making, saving time and resources. • **Better Project Management:** The CDE allows effective coordination and planning with other Delivery Partners by providing centralized visibility into Project timelines, dependencies, and milestones, reducing conflicts and ensuring smoother execution. • **Improved Data management:** The CDE offers robust Data management capabilities, including version control and access controls. The CDE facilitates reporting requirements by tracking updates and ensuring diligent documentation, as outlined in the Manual.
Adopt and implement specific standards and protocols for representing power system components. For example, Uniclass 2015 for organizing construction information, Industry Foundation Classes (IFC) for software interoperability, and Common Information Model (CIM) standards.	DTO will support compliance with relevant standards and requirements through investigations and the issuance of Administrative Monetary Penalties, where appropriate. This includes adherence to Uniclass 2015 for organizing construction information, Industry Foundation Classes (IFC) for interoperability, and Common Information Model (CIM) standards for	• **Better organization and quality control:** Adopting Uniclass 2015 standardizes construction information, ensuring consistent and easy-to-under utility Data across Projects, enhancing efficiency and accuracy. • **Operational sustainability and technology compatibility:** Implementing Industry Foundation Classes (IFC) enables seamless Data exchange between software systems, reducing manual entry and improving collaboration, streamlining processes, and minimizing errors. Additionally, adopting widely accepted standards helps to ensure compatibility with emerging technologies and adaptable utility Data and enables seamless integration with new tools, platforms, and technologies.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
	representing power system components.	• **Improved Data management:** Adhering to standards, including Common Information Model (CIM) standards enables the integration and analysis of utility Data, allowing for valuable insights, proactive asset management, maintenance planning, and optimization of utility operations. • **Enhanced collaboration and coordination**: Common standards enhance collaboration and coordination across Delivery Partners, enabling improved information exchange and coordination for more efficient Project delivery.
Follow the DTO Data Sharing Process, which encompasses Data submission, sharing, reconciliation, ingestion specifications, Data updates, reviews, and the sign-off/transmittal process for shared utility Infrastructure Data in Ontario.	DTO will facilitate the AssetFlow Hub and support the integration of Appointing Parties' Data into the systems and processes of the AssetFlow Hub.	• **Streamlined processes and increased efficiency:** The DTO Data Sharing Process provides clear guidelines for Delivery Partners to submit and share Data efficiently. This eliminates confusion and helps to ensure that the right Data is shared with relevant Delivery Partners in a timely manner. • **Improved Data management:** The DTO Data Sharing Process eliminates confusion and helps ensure that the correct Data is shared with relevant Delivery Partners on time. Additionally, Delivery Partners can request and receive timely updates and participate in regular reviews to support accuracy and relevance. • **Better Project Management:** The DTO Data Sharing Process provides a clear process for Delivery Partners to review, approve, and transmit shared Data. This supports proper acknowledgement and standardized transmission to relevant parties.
Submit Deliverables specified in the Manual throughout the Project and provide relevant Information upon request(s) through the DTO AssetFlow Hub.	DTO will define the product requirements for engineering and design efforts for Projects that must be delivered to the Client as digital files and/or printed documents.	• **Better Project Management:** By submitting deliverables to the AssetFlow Hub, Delivery Partners can better track and manage Projects. • **Enhanced transparency:** Providing deliverables and relevant information to a system of reference can generate transparency in Project operations. This can build trust across Delivery Partners, which can be enhance Project delivery. • **Better organization and quality control:** Submitting engineering and design deliverables to a central system of reference can improve visibility into Project Operations. This helps identify and correct any issues early on to support quality control for the Project and improve decision-making.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
Comply with Data security measures outlined by DTO to protect sensitive Data and maintain confidentiality.	The province and DTO will adhere to the mandated Security and Confidentiality standards when holding any Data within the AssetFlow Hub. DTO will have the authority to issue Administrative Monetary Penalties based on the specific circumstances of a violation pertaining to security measures up to a maximum amount.	• **Intellectual property safeguarding and Data protection:** Compliance with DTO and IO guidelines helps safeguard valuable intellectual property from unauthorized access, theft, or infringement. Further, following the Utility Manual's steps ensures effective management and safeguarding of sensitive Data, reducing the risk of unauthorized access or Data breaches. • **Enhanced collaboration and coordination:** Creating consistency across Data security and confidentiality processes builds trust across all Delivery Partner authorities who rely on each Infrastructure Owner and the province to protect sensitive Data.
Use digital tools and platforms to enhance efficiency in Data sharing and collaboration, as recommended in the Manual.	DTO will specify the requirements and relevant regulations which digital tools and platforms for Designated Priority Projects must meet. DTO will support in attributing costs associated with collecting, processing, and analyzing Data across Delivery Partners involved with Designated Priority Projects through additional tactical guidance.	• **Streamlined processes and increased efficiency:** Digital tools and platforms streamline data sharing, which leads to cost savings by requiring fewer physical documents, shorter project timelines through real-time information exchange, improved data quality via standardized processes, and effective risk management due to prompt issue resolution. • **Improved Data accuracy and quality:** Digital tools and platforms enforce standardized Data formats, ensuring consistent and accurate asset information across Projects. • **Cost savings in asset management:** Leveraging digital tools and comprehensive asset management aspects leads to cost savings by optimizing asset performance, reducing maintenance costs, and improving lifecycle management through digital twins.
Track and measure specific Key Performance Indicators (KPIs) related to Data Ingestion, Data Exploration, Data Sharing, and Data Collaboration.	DTO specifies the KPIs that should be tracked depending on the type and scale of the Designated Priority Project in the Manual. Additionally, DTO may specify the processes under which KPIs should be tracked.	• **Performance evaluation and benchmarking:** Tracking KPIs allows Infrastructure Owners to evaluate the efficiency, accuracy, and timeliness of Data sharing, identify areas for improvement, and make informed decisions to enhance overall performance related to Infrastructure coordination. Further, tracking KPIs can support the implementation of initiatives to support higher performance. • **Enhanced transparency:** Tracking KPIs improves accountability and transparency by establishing clear expectations and fostering trust across Delivery Partners and the public. In turn, Delivery Partners can better coordinate, plan and avoid delays. • **Streamlined processes and increased efficiency:** Tracking KPIs helps identify opportunities for resource allocation, workflow optimization, and cost savings, leading to improved Project outcomes.

Utility Manual Requirement for Delivery Partners	Requirements for the government & Digital Twin Ontario	Value Added to Delivery Partners
Acquire the appropriate tools and technology, such as photogrammetry and laser scanners, GIS (or suitable alternatives), and other relevant tools, to fulfill the Data quality requirements for BIM integration in Projects and Digital Twins.	DTO may provide funding to smaller Delivery Partners, whose existing technology systems would require significant investment to have the appropriate tools. Funding is dependent on the extent to which the Manual requires a Material increase in effort and/ or investment beyond what would otherwise be expected.	• **Improved Data accuracy and quality:** Using recommended technologies helps to ensure precise Data collection, reducing errors and improving Data quality. • **Better Project Management:** Leveraging relevant technologies supports the capture of comprehensive Data to inform decisions, identify conflicts, and optimize the design process for efficient and cost-effective Projects. • **Enhanced collaboration and coordination:** Appropriate tools facilitate collaboration and real-time Data sharing among Delivery Partners, enabling efficient decision-making and issue resolution. • **Operational sustainability and technology compatibility:** Adopting tools such as laser scanners and GIS enhances productivity for asset management, inspections, and maintenance activities. Additionally, early investments in technology will support Delivery Partners in achieving their return on investment and facilitate equipment upgrades to keep pace with technological advancements.

Digital Twin Ontario

Utility Manual:

Executive Summaries to Support Sector Engagement

2025

CONFIDENTIAL DRAFT FOR DISCUSSION PURPOSES ONLY

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The Manual presumes that the Digital Twin Ontario Act has been enacted, providing enabling legislation for legislative and regulatory measures. Including presumptive legislation in the Manual is intended to assist Industry consultations by building an understanding the expectations of Appointing Parties, Lead Appointed Parties, and other Appointed Parties in supporting Digital Twins to accelerate Infrastructure deployment. Note that the Province of Ontario has yet to adopt any legislation or regulation officially, and any discussions regarding regulatory tools are solely for authorized discussion purposes to inform policy recommendations.

As per Industry standards, a capitalized word indicates that a definition can be found in the glossary of the Utility Manual.

Overview of Section 1: Introduction

Introduction:

Section 1 provides an overview of the Manual and its role in implementing Digital Twins in Ontario. It outlines guidelines and procedures for Delivery Partners to comply with relevant legislation and regulations, provides context on the development of the Manual, outlines the roles and responsibilities of Delivery Partners, and explains how the Manual aligns with Industry Leading Practices.

Adherence to the Manual is critical for the successful completion of Designated Priority Projects. The Manual aims to establish a repeatable, sustainable process for supplying utilities Data to DTO platforms and will undergo bi-annual reviews to ensure it is complete and up-to-date (Update Cycle). Greater specification to Delivery Partners will be provided through Bulletins as is required (at the sole discretion of DTO or as ordered by the Minister) to support the implementation and operation of DTO.

Structure of the Manual:

The Manual serves as a comprehensive guide for Delivery Partners involved in managing Digital Assets within the DTO Framework, which guides Information Management for Projects. The Manual is divided into three parts:

1. Context Framing
2. Instructional Manual
3. Summary & Next Steps

The Manual covers various categories of content, including BIM strategies, Data Policy, Data Sharing, Digital Twins, Information Management, and Utility Coordination. It references and complies with several existing standards, including CSA S25020, ASCE 75-22, ASCE 38-22, ISO 19650-1, ISO 19650-2, ISO 19650-3, ISO

19650-4, ISO 19650-5, ISO 55000, and United Nations Sustainable Development Goals.

Who the Manual Applies to:

The Manual applies to Delivery Partners, who encompass a wide range of entities, such as Provincial Government Entities (Including Infrastructure Ontario), Municipalities, Utilities Industry, Project Partners, and the DTO Operations Team. The Manual provides specific instructions and definitions for

each key Delivery Partner, ensuring clarity and alignment throughout the implementation process.

Benefits of the Manual:

Overall, the Manual aims to enhance Project delivery, improve decision-making, and optimize the management of Digital Assets within the DTO Framework. It promotes the adoption of leading practices, aligns with industry standards, and emphasizes the importance of data governance, utility coordination, and BIM integration. By adhering to the Manual, Delivery Partners can achieve better Project outcomes, improve Project efficiency throughout the construction lifecycle, and contribute to broader economic and social benefits for Ontarians.

Key Takeaways

1. The Digital Twin Ontario Utility Manual is a guide for managing Digital Assets within the Digital Twin Ontario Framework.
2. It comprises three parts: Context Framing, Instructional Manual, and Summary & Next Steps.
3. It outlines Data Sharing, Utility Coordination, and roles for Delivery Partners.
4. The Manual focuses on integrating Subsurface Utility Engineering (UIE), Building Information Modeling (BIM), and Geographical Information Systems (GIS).
5. It aims to create a sustainable process for supplying utilities data to DTO platforms.
6. It covers BIM strategies, Data Policy, Data Sharing, Digital Twins, Information Management, and Utility Coordination.
7. It adheres to standards such as CSA S25020, ASCE 75-22, ASCE 38-22, ISO 19650 series, ISO
8. 55000, and United Nations Sustainable Development Goals.
9. Delivery Partners include Government Entities, Municipalities, Utilities Industry, Project Partners, and the DTO Operations Team.
10. The Manual seeks to enhance Project delivery, decision-making, and Digital Asset management.
11. It promotes leading practices, industry standards alignment, and emphasizes data governance, utility coordination, and BIM integration.

Overview of Section 2: Designated Priority Projects

Introduction:

Section 2 outlines the process for identifying Designated Priority Projects ("Projects") and its key features and requirements that make them distinct from other initiatives. The authority to designate a Project lies with the Minister of Infrastructure (the Minister). Projects receive priority access to resources, funding, and support from and for Delivery Partners, and are required to adhere to the requirements set out in the Manual, and as prescribed by legislation and regulation.

Process for Identifying Designated Priority Project:

The Minister will consider several factors when designating Projects, including but not limited to:

- Ministry of Infrastructure (MOI) / Infrastructure Ontario (IO) Mandate
- Impact on citizens/community in the Project area
- Alignment with government priorities
- Time to impact, balancing quick wins while working to solve long term challenges
- Financial impact, including potential cost savings
- Feasibility, including technical (e.g., systems, data) and non-technical (e.g., capacity)
- Opportunities for repeatability and scalability

Delegated Tasks for Designated Priority Projects:

The Manual prescribes and references the same delegated tasks for Priority Projects as outlined in the Building Transit Faster Act (BTFA), 2020. The Utilities Industry is obligated to inform the Minister of Infrastructure about permit matters related to corridor development permits, following Ministerial directives. Notification to the Minister is required for various activities, including entering lands without the property owner's agreement, construction danger inspection, and obstruction removal. Procedures for handling stop-work orders, compliance inspections, and obtaining warrants for inspections are also specified, requiring notification and reporting to the Minister. The Utilities Industry is responsible for registering land designation notices and notifying landowners of designated utilities Infrastructure land.

Initiating a Designated Priority Project:

The Manual outlines the steps required to initiate a Project including but not limited to determining executive sponsorship, establishing a governance model and team, and executing and documenting each stage of the Project life cycle (Briefing Concept, Defined Design, Build and Handover, Operate and Maintain). The Manual also identifies several considerations when determining procurement agreements, such as defining a clear payment structure, incorporating performance-based payment mechanisms to incentivize Delivery Partners, ensuring payment security through provisions like performance bonds, and establishing a transparent and accountable payment process with mechanisms for dispute resolution.

Additionally, compliance with relevant laws and regulations, such as tax laws and procurement rules, should be a key consideration in these agreements.

Key Takeaways

1. The Manual applies to Designated Priority Projects. Section 2 outlines the process of identifying Designated Priority Projects based on the Minister's authority.

2. Factors considered for Project designation include alignment with government priorities, impact on Ontarians, feasibility, financial impact, and opportunities for repeatability and scalability.

3. Delegated tasks for Priority Projects leverage the approach used in the BTFA, with specific requirements for notification to the Minister for various activities, including permit matters, land entry, inspections, and compliance.

4. Initiating a Designated Priority Project involves steps like determining executive sponsorship, establishing governance, and executing Project stages.

5. Considerations for procurement agreements include defining payment structures, incorporating performance- based mechanisms, ensuring payment security, and addressing compliance with relevant laws and regulations.

Overview of Section 3: Legislation and Regulations

Introduction:

Section 3 outlines the legislation that grants Digital Twin Ontario (DTO) authority over all Designated Priority Projects, including as it relates to Utilities Industry Data Sharing and Utility Coordination standards and practices.

The Manual presumes that the Digital Twin Ontario Act (DTO Act) has been enacted. However, the Government of Ontario has not yet adopted any legislation or regulation. Including presumptive legislation in the Manual is intended to assist industry consultations by building an understanding of expectations for Delivery Partners to accelerate Infrastructure deployment.

Main Requirements for Delivery Partners:

To enable Digital Twin technology and accelerate the deployment of critical Infrastructure in Ontario, Delivery Partners are required by legislation and regulation to:

- Comply with requirements outlined in the Manual.
- Notify other Infrastructure Owners when a subsurface utility has been located during excavation.
- Create a Digital Asset as per standards in the Manual, upon notification by an Appointing Party that a Subsurface Utilities Infrastructure has been located.
- Ensure that underground utilities installed, repaired, or altered after a specified date include radio frequency identification (RFID) technology or a suitable alternative.
- Provide a Digital Asset to an Appointing Party acting as the Project Proponent through the DTO AssetFlow Hub within the time period mandated for a Locate Request.
- Maintain a Digital Asset and record of the Infrastructure for a defined time period.
- Submit all permits required for or in proximity to a Project through the E-Permitting Platform; and
- Hold a minimum level of insurance in the event of an accident on a Project.

In addition, the DTO Act exempts Infrastructure Owners from existing legislative requirements

to provide a marking of their underground Infrastructure when a Digital Asset is provided. It also reinforces a Project Proponent's right to seek damages in case of an inaccurate locate and the prohibition on fees for locates.

Powers Granted to Digital Twin Ontario:

To support the enablement of the Manual and to ensure the regulatory framework supports the collection and sharing of required Data, The DTO Act provides DTO with Administrative Authority to:

- Update existing regulations (e.g., Ontario Building Code) to apply Data-relevant standards.
- Create regulations that define the requirements for sharing Data with the AssetFlow Hub.
- Administer a single Data capture and sharing system that will allow for the issuance of digital locate records and facilitate the flow of Information between Infrastructure Owners during Projects.
- Receive and review complaints related to inaccurate, incomplete, or delayed Data.
- Issue Administrative Monetary Penalties based on the violation of any of the above mandates.
- Require the government to collaborate with municipalities to apply the Manual and relevant Data standards, including by empowering municipalities to issue Administrative Monetary Penalties.

Key Takeaways

1. Section 3 outlines DTO's authority over Infrastructure related to Designated Priority Projects, and Utility Coordination standards and practices.
2. Delivery Partners must comply with the Manual, create Digital Assets of located underground utilities Infrastructure, and install RFID technology in new subsurface utilities.
3. Delivery Partners must submit all permits related to Designated Priority Projects through a central DTO E-Permitting Platform.
4. The DTO Act exempts Infrastructure Owners from marking underground Infrastructure for a locate request when a Digital Asset is provided.
5. DTO has the power to update existing regulations, create regulations for data sharing, and issue monetary penalties in cases of non-compliance.

Overview of Section 4: Digital Twin Ontario

Introduction:

The Utility Manual is one of Digital Twin Ontario's (DTO) initiatives. DTO is dedicated to increasing efficiency, increasing cohesion among stakeholders, and driving innovation across the Infrastructure lifecycle. DTO's vision, objectives, and implementation processes are outlined in section 4 of the Manual, with a focus on the utilization of Utilities Infrastructure Engineering (UIE) and Building Information Modeling (BIM).

DTO's Mission and Priorities:

Through the Utility Manual, DTO is aiming to standardize Information and Data Management across Ontario. DTO's mission includes enabling Digital Twins, establishing data quality, development standards, and guidelines, setting up required capabilities, and operating and maintaining the Digital Twin ecosystem. DTO's priorities are to manage Digital Engineering Data effectively, standardize data use, maximize efficiency, inform, and support key aspects of Digital Engineering, and manage major assets effectively. DTO will offer services like Digital Twin Development, Operations and Maintenance, and Change Management. DTO's approach involves starting small with reusable assets to demonstrate value and return-on-investment (ROI) and relies on Open Data and Leading Practices for Data Management. DTO's focus for 2023-2024 is on enabling the Manual (Phase 1), defining criteria for Delivery Partner Project proposals, and identifying use cases. The DTO Framework guides Information Management for Projects, including Skills and Roles Development, and Security and Confidentiality Requirements. Training materials and templates will be provided to Delivery Partners as part of the DTO Framework to ensure they effectively contribute to the mandate's success.

DTO's Administrative Authority:

The Digital Twin Ontario Act (DTO Act) grants the Minister of Infrastructure specific powers to create new regulations related to Data standards and sharing to enable Digital Twin technology and accelerate the deployment of critical Infrastructure in Ontario.

Note: the DTO Act has not yet been enacted. Including presumptive legislation in the Manual is intended to assist industry consultations by building an understanding of expectations for Delivery Partners to accelerate Infrastructure deployment.

Precedent for DTO as an Administrative Authority exists in various acts such as the Technical Standards and Safety Act, 2000 and the Ontario New Home Warranties Plan Act, 1990. DTO's role is

to assist Delivery Partners in adapting to the regulatory framework related to Digital Twin technology in Infrastructure development. The Act also enables DTO to enforce compliance with legislative and regulatory provisions, including the power to issue Administrative Monetary Penalties for violations. DTO, following the Ontario Dispute Adjudication for Construction Contracts (ODACC) as condition precedent, can appoint adjudicators, conduct hearings, issue binding decisions, and enforce those decisions. DTO also facilitates a dispute resolution process between Delivery Partners to resolve issues related to construction contracts promptly and cost-effectively.

Key Takeaways

1. DTO standardizes Information and Data Management in Ontario through the DTO Framework.
2. DTO centralizes Ontario's Infrastructure practices, enabling Digital Twins creation.
3. DTO's priorities involve managing Digital Engineering Data, standardizing data use, maximizing efficiency, and managing assets.
4. DTO services include Digital Twin Development, Operations and Maintenance, and Change Management.
5. DTO's approach involves starting with small, reusable assets to maximize ROI.
6. The DTO Mandate, built on leading practices, is regularly updated.
7. Open Data is central to the DTO Mandate, improving cost, value, and performance.
8. The DTO Core Team leads and coordinates the DTO Mandate.
9. DTO's 2023-2024 focus is on enabling v1.0 of Manual and developing Bulletins (expanded requirements) for specific use cases.
10. The DTO Framework guides Information Management for Projects and includes Skills and Roles Development, and Security and Confidentiality Requirements.
11. DTO provides training materials and templates to Delivery Partners for effective mandate contribution.

Overview of Section 5: Data Ingestion and Data Exploration

Introduction:

This section details the requirements for Data Ingestion and Data Exploration related to Data Sharing, Digital Twins, and Utility Coordination for Projects. It provides guidance on implementing DTO standard practices in Utilities Infrastructure Engineering (UIE) and Building Information Modeling (BIM) Projects and outlines the minimum requirements for successful Data Ingestion and Data Exploration implementation. UIE requirements primarily address Horizontal Structures, while BIM requirements primarily address Vertical Structures.

Key Understandings for Data Ingestion:

Data Ingestion involves collecting and importing Data from various sources such as Geographical Information Systems (GIS), Asset Management systems, and construction documents. This Data is then analyzed and visualized in the Data Exploration process to gain insights and identify patterns or trends, which is crucial for the development of Digital Twins. The iterative cycle of Sense/Ingest, Classify, Refine, Decide, and Act/Optimize refines and optimizes Data throughout a Project. Key roles in this process include Assets Manager, BIM Specialist, and Data Custodian. It is also essential to identify and attribute costs associated with collecting, processing, and analyzing Data to determine its true value and make informed decisions.

Key Understandings to Enable Data Exploration:

The Common Data Environment (CDE) is a centralized digital platform that facilitates the sharing and management of Project information throughout its entire lifecycle. Uniclass 2015 is a leading practice and is used for organizing construction information, with the Industry Foundation Classes (IFC) facilitating interoperability between different software applications. The asset classification standard is based on Uniclass 2015, with IFC used to exchange this information seamlessly. Relevant IFC schemas for a Project include IFC Infrastructure Alignment, Bridge, Tunnel, Building Service, and Site.

Key Understandings to Enable Data Exploration:

Delivery Partners must adhere to Open Data standards for Data Ingestion and Data Exploration processes, supporting Digital Twins and Infrastructure construction in line with the Building Code Act, 1992, Technical Standards and Safety Act, 2000, and Ontario Provincial Standards. The DTO Act mandates Appointing Parties to comply with Data and construction standards, notify when a subsurface utility is located during excavation, create a Digital Asset, and include radio frequency

identification (RFID) technology (or an equivalent alternative, as required) in newly installed underground utilities.

Key Takeaways

1. Data Ingestion is the collection and importation of Data from various sources into a system.
2. Data Exploration involves analyzing and visualizing Data to gain insights and identify patterns or trends.
3. The Iterative Cycle refines and optimizes Data throughout a Project via stages of sense/ingest, classify, refine, decide, and act/optimize.
4. Key roles for Data processes include Assets Manager, BIM Specialist, and Data Custodian.
5. Cost attribution identifies, and attributes costs related to Data collection, processing, and analysis.
6. UIE requirements address Horizontal Structures, while BIM requirements address Vertical Structures.
7. The Common Data Environment (CDE) is a centralized platform that facilitates sharing and management of Project information.
8. Uniclass 2015 organizes and structures construction information, while Industry Foundation Classes (IFC) facilitate interoperability between software applications.
9. Asset classification is based on Uniclass 2015, with IFC used for seamless information exchange between software applications.
10. Relevant IFC schemas for a Project include IFC Infrastructure Alignment, Bridge, Tunnel, Building Service, and Site.

Overview of Section 6: Data Sharing and Data Collaboration

Introduction:

Section 6 sets out requirements and implementation instructions for Data Sharing and Data Collaboration in Projects, for Utilities Infrastructure Engineering (UIE) and Building Information Modelling (BIM). Please refer to Section 8 to understand how requirements apply to each stage of Projects.

Data Sharing is the process of sharing Data with others within or outside an Organization. Data Collaboration is the process of working together to create and maintain a comprehensive and accurate Digital Model of the Infrastructure. In the context of UIE and BIM, Data Sharing serves the purpose of validating Information for decisions based on the Digital Model.

Key Requirements for Data Sharing and Data Collaboration:

To improve collaboration and coordination amongst Delivery Partners, the Manual requires Project Teams to:

- Make relevant Data and Information available to Delivery Partners and Project Team Parties during a Project. This helps to facilitate collaboration and improve Project decision-making.
- Work with other Delivery Partners and Project Team Parties to input Data, as well as review and validate Information. This ensures that the Digital Model is accurate and up-to-date, and that decisions made based on it are reliable and effective.

The following outlines the guidelines and protocols for Data Sharing, Data Collaboration, and Stewardship. Note that Requirements differ for UIE and BIM practices.

To enhance data accessibility and efficiency as part of UIE, Delivery Partners are required to:

- Implement appropriate data security measures.
- Utilize digital tools and platforms to improve efficiency.
- Foster a culture of collaboration and trust.
- Follow ASCE and CSA standards for recording and exchanging Utility Infrastructure data.

To strengthen Project coordination and planning through BIM, Delivery Partners are required to:

- Develop Asset Information Requirements that comply with regulatory requirements and address various aspects of Asset Management.
- Comply with ISO 19650-1, a framework for managing Information over the whole life cycle of a built Asset using BIM.
- Implement an Information Structure and Asset Classification System.
- Utilize Construction Operations Building Information Exchange (COBie).
- Utilize a Model Element Authoring Schedule.

Additional guidance for each requirement is available in Sections 6.3 and 6.5 of the Manual.

Delivery Partners are also required to track and measure certain Key Performance Indicators (KPIs) to achieve Data Sharing and Data Collaboration requirements. Activities to enable KPIs must be performed by Project Teams once per quarter, twice per year, or once per year, depending on the scale of the Project. Detailed metric(s) per KPI is available in Section 6.6 of the Utility Manual.

Delivery Partners must also align on the processes and expectations for shared utility Infrastructure Data in Ontario under DTO. As part of the DTO Data Sharing Process, Delivery Partners are required to:

1. Mandate Data submission and Soft Landings.[1]
2. Enforce Data Sharing and reconciliation.
3. Establish Data Ingestion Specification.
4. Update and review Data.
5. Sign-off / transmittal process.

Detailed instructions can be found in Section 6.7 of the Manual.

UIE and BIM Data Security and Confidentiality Compliance:

As DTO is the mandatory interchange hub for Data flow between different Utility Service Types, DTO plays a key role in ensuring compliance and maintaining Data Security. Delivery Partners are required to comply with mandatory steps (to be outlined) for managing and protecting Data Assets. Guidance will be provided in the final Manual.

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1 Soft Landings describes the planned, structured, and graduated handover of an Asset from the design and construction team to the operation and maintenance team. The aim of Soft Landings is to improve operational performance; as a process it aligns the interests between those who design and construct an Asset and those who subsequently use it.

Key Deliverables Required from Delivery Partners:

Delivery Partners on a Project are required to complete the following Deliverables during a Project and provide relevant Information upon request(s) through the DTO AssetFlow Hub, across both UIE and BIM:

- Digital Tools Implementation.
- Asset Information Requirements.
- Information Structure and Asset Classification System.
- Model Element Authoring Schedule.
- Modelling Process with scope, timeline, and resources outlined.
- Model Location and Model Orientation.
- Defining the Level of Development for each Element of the model.
- KPIs for Data Sharing and Data Collaboration (general and BIM Compliance).
- Asset Information strategy.
- Data Sharing and reconciliation policies and procedures.
- Data Ingestion Specification.

Relevant Legislation and Regulations:

To accelerate the deployment of Infrastructure through Open Data Collaboration across Delivery Partners, it is essential to consider legislation in Ontario that establish precedent for Data Sharing and Data Collaboration, including the Infrastructure for Jobs and Prosperity Act, 2015, the Simpler, Faster, Better Services Act, 2019, The Building Transit Faster Act, 2020 and the Building Broadband Faster Act, 2021.

The DTO Act establishes legislative provisions to facilitate Data Sharing and Data Collaboration to enable Digital Twins in Ontario. Appointing Parties are required to provide Digital Assets and records of Infrastructure upon receiving a Locate Request and maintain these Digital Assets and records in a local repository. At the same time, DTO's AssetFlow Hub facilitates the flow of Digital Assets and records from and to Appointing Parties.

Key Takeaways

1. Data Sharing is the process of sharing Data with others within or outside an Organization. Data Collaboration is the process of working together to create and maintain a comprehensive and accurate Digital Model of the Infrastructure.

2. The Manual covers both UIE and BIM requirements depending on key elements identified in Projects. UIE and BIM have different requirements.

3. The Manual outlines KPIs that Delivery Partners must adopt to measure quality of Data Sharing and Data Collaboration in UIE and BIM.

4. Delivery Partners need to understand who to send their Data to, where it goes, and how to receive Data back. This Manual establishes a single Data Sharing process for Delivery Partners' interactions through DTO.

5. DTO plays a key role in ensuring compliance with National and Provincial Data Security standards to enable effective Data Sharing. The Manual establishes instructions on how to properly manage and protect Data Assets and report on Data Security Compliance.

Overview of Section 7: Integration of BIM Standards and Processes

Introduction:

Section 7 provides instructions on how Building Information Modeling (BIM) is integrated into Projects. BIM is a digital process that involves the creation, management, and sharing of comprehensive and accurate information about a building or Infrastructure Project. It utilizes advanced software and technologies to create a virtual representation of the Project. By consequence, BIM improves collaboration and increases efficiency.

The BIM Standards in the Manual are specific to Data types, quality, processes, and requirements of Projects. Delivery Partners are required to follow the BIM standards throughout the Project stages and for any BIM Asset shared through the DTO AssetFlow Hub.

Key Requirements for Building Information Modeling:

The BIM standards in the Manual are based on the ISO 19650 series, which both the Centre for Digital Built Britain UK BIM Framework and the Office of Projects Victoria Digital Assets Strategy reference as Leading Practice. Delivery Partners must adhere to the following requirements to support BIM integration and implement the Manual:

- Understand BIM standards for Data types, Data quality, processes, requirements in Projects and DTO, and the purpose of BIM standards in the Manual.
- Understand the information management processes required to achieve BIM ISO 19650 standards.
- Map Infrastructure and utilities Data using geospatial mapping systems and meet the requirements for geospatial mapping and analysis as a key digital Data asset.
- Obtain the necessary tools and technology to meet Data quality requirements for BIM integration in Projects and Digital Twins, including photogrammetry, laser scanners, GIS, and other relevant tools.
- Understand the processes for integrating BIM with Digital Twins, including but not limited to reality capture, “As-Built” modelling, site awareness and visualization, and clash detection.

Relevant Legislation and Regulations:

The Manual provides guidance on the importance of complying with existing legislation and regulation throughout a Project's lifecycle. This includes but is not limited to:

- Ontario Underground Infrastructure Notification System Act, 2012
- Municipal Act, 2001
- Technical Standards and Safety Act, 2000
- Ontario Provincial Standards
- Ontario Construction Act, 1990
- Environmental Assessment Act, 1990
- Planning Act, 1990
- Ontario Infrastructure and Lands Corporation Act, 2011
- Ontario Building Code (O. Reg. 332/12)

Key Takeaways

1. BIM is a digital process that creates, manages, and shares accurate information for buildings and Projects, improving collaboration and efficiency.
2. The Manual's BIM Standards cover Data types, quality, processes, and Project requirements, which Delivery Partners must follow throughout the Project stages and when sharing BIM assets through the DTO AssetFlow Hub.
3. The Manual's BIM Standards are based on the ISO 19650 series, recognized as leading practice by the Centre for Digital Built Britain and the Office of Projects Victoria Digital Assets Strategy.
4. Delivery Partners must understand the Manual's BIM standards for Data types, quality, processes, Project requirements, and their purpose.
5. Delivery Partners must also understand the information management processes required to meet the ISO 19650 Series BIM standards.
6. Photogrammetry, laser scanners, and geospatial mapping are required to meet Data quality requirements for BIM integration in Projects and Digital Twins and are essential for accurate mapping of Infrastructure and utilities Data.
7. Delivery Partners should be familiar with processes for integrating BIM with Digital Twins, including reality capture, "As-Built" modeling, site awareness, visualization, and clash detection.
8. Compliance with relevant legislation and regulations is crucial throughout the Project lifecycle.

Overview of Section 8: Data Sharing and Utility Coordination Requirements for Project Stages

Introduction:

Section 8 provides instructions on activities required for Data Sharing and Utility Coordination across the four (4) key stages of a Project: (1) Briefing Concept Stage; (2) Defined Design Stage; (3) Build and Handover Stage; and (4) Operate and Maintain Stage. The stages are adaptable, allowing for compatibility with different procurement routes.

Summary of Project Stages:

The Briefing Concept Stage is the initial stage of a Project where the Appointing Party articulates the problem statement into a Project opportunity statement by gathering relevant contextual information. The stage involves assessing a wide range of procurement options, including Traditional Design-Bid-Build, Public-Private Partnerships, Design-Build, Design-Build-Finance-Operate-Maintain, Integrated Project Delivery, and Collaborative Contracting. The Briefing Concept Stage requires Delivery Partners to comply with data and information requirements, complete the Due Diligence process for utilities on a Project, and select the preferred procurement route, which will inform the next stage of the Project.

The Defined Design Stage expands on the selected procurement option from the Briefing Concept Stage and provides a more detailed Business Case confirmed by the Appointing Party. This stage involves gathering a significant amount of information and initiating the procurement of the Lead Appointed Party and/or Appointed Parties. Detailed design and engineering activities can commence once the necessary parties have been confirmed. During this stage, information gathering, detailed design, community engagement, commercial reviews, pre-construction activities, permitting, technical studies, and the development of a Digital Engineering Execution Plan occur simultaneously, which includes a RACI Matrix to guide construction and site activities. The Defined Design Project Stage Gate is marked by agreement among all parties on the strategies, documents, and execution plan(s) assigned to the Project Stage.

The Build and Handover Stage transforms designs and intentions into a tangible and functional entity, such as a building, bridge, or Infrastructure, to initiate the Project. With improvements to Data Management, prescribed through the Manual, Delivery Partners in the Build and Handover Stage should experience increased efficiency and accuracy in construction plans. The Appointed Party and its supply chain (includes Lead Appointed Party and Appointed Parties) are responsible for executing the Project and creating Handover Material to be presented to the Asset Owner upon completion of the Project. This handover must include all necessary information from the Briefing Concept

stage to the Build and Handover stage of the Project, and the Asset Information Model should be utilized during this process. It is essential to use BIM during the handover process to ensure that all necessary information is accurately transferred to the Asset Information Model for effective management and maintenance of the Project throughout its lifecycle.

The Operate and Maintain Stage requires partners to maintain the Asset Information Model, manage Data, implement the Asset Management plan, coordinate with Utility Providers, and review and update plans. Effective Data Management and Utility Coordination involve various activities, including real- time Asset performance monitoring, continuous improvements, predictive maintenance strategies, utility management planning, Data Sharing protocols, and adherence to CSA S25020 Mapping of Underground Utility Infrastructure requirements. The Asset Management Deliverables checklist includes an executive Project report, ongoing feedback, new systems budgeting, Data updates, and reporting on Project progress.

Benefits of Utility Coordination for Delivery Partners:

Utility Coordination is vital for managing utilities within a Project area to prevent delays, cost overruns, and safety hazards. It involves managing utilities like water, gas, electricity, and telecommunications. Subsurface Utility Engineering (SUE) investigations, in line with ASCE 38-02, ensure consistent and transparent utility collection and depiction. Quality Levels range from QL-D to QL-A, each with increasing requirements for collecting and confirming Subsurface Utilities Information. Understanding the Quality Level of utilities on engineering drawings is crucial for effective Utility Coordination. Investigations should minimize potential utility damage, provide precise location information, and other utility attributes, with an accuracy of 15-mm vertical and to the expected horizontal survey and mapping accuracy.

Key Deliverables Required from Delivery Partners:

Delivery Partners on a Project are required to complete the following deliverables, across the 4 Project Stages, and share documentation with the Appointing Party and through the DTO AssetFlow Hub upon request. The deliverables are intended to improve Data Management to enable Digital Twins:

- Asset Information Requirements
- Asset Information Model
- Organizational Information Requirements
- Exchange Information Requirements (includes Soft Landings)
- Digital Engineering Execution Plan

- Digital Engineering Execution Response
- Building Information Modeling Execution Plan

Relevant Legislation and Regulations:

- Master Information Delivery Plan
- Preferred Alignment Base Plan
- Utility Conflict Matrix
- Street Tree Inventory
- Street Tree Preservation Plan
- Utility Risk Assessment Matrix
- 30%, 60%, and 90% Detailed Design
- Utility Coordination Plan
- Utility Communication Plan
- Composite Utility Plan
- Utility Relocation Matrix
- Utility Coordination Schedule
- Enhanced Design
- "As-Built" Records and Drawings
- Lesson Learned Reports, includes 360- degree Digital Engineering Lessons Learned Feedback
- Utility Management Plan

The Manual emphasizes the importance of considering various Acts and directives throughout the construction lifecycle of a Project. It lists several relevant Acts such as the Ontario Underground Infrastructure Notification System Act, 2012, the Ontario Infrastructure and Lands Corporation Act, 2011, the Municipal Act, 2001, the Technical Standards and Safety Act, 2000, the Ontario Construction Act, 1990, the Environmental Assessment Act, 1990, the Planning Act, 1990, the Ontario Building Code (O. Reg, 332.12), the Broader Public Sector Procurement Directive, and the Ontario Provincial Standards. The Manual requires all Appointing Parties to comply with all legislative and regulatory requirements that are relevant to the Project in Ontario. The Manual's legislative and regulatory regime enables Digital Twins throughout the Project lifecycle, with provisions such

as creating a Digital Asset and record, including radio frequency identification technology (or an equivalent alternative where not possible), providing Digital Assets and records upon a Locate Request, and not allowing external parties to charge for a Locate Request.

Key Takeaways

Briefing Concept Stage:

1. Articulate problem statement and assess procurement options.
2. Comply with data and information requirements.
3. Complete Due Diligence for utilities.
4. Select preferred procurement route.

Defined Design Stage:

1. The Appointing Party must complete, and internally confirm, a detailed Business Case for the Project.
2. Procure Lead Appointed Party and/or Appointed Parties.
3. Commence detailed design, engineering, and pre-construction activities.
4. Develop Digital Engineering Execution Plan and RACI Matrix.

Build and Handover Stage:

1. Transform designs into physical structure.
2. Create Handover Material and use BIM to transfer necessary information.
3. Ensure all info from previous stages is included in handover.

Operate and Maintain Stage:

1. Develop and implement comprehensive maintenance plan.
2. Conduct regular inspections and preventative maintenance.
3. Monitor energy consumption and respond to issues/emergencies.
4. Maintain accurate records and continuously evaluate.

Overview of Section 9: Conclusion and Next Steps

Introduction:

Section 9 provides a summary of the Manual's key points discussed for each of the Delivery Partners. The information is intended to be a helpful reference for Delivery Partners and can be used to guide decision-making throughout the Project. As new technologies and Leading Practices emerge, the Manual will be updated to reflect these changes.

This ensures that the Manual remains relevant and up-to-date, and that Delivery Partners have access to the most current information available. Section 9 also outlines where Delivery Partners can go to find more detailed information on specific topics, as well as additional resources that may be useful throughout the Project.

Manual Development and Context:

The development of the Manual leveraged a two-phased approach, informed by a review of over 45 combined Reference Documents and standards:

- Phase 1, the "DTO Utility Manual," provides high-level instruction for Data Sharing and Utility Coordination that applies to all Delivery Partners involved in Projects.
- Phase 2 will focus on developing "Utility-Specific Instructions," for specific utility owners or use cases, such as water or gas, through the form of Bulletins.
- Throughout the two-phases, the Manual presumes that the Digital Twin Ontario Act (DTO Act) and associated regulations have been enacted. However, the Government of Ontario has not yet adopted any legislation or regulation. Including presumptive legislation in the Manual is intended to assist industry consultations by building an understanding of expectations for Delivery Partners to accelerate Infrastructure deployment.

The Manual is based on ISO 19650, incorporating global and future digital perspectives, and will progress to adopt BIM Level 3, which integrates the entire asset lifecycle and is considered the future of Building Information Modeling (BIM) as technology and processes continue to evolve.

To comply with Utility Infrastructure Engineering (UIE) standards, the Manual references ASCE 38-22 and ASCE 75- 22, which will be updated in the Manual's next review cycle to reflect changes in the standards and guidelines. As 3D modeling of utilities becomes more common and standards are developed, the Manual will incorporate appropriate 3D modeling standards for utilities.

Next Steps:

Future iterations of the Manual will integrate sustainability practices and procedures as Ontario is expediting construction Projects by streamlining review processes and minimizing barriers, while ensuring robust environmental oversight. Simultaneously, the Province is taking substantial measures to reduce greenhouse gas emissions to meet the 2030 target and assist communities in preparing for the impacts of climate change. This includes practices for further consultation and coordination with Indigenous communities, beyond what is currently set in the Manual.

The Manual will undergo a review every two years to ensure completeness and currency, and if necessary, the Update Cycle will be adjusted to a yearly basis, prompting revisions or updates to terminology, processes, and requirements.

Key Takeaways

1. Delivery Partners must review the Introduction section of the Manual for important Information about its purpose, as well as requirements and key roles for Delivery Partners.

2. Delivery Partners are advised to have a foundational understanding of Digital Twins, including key definitions, perceived barriers and challenges, and benefits for Utilities Infrastructure productivity and decision-making.

3. The Manual was developed based on a review of over 45 Reference Documents and leverages a two-phased approach. Phase 1 (the DTO Utility Manual) provides high- level instructions that apply to all Delivery Partners in Projects. Phase 2 will focus on developing bulletins with more detailed instructions for specific utility owners or use cases.

4. Delivery Partners are advised to navigate the Manual carefully and refer to the Reference Documents provided to ensure they understand their roles and responsibilities.

Message from the Working Group Chair

Note: A subsequent version of the Manual will include a message from the working group chair.

Message from the Government

Note: A subsequent version of the Manual will include a message from the government.

Message from Digital Twin Ontario

Note: A subsequent version of the Manual will include a message from Digital Twin Ontario as an entity.

Acknowledgement

Digital Twin Ontario recognizes the Ministries and Agencies of the Ontario government who participated in the development of this Manual.

Digital Twin Ontario also wishes to acknowledge the many individuals, companies, and Organizations across the architecture, engineering, construction, utilities, operations Industry, and supply chain sectors. This document represents their collaborative efforts.

Executive Summary

The Digital Twin Ontario (DTO) Utility Manual on Data Sharing and Utility Coordination (also referred to as the Manual) is a milestone for Ontario's digitally- driven future. The Manual sets out minimum requirements for practices concerning the design, construction and operation of priority Infrastructure Projects called Designated Priority Projects (also referred to as Projects). Through the use of Digital Twins, the Manual aims to increase productivity, enhance Delivery Partners' confidence, reduce Project costs, and enhance public safety, among other benefits.

The Manual defines processes and procedures for Delivery Partner collaboration, including conformance measures and Confidentiality Compliance with ASCE, ANSI, CSA, ESA (where applicable), ISO, OSHA, and TAC standards[2]. It describes the integration of BIM standards and processes and provides guidelines for effective Data Sharing and Utility Coordination throughout a Project's lifecycle, with Project Stages that are adaptable.

The Manual is divided into three parts:

1. Context Framing

    a. Sections 1-4: Necessary context for Delivery Partners to orient themselves to the contents of the Manual.

2. Instructional Manual

    a. Sections 5-8: Instructions for Data and Information Management, both in Organizations and for Projects.

2. Summary & Next Steps

    a. Section 9: Summary of each of the 9 Sections and next steps for the Manual and DTO.

Digital Twin Ontario aims to establish repeatable, sustainable practices for the ongoing supply of utilities and Infrastructure Data into DTO platform(s), focusing on Designated Priority Projects (also referred to as Project or Projects). The Manual provides instructions for successful implementation of the DTO Framework in Ontario. The DTO Framework is the Information Management system for Projects.

The Manual instructs Delivery Partners on the DTO Framework through each Project Stages (Briefing Concept, Defined Design, Build and Handover, and Operate and Maintain) and sets requirements for

2 ASCE – American Society of Civil Engineers; ANSI – American National Standards Institute; CSA – Canadian Standards Association; ESA – Electrical Safety Authority; ISO – International Organization for Standardization; OSHA – Occupational Safety and Health Administration; TAC – Transportation Association of Canada.

Delivery Partners with the Digital Asset strategy for improving Infrastructure productivity through the DTO AssetFlow Hub.

Delivery Partners can contact the working group for further information and guidance at the following email: info@digitaltwinontario.ca.

1. Introduction

1.0 Section Objective

The purpose of Section 1 is to provide an overview of the Digital Twin Ontario Manual (also referred to as the Manual) and its role in enabling the implementation of Digital Twins through Data Sharing and Utility Coordination of Projects in the Province of Ontario. To ensure compliance with relevant legislation and regulations, the Manual outlines guidelines, and procedures that Delivery Partners must follow.

Key context is introduced to provide a comprehensive understanding of the Manual. The roles and responsibilities of various Delivery Partners are outlined to ensure successful implementation of the Digital Twins. Additionally, the Manual aligns with existing and emerging Industry Leading Practices to ensure that the implementation is in line with the latest standards and technologies. It is essential that Delivery Partners follow the guidelines outlined in the Manual to ensure the successful completion of Designated Priority Projects (also referred to as a Project or Projects).

1.1 Purpose of the Digital Twin Ontario Utility Manual

Outcome(s)

Align readers on the scope of the Manual. Utilize Elements of the "Purpose" section found in key resources covering similar content in three key areas: Data Sharing, Utility Coordination, and Digital Twins.

Considerations

Establish three "Parts" for the Manual (described below), as taken from the Victorian Digital Asset Strategy, which allows Delivery Partners to navigate the Manual with ease.

The Manual is presumptive with respect to legislation and regulation which would need to be adopted by the government and is for authorized discussion purposes only to inform policy recommendations. In no event shall Digital Twin Ontario (DTO) be liable for incidental, special, exemplary, or consequential Damages caused by any parties' reliance on any material found within this Manual.

Content

1.1.1 General Context

The purpose of the Digital Twin Ontario Utility Manual (also referred to as the Manual) is to provide instructions and requirements for Delivery Partners on managing Digital Assets in the Digital Twin Ontario Framework (also referred to as the DTO Framework) for Data Sharing and Utility Coordination of Designated Priority Projects (also referred to as Projects) in Ontario. This Manual is a key milestone in Digital Twin Ontario's (DTO) initiative to build a province-wide Digital Twin ecosystem, starting with Projects.

The Manual is divided into three parts:

- **Part A:** Context Framing (Section 1-4). This section provides context for the Manual and explains how it aligns with legislation, regulations, and strategies to drive towards a future where Digital Twins are used to plan, design, and operate Infrastructure more efficiently for Ontario's Projects.
- **Part B:** Instructional Manual (Section 5-8). This section provides detailed instructions to Delivery Partners on how to manage Digital Assets in the DTO Framework for Projects. It is intended to be a practical guide for Delivery Partners to follow.
- **Part C:** Summary & Next Steps (Section 9). This section summarizes key takeaways for Delivery Partners and provides actionable options for next steps to integrate Manual requirements into operations. It is intended to help Delivery Partners understand the Manual's requirements and take steps to implement them effectively.
- The Appendices for this Manual consolidated key additional materials (e.g., templates) and references used in various Parts of the Manual.
- The Glossary provides a reference description for all capitalized terms in the Manual.

DTO is further detailed in Section 4 on the full scope of its intended mission, implementation, and focus, in the context of the Manual.

- The DTO Mandate for Information Management and Data Management enables the creation of Digital Twins for Ontario's Infrastructure.
- The Information Management system for the DTO is called the DTO Framework and the digital Data Management system for the DTO is called the DTO AssetFlow Hub.

- DTO supports the enablement of the Manual through Phase 1 and 2 of the Manual as defined in Section 9.2.

1.1.2 Purpose of this Manual

The Manual provides tactical guidance and instructions for Delivery Partners on Data Sharing and Utility Coordination to drive Digital Twins aligned with Governing legislation, regulations, and Industry Leading Practices.

- The Manual sets out roles and responsibilities for Delivery Partners within their Organization and during Projects considering Data Sharing and Utility Coordination to drive Digital Twins.

The Manual focuses on providing high-level instructions for Data Sharing and Utility Coordination that can be applied to all Utility Service Types.

The Manual is introduced as part of Phase 1 of the DTO Framework by IO. The DTO Framework is discussed further in Section 5 and aligns Delivery Partners on a path towards Digital Twin Development with DTO starting with Projects. Projects are discussed further in Section 2.

The Manual is the starting point to enable a secure, auditable, trusted, and sustainable platform.

- The Manual aims to establish a repeatable, sustainable, process for the ongoing supply of utilities Data to DTO platform(s) to ensure that the latest Data and Industry Leading Practices are available to those planning and undertaking utilities Projects, starting with Designated Priority Projects.

The Manual provides specific instructions on Data Sharing and Utility Coordination. Specifically, the Manual set out requirements for Subsurface Utility Engineering (SUE), Building Information Modeling (BIM), and Geographical Information Systems (GIS) integration to drive Digital Twins development.

- SUE is incorporated into the terminology Utility Infrastructure Engineering (UIE), to capture both above ground and Subsurface Utility Engineering.

- BIM and GIS integration allows the creation of Digital Twins, combining ‘micro-level’ and ‘macro-level’ Information that can generate powerful insights and deliver value on a range of use cases.

The Manual will be reviewed on a bi-annual basis to ensure instructions are complete and up to date (Update Cycle). The cadence of this Update Cycle (for

Manual content) will be reconfirmed on a yearly basis. Greater specification will be provided through Bulletins as is required (at the sole discretion of DTO or as Ordered by the Government) for the orderly implementation and operation of the DTO.

Figure(s)

Yes ☒ No ☐

- Figure 1.1.1: Referenced ➔ Digital Twin Ontario Program Strategy: Report-Back to the Ministry of Infrastructure – Figure 3, Digital Twin
    - Describes the interaction of a Digital Twin with its real-world applications and introduces potential Elements of a Digital Twin to drive that interaction
- Figure 1.1.2: Referenced ➔ Centre for Digital Built Britain – Digital Twin Journey Infographic
    - Visually describes how Data from the physical & socio-technical environment informs Digital Twins to drive interventions

References

- Digital Twin Ontario Program Strategy: Report-Back to the Government
- CDBB – The Pathway Towards an Information Management Framework
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
- Government of Canada – Canada's Digital Ambition 2022
- Government of Canada – Digital Standards: Playbook

1.2 Context for the Manual

Outcome(s)

The knowledge base used to define terms, practices, and requirements in this Manual is derived from the Reference Documents and expertise cited in this Section. It is essential that all Delivery Partners have a thorough understanding of the Information contained within these documents to effectively apply the practices and requirements outlined in this Manual.

Considerations

When mandating the use of BIM, it is crucial to provide clear guidance to Delivery Partners that goes beyond a national directive and technical standards. The United Kingdom's experience has shown the importance of aligning with existing Leading Practice principles and frameworks, both global and local to Ontario municipalities. To this end, Reference Documents were carefully chosen from jurisdictions that align with Canada's regulatory framework and/or are recognized for Industry Leading Practices related to Data management for Digital Twins, BIM and GIS integration, and Utility Coordination internationally.

Various Reference Documents also included an "Alignment/Compliance" section to help demonstrate compliance with Industry standards and Leading Practices. By basing content on existing Industry Leading Practice documents and resources, Delivery Partners can be confident that the Manual meets the needs of Ontario's Infrastructure and Utilities Industry and serves its intended purpose.

Content

1.2.1 Context of Content

Categories of content covered in Manual (Reference Documents cover at least one of the categories):

- BIM strategies (BIM)
- Data Policy (DP)
- Data Sharing (Data Sharing)
- Digital Twins (DTs)
- Information Management (IM)
- Utility Coordination (UC)

1.2.2 Reference Documents

- Reference Documents were chosen from jurisdictions that align with Canada's regulatory framework and/or are recognized for Industry Leading Practices.

- Reference Documents have established the building blocks for future development of the Manual and related documents.

- 36 Reference Documents were utilized and directly referenced throughout the Manual specific to Canadian, British, Australian, and New Zealand jurisdictions.[3]

1.2.3 Compliance with Standards

Standards that the Manual complies with, and references, include:

1. [Canada] Canadian Standards Association (CSA Group) – CSA S25020: Mapping of Underground Utility Infrastructure

2. [North America] American Society of Civil Engineers (ASCE) – ASCE 75-22: Standard Guideline for Recording and Exchanging Utility Infrastructure Data

3. [North America] ASCE – ASCE 38-22: Standard Guideline for Investigation and Documenting Existing Utilities

4. [International] International Organization for Standardization (ISO) – BS EN ISO 19650-1:2018 – Organization and Digitization of Information About Buildings and Civil Engineering Works, Including Building Information Modelling (BIM) - Information Management using Building Information Modelling – Part 1: Concepts and Principles

5. [International] ISO – BS EN ISO 19650-2:2018 – Organization and Digitization of Information About Buildings and Civil Engineering Works, Including Building Information Modelling (BIM) - Information Management using Building Information Modelling – Part 2: Delivery Phase of the Assets

6. [International] ISO – BS EN ISO 19650-3:2020 – Organization and Digitization of Information About Buildings and Civil Engineering Works, Including Building Information Modelling (BIM) - Information Management using Building Information Modelling – Part 3: Operational Phase of the Assets

7. [International] ISO – BS EN ISO 19650-3:2020 – Organization and Digitization of Information About Buildings and Civil Engineering Works, Including Building Information Modelling (BIM) - Information Management using Building Information Modelling – Part 4: Information Exchange

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3 The full list of Reference Documents is found at the bottom of this document.

8. [International] ISO – BS EN ISO 19650-3:2020 – Organization and Digitization of Information About Buildings and Civil Engineering Works, Including Building Information Modelling (BIM) - Information Management using Building Information Modelling – Part 5: Security-minded Approach to Information Management[4]

9. [International] ISO 55000:2014[5] – Asset Management, Overview, principles, and terminology

10. [International] United Nations - Sustainable Development Goals: Decent Work and Economic Growth; Industry, Innovation, and Infrastructure; Sustainable Cities and Communities

Figure(s)

Yes ☒ No ☐

References N/A

4 UK, Australia, and New Zealand Reference Documents explicitly apply ISO 19650-1, 19650-2:2018, and ISO 19650-3:2020 contents, and terms from ISO 19650-4:2022 as well as ISO 19650-5:2020 are included in the "ISO 19650 Series" used in this Manual.

5 As of 2023, to be replaced by ISO/DIS 55000 which is currently under development.

1.3 Whom This Manual Applies To

Outcome(s)

To ensure effective Data Sharing and Utility Coordination, it is crucial to identify the Delivery Partners involved in the process. Delivery Partners involved includes both public and private sector entities. This will avoid any confusion or miscommunication. It is important to clarify the involvement of each Delivery Partner to avoid any confusion or miscommunication.

Considerations

The Manual provides four categories of Delivery Partners to allow for greater specificity as needed, as outlined in the relevant sections. The DTO Report-Back informed the application of the Manual, while other Reference Documents were used to refine the terminology.

Content

1.3.1 Categories of Delivery Partners

Proponents to whom this Manual is mandatory are defined in five categories and are collectively referred to as "Delivery Partners":

1. Provincial Government Entities, such as Ministries and Agencies
2. Municipalities
3. Utilities Industry (Includes Infrastructure Owners[6])
4. Project Partners (e.g., Project Consortiums)
5. DTO Operations Team

Within the five categories for Delivery Partners, relevant sections of the Manual will clarify specific individuals and/or roles with further specificity. Definitions for each key Delivery Partner listed above are found in the Glossary, along with any capitalized terminology.

Figure(s)

Yes ☒ No ☐

References N/A

6 As defined by the Ontario Underground Infrastructure Notification System Act, 2012, see glossary for full description.

1.4 How to Use the Manual

Outcome(s)

This section aims to provide guidance to Delivery Partners on how to access and navigate the relevant content in the Manual. It is essential that all Delivery Partners are aware of the Information that pertains to their role and responsibilities in the Project. Therefore, it is strongly recommended that all Delivery Partners know how to review the relevant sections of the Manual thoroughly and seek clarification from the DTO Support Team as necessary, at the following email: info@digitaltwinontario.ca.

Considerations

To facilitate future iterations of the Manual, it is necessary to create a dedicated section providing clear guidance for overall navigation. This section will enable users to easily locate Information and ensure that the Manual remains a comprehensive resource for all relevant procedures and guidelines.

Content

1.4.1 Navigating the Manual as a Delivery Partner

To navigate the Manual, readers are encouraged to:

1. Review Part A of the Manual: Introduction and Context Framing.
2. Determine your respective Delivery Partner category and what is expected to meet the stated requirements.
3. Identify your Organizational strengths, gaps and set goals to meet or exceed the requirements.
    - **Appendix A** (Template for Organization DTO Alignment Strategy) is provided to facilitate this exercise and considers the Organizations current Digital Asset level of maturity as compared to the Manual's vision for the Organization.
4. Navigate the Manual based on the prescribed pathways designed for each Delivery Partner.
    - **Appendix B** (Pathways for Delivery Partners Navigating the Manual) provides detailed diagrams for Delivery Partners to use as navigation through the Manual.

Figures

Yes☒ No☐

- Figure 1.3.3: Not Referenced ➔ Overview of Pathways to Navigate the Manual for Delivery Partners.

References

N/A

1.5 Mandatory Requirements for Delivery Partners

Outcome(s)

It is imperative that Delivery Partners understand their roles in upholding the requirements outlined in the Manual. To achieve this, it is crucial to ensure that all Delivery Partners are aware of the relevant content in the Manual that pertains to their participation.

Considerations

To ensure that Delivery Partners meet all requirements and expectations, it is considered a Leading Practice to provide them with an initial scope of work. This will ensure that all necessary tasks are covered and that the Project is completed successfully.

Content

1.5.1 4 Steps for Application of the Manual

There are four steps to implementing measures defined in the Manual. Each step will differ based on the scope, duration, and allocation of resources (e.g., funding) for every department and agency. Delivery Partners can expect the Ontario government to provide some level of funding to cover some of the costs associated with the transition towards full Manual integration in Ontario's Infrastructure and Utilities Industry. This funding is dependent on the extent to which the Manual requires a Material increase in effort and/or investment beyond what would otherwise be expected. DTO would have the discretion to determine the appropriateness of this compensation. The four steps are:

1. **Step 1** – Assign the role of Manual Implementation Lead who is responsible for the implementation of Manual. **Appendix C** summarizes template job descriptions for this, and other, role(s).

2. **Step 2** – Use the template for Organizational DTO Alignment Strategy, found in **Appendix A**, to develop a Manual Implementation Roadmap, Organization's Information Requirements (Organizational Information Requirements), Asset Information Requirements (Asset Information Requirements), and more.

3. **Step 3** – Align with the Manual Implementation Roadmap to deliver a Project leveraging the Manual. A Manual investment matrix can be found in Part B.

    - The investment matrix will estimate total investment against a number of factors including the risk profile, value at stake, and level of scope.

4. **Step 4** – Review performance of Manual implementation against plan and begin to make the Manual "business as usual" as the Organizations approach is refined to adopt Data Sharing

and Utility Coordination policy and standard.

1.5.2 General Requirements for Delivery Partners

General requirements for Delivery Partners include:

- Execution of Projects per contractual and/or legislative and regulatory compulsions (Section 2 for added context).
- Follow instructions for Data Sharing and Utility Coordination within the DTO Framework (Section 2 and Section 4 for added context).
- Allocate implementation functions on both an Organization and Project level.
    - If an Organization does not have the budget and/or capacity to support new roles, the accountabilities, and responsibilities of Manual roles can be aligned with existing roles or assigned to a Third Party in an agreed upon scope of services to carry out all or some of these Information Management activities.
    - There is a risk that individuals in existing roles, which are assigned Manual roles and responsibilities, may consider these secondary in importance to their usual role when particularly busy or under pressure. This risk is recognized and managed by the legislative and regulatory requirement of the Manual embedded in Project contracts.
- Perform tasks in a manner that guarantees the secure implementation and continuous functioning of utilities in Ontario.
- Follow instructions in their entirety to ensure adherence to legislative and regulatory commitments:
    - If Delivery Partners in Projects fail to comply with performance timelines and other aspects of the Guideline, the legislative and regulatory framework outlined in the Manual act as safety measures to prevent or mitigate a lack of cooperation (see Section 3).

1.5.3 Required Roles for Delivery Partners

This section identifies the Organizational Team and Project Team roles required for delivering Manual standards.

1.5.3.1 Organizational Team Roles

The following Organizational roles are required for Government Entities, Project Partners, and Utilities Industry Delivery Partners:

- Implementation Lead

- Assets Manager

1.5.3.2 Defining Organizational Key Roles for Delivery Partners

This section defines key requirements and responsibilities for Organizational roles in Section 1.5.3.1[7].

A. Implementation Lead

Executive responsibility to establish and deliver the Manual in their Organization. They are Accountable for the development of key Deliverables such as the Organizational Information Requirements and Asset Information Requirements.

B. Assets Manager

Ensures that all relevant Data related to their Organization's Assets is properly collected, stored, analyzed, and shared as needed by the Manual.

The responsibilities of an Assets Manager may involve working with various departments within the Organization, such as IT, finance, and operations, to ensure that all Data is accurate and up to date. Assets Managers may also work with external Partners, such as vendors or contractors, to collect and share Data related to Assets.

In addition, Assets Managers may be responsible for developing and implementing Data management policies and procedures to ensure that Data is properly secured, backed up, and accessible to those who need it.

This could involve working with IT teams to ensure that appropriate Data Security measures are in place, as well as developing training programs to help employees understand how to properly handle Data related to Assets.

By performing the functions of this role, Assets Managers support effective decision-making and Asset Management strategies.

1.5.3.3 Project Team Roles

The following Project Team roles are required for Government Entities, Project Partners, and Utilities Industry Delivery Partners During a Project:

- Appointing Party, Lead Appointed Party, and Appointed Party or Parties.
    - For Projects in this Manual, the Appointing Party will likely be the Government of Ontario, and/or the Ministry of Infrastructure, and/or Infrastructure Ontario, as determined by the Minister and designated through legislation and regulation.

7 These roles are compliant with ISO BS EN 19650-2 by referencing the CDBB Information Management According to BS EN ISO 19650 Guidance Part A and Office of Projects Victoria Digital Asset Strategy.

- For each Lead Appointed Party and/or Appointed Party (depending on procurement type) identify the BIM Specialist, Data Custodian, Design Manager, Facility Manager, Project Manager, Quantity Surveyor and Utility Coordinator.

For all procurement types, the DTO Operations Team operates as a separate entity during all Projects. The DTO Operations Team operates the DTO AssetFlow Hub for Data recording, Data Sharing, and the enforcement of Manual Data standards.

Separate from their roles as a Government Entity, DTO has the additional responsibility of allocating resources to plan and implement the Manual.

1.5.3.4 Defining Project Team Key Roles for Delivery Partners

This section defines key requirements and responsibilities for Project Team roles in Section 1.4.3. These roles are compliant with ISO BS EN 19650-2 by referencing the CDBB Information Management according to BS EN ISO 19650 Guidance Part A and Office of Projects Victoria Digital Asset Strategy:

A. Appointing Party

The role of "Project Owners" in ASCE 38-22 is shared by the Appointing Party and Project Manager. The Appointing Party is the "owner" or "Province" for a Project, they appoint the Lead Appointed Party or Parties. They have overall accountability for assigning responsibility of the Information Management functions set out in the Manual to their Lead Appointed Party or Parties.

If an Appointing Party has multiple Lead Appointed Parties, they will need to review various BIM Execution Plans and Master Information Delivery Plans, which may be presented in modified structures and formats.

B. Lead Appointed Party

The Lead Appointed Party has a direct appointment with the Appointing Party in accordance with ISO 19650. They oversee employing ISO 19650 processes to the Project. The Lead Appointed Party may appoint other Organizations as the Appointed Party or Parties for these functions. They may need to engage other subcontractors and consultants as needed.

In the Briefing Concept Phase (which is similar to the "tender response" phase in the ISO 19650 standard for BIM), the Lead Appointed Party or Parties are responsible for several important documents, including the Pre-Appointment BIM Execution Plan, which outlines how BIM will be used on the Project, the Capability and Capacity Summary, which details the team's skills and resources, the Mobilization Plan, which outlines how the team will get started on the

Project, and the Risk Register, which identifies potential risks and how they will be managed.

In the Defined Design Stage (which is similar to the "appointment phase" in the ISO 19650 standard for BIM), the Lead Appointed Party or Parties are responsible for several important documents, including the BIM Execution Plan, which outlines the overall strategy and approach for BIM implementation, the Detailed RACI[8] Matrix, which defines roles and responsibilities for each team member involved in the Project, Lead Appointed Party's Exchange Information Requirements, which specify the Information that needs to be exchanged between Project Parties, and the Master Information Delivery Plan, which outlines the delivery of Information and Data required for the Project.

To ensure consistency in structure and format, the Appointing Party should use templates found in **Appendix D through to K** as shared resources for Projects.

If the Lead Appointed Parties have significantly different scopes of work and Information Deliverables, the Appointing Party's templates may not be suitable. Any modified Deliverables shall contain the template Information as a minimum before applying any additional Project needs.

It is important to consider the risk of errors in shared resources produced by the Appointing Party for use by other Project Team members. These shared resources should be tested during mobilization if necessary.

C. Appointed Party

Appointed by the Lead Appointed Party to act as a Task Team to help fulfill the Lead Appointed Party role functions. Such as a consultant, supply chain, and/or subcontractor team.

The Lead Appointed Party and/or Appointed Parties form the delivery team made up of internal Task Team(s). The "Lead Appointing Party" or "Appointing Party" function allocation will depend on the procurement/contracting model for the Project.

Note that key roles within the Lead Appointed Party or Appointed Party are required to deliver the function of the role for an Organization, with the understanding that some functions may not be required due to the type of Project. Namely, a BIM Specialist, Data Custodian, Design Manager,

8 RACI ➔ R is Responsible for undertaking activity/task, A is Accountable for activity/task completion, C is Consulted during activity/task, I is Informed following activity/task completion.

Facility Manager, Project Manager, Quantity Surveyor and Utility Coordinator:

D. BIM Specialist

The BIM Specialist is the professional responsible for managing and implementing BIM Technology for the Project. They set up software and ensure compliance with BIM standards. They work with Project Team members to coordinate the BIM model, minimize errors, and update the model throughout the Project lifecycle. BIM software is used to analyze and visualize various aspects of the Project and identify potential problems before construction. The role of a BIM Specialist is essential for completing a Project on time, within budget, and to required quality standards.

E. Data Custodian

The Data Custodian facilitates how Data Information is shared and represented to other custodians and users, they are Accountable for the ownership, management, and quality of the Project Data. Their responsibility includes the technical aspects of Data management, including Data storage, security, regulatory compliance, and access control. They are also responsible for ensuring that Data is backed up and can be recovered in the event of a disaster. These are typically IT professionals.

F. Design Manager

The Design Manager is responsible for managing the Defined Design phase of a Project. They work closely with the Project Team to develop the design concept, create detailed design drawings, and ensure that the design meets the Appointing Party requirements and specifications. They are also responsible for managing the design team and coordinating with other Project Teams, such as contractors and suppliers.

G. Facility Manager

The Facility Manager oversees the maintenance and operation of a building or facility. This includes managing the physical Infrastructure, equipment, and services required for the facility to function effectively. The role of a Facility Manager in Data Sharing and Utility Coordination is to ensure that all relevant Data in the Operate and Maintain stage is shared appropriately to support decision-making and improve overall facility performance.

H. Project Manager

The Project Manager shares the role of “Project Owners” in ASCE 38-22 and oversees the entire

Project. They are responsible for Appointing Party communications, maintaining progress trackers, producing stage reports, meeting agendas/minutes, and ensuring effective Project Team communications. Additionally, the Project Manager is responsible for notifying Suspended Deficiencies and communicating any Changed Conditions. They work closely with the Project Team, including architects, engineers, contractors, and clients, to ensure that the Project is completed on time, within budget, and to the required quality standards.

I. Quantity Surveyor

The Quantity Surveyor is a professional who specializes in cost management for construction Projects. They estimate and monitor the costs of materials, labor, and equipment needed for a Project. In addition, they prepare budgets, analyze costs, and negotiate contracts. They work closely with the Project Team to ensure that the Project is completed within budget and on time.

J. Utility Coordinator

The Utility Coordinator assumes the role of Engineer/Professional as defined in ASCE 38-22, which involves tracking changed conditions, training Project Team members on how to use BIM software and providing Utility Records assistance. Tasks of Utility Coordinator include detailing Project goals, assessing Project impacts on utilities, ensuring compliance with utility Quality Levels, utilizing historical Data, ensuring Quality Assurance, and managing Third Parties' involvement.

This Manual recognizes there are additional Asset Users and Project Team roles to consider though not directly addressed in this Manual:

K. Asset Occupants

Asset Occupants are employees, non-employees, and members of the public.

L. Contractors and Services

Examples of Contractors and Services include MEP[9], security, IT, general contractors, and emergency personnel.

M. Third Parties

Third Parties include insurers, regulators, and reporting entities.

9 In construction, MEP is a standardized term for "mechanical, electrical, and plumbing."

1.5.3.5 Delegation of Authority in ISO 19650-2 Clauses 5.1.1 and 5.3.1

Sections 5.1.1 and 5.3.1 speak to the ability of the Appointing Party and Lead Appointed Party, respectively, to delegate the responsibility for all or part of the Manual role function.

Responsibility can be delegated, but Accountability must remain with the Party identified in each clause from ISO 19650-2 (refer to Figure 1.4.1). The differentiation between Accountable and Responsible Organizations is as follows:

N. Accountable Organization

An Accountable Organization is assigned to an activity and is answerable for the activity ("yes" or "no" authority and veto power).

O. Responsible Organization

A Responsible Organization completes the activities and tasks that have been delegated to them.

1.5.4 Digital Twin Ontario Key Roles for Designated Priority Projects

DTO's core team includes the following roles:

A. Overall Lead

Defines and drives the strategy and road map for DTO. Makes critical decisions for the platform. Promotes the initiative inside and outside of IO by sharing a fact-based perspective on how Ontario can engage Digital Twins to make critical decisions. Collects use cases from Delivery Partners for prioritization.

B. Delivery Lead

Coordinates the delivery of Digital Twins across Projects, sponsors, and Delivery Partners. Leads the change management plan to drive adoption and scale in Ontario.

C. Use Case Lead(s)

Owns the relationship with the end-user entity. Actively supports the Owner in developing the vision and prioritizing the user stories for the Digital Twin.

Supports the end-user entity in adapting current process to drive the adoption of the solution and developing a rollout plan to maximize the impact.

D. Technology/Data Lead

Designs and owns the platform architecture decisions. Coordinates Technology decisions across Delivery Partners. Sets the vision for all Technology roles and architectures.

E. Data Governance Lead

Establishes and ensures the adoption of Data Management practices across Projects. Oversees Data relationships with end-users.

F. Partnership Lead

Serves as the first point of contact for research partnerships with universities and manages these relationships to identify opportunities to leverage research.

Each Project will be assigned the following DTO Operations Team roles. This includes:

G. Data Liaisons

Data Liaisons are responsible for operating the DTO AssetFlow Hub. They facilitate communication between departments or Project Teams within an Organization regarding Data-related issues. They function as a liaison between technical teams and non-technical teams, ensuring that everyone is on the same page when it comes to Data management. Data Liaisons may also be responsible for helping to develop Data policies and procedures, and for ensuring that all relevant Parties follow these policies.

H. DTO Architects

DTO Architects will build and operate the platform and IT; system required to perform the function of the DTO and house the DTO AssetFlow Hub.

Figure(s)

Yes☒ No☐

- Figure 1.5.1: Referenced ➔ CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources – Figure 2 – Information Management process responsibilities and activities
    - Identifies clauses in ISO 19650-2 for the Appointing Party, Lead Appointed Party, and Appointed Party
- Figure 1.5.2: Multiple references ➔
    - ASCE 38-22 Standard Guideline for Investigating and Documenting Existing Utilities – Figure 2 -The Information Chain

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources – Figure 3 – Interfaces between Parties and teams
- Visual representation of how Parties and teams interact
- CDBB – Government Soft Landings – Appendix A – ISO 19650 Parties in the GSL Context

- Figure 1.5.3: Referenced ➔ CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources – Table 3 – ISO 19650-2 Resources to be prepared by an Appointing Party, Lead Appointed Party and/or Appointed Party
  - Presents the required Deliverables for the Parties in a summative manner
- Figure 1.5.4: Referenced ➔ CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources – Information Management Assignment RACI Matrix
- Figure 1.5.5: Referenced ➔ CDBB – Developing a Capability Enhancement Programme – Figure 1 – The Elements that Make Up Organization Capabilities
- Figure 1.5.6: Multiple references ➔
  - Office of Projects Victoria – Digital Asset Strategy – Alignment of Victorian Digital Asset Strategy Stages (Brief, Concept, Definition, Design, Build and Commission, Handover and Closeout, and Operations and Maintenance) with the Manual Stages (Briefing Concept, Defined Design, Build and Handover, Operate and Maintain) and IO Project Stages
  - CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources – Alignment of CDBB BIM Framework Stages in Accordance with BS EN ISO 19650 (Invitation to Tender, Tender

References

Response, Appointment) with the Manual Stages (Briefing Concept, Defined Design, Build and Handover, and Operate and Maintain

- Digital Twin Ontario Program Strategy: Report-Back to government
- CDBB – The Pathway Towards an Information Management Framework
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy

1.6 Foundational Understanding of Digital Twins

Outcome(s)

Align the Delivery Partners on the definition of Digital Twins and its capabilities.

Ensure Delivery Partners understand the underlying benefits of Data Sharing through the DTO.

Ensure Delivery Partners understand the challenges, priorities , and opportunities for Ontario and Industry to improve the productivity of Ontario's Infrastructure through Data Sharing and Data Collaboration.

Considerations

In addition to the Purpose statement, this sets the broader landscape for where the Manual fits into DTO at large.

To pre-emptively address potential resistance and/or concerns, clearing stating the benefits of the Manual and DTO is critical to maximize the quality of Industry adoption.

Content

1.6.1 Key Definitions for the Manual

Delivery Partners must understand the following key definitions to align on the purpose of the Manual. Key definitions here are also included in the glossary of all defined terms in this Manual[10].

1.6.2 Digital Twins

Digital Twins are "virtual representations of a real Asset or process – Assets can be considered individually, as a network or at neighborhood level – enriched with analytics, which *can* act as a single source of truth to effectively support more dynamic decision-making while helping manage uncertainty"[11].

A Digital Twin is a digital representation of an Observable Element with a means to enable convergence between the Observable Element and its digital representation. Digital Twins have the ability to accurately simulate the behavior of the physical system or process. A successful Digital Twin is able to model and simulate the Asset's components, interactions, and behaviours, and analyze the resulting Data to identify patterns and trends.

Within a Project, multiple Digital Twins may be operated to translate Information into decision making for both the Project Team and their respective Organizational Teams.

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10 Please note, as per Industry standards, a capitalized word in this Manual indicates that a definition can be found in the glossary.

11 The definition for Digital Twins is from the Digital Twin Ontario Program Strategy (Report-Back to the Ministry of Infrastructure). The Report-Back definition is used in this Manual instead of the BS ISO 15704:2019, 3.4, definition to be more specific to the intended application of Digital Twins in Ontario.

Asset Management, Information Management, and the 4 Data Management Pillars are essential for the operation and synchronization of Digital Twins in a Project and across Infrastructure in Ontario.

1.6.2.1 "Gemini Principles"[12]

Consistent with "the Information value chain" where Data Management leads to sense-making which leads to decision-taking.

Data Management is iterated on by continued learning, the output of which is improved insights for sense-making and improved decisions for decision-taking.

1.6.2.2 Built Environment

A collection of manufactured or induced physical Objects located in a particular area or region.

- The extent of the Built Environment includes:
    - Transportation (all modes) Infrastructure
    - Energy Infrastructure
    - Water Infrastructure (including municipal, commercial, and industrial)
        - Potable water Infrastructure
        - Wastewater Infrastructure
        - Storm water Infrastructure
    - Social Infrastructure (health, education, justice, long term care)
    - Buildings (residential, commercial, industrial, institutional)
    - Public Space (includes recreational public Space)
    - Privately-owned Recreational Space

1.6.2.3 Natural Environment

All living and non-living things that exist on Earth affecting ecosystems and human life [Sourced from BS ISO 21401:2018, 3.23].

12 "Gemini Principles" is a term taken from the Centre for Digital Built Britain (CDBB) Digital Twins Framework.

1.6.2.4 Horizontal Structures

Horizontal Structures refer to Infrastructure that runs along the ground or just below the surface, such as water and gas pipelines, district heating and cooling, electrical and communication cables, water lines, sanitary lines, and stormwater lines. These structures are often located beneath roads and sidewalks, making them accessible for maintenance and repair.

1.6.2.5 Vertical Structures

Vertical Structures refer to Infrastructure that runs vertically, such as power lines and transmission towers, buildings, cell phone towers, and water towers. Structures located above ground are more visible and vulnerable to damage from weather and other environmental factors.

1.6.2.6 Utility Infrastructure

Utility Infrastructure refers to the physical systems and structures that provide essential services to communities, businesses, and individuals. These services typically include the provision of water, electricity, pipelines (i.e., natural gas, heating, and cooling), telecommunications, and transportation.

1.6.2.7 Information Management

Information Management is the management and execution of tasks related to defining Information requirements, producing, checking, and delivering Information.

Understand Information Management according to BS EN ISO 19650 – Guidance Part A – The Information Management Function and Resources.

- Information Management is a critical function that applies to all types of Information, and it involves a structured and consistent approach to managing digital Data. The Information Management lifecycle includes Data planning, Data acquisition, Data operations, and Data disposal/archival. It is essential for documenting responsibility and accountability for activities and tasks, particularly in the context of a move to digital ways of working. Poor procurement and management of Information can generate risks, and it is important to recognize that digital Data is more volatile than its analogue predecessor. This makes it vulnerable to inappropriate access or distribution of Information, which can lead to security breaches.

    - Recognize that “Information as an Asset” is just as important as the physical Asset.

1.6.2.8 Facilities Management

Facilities Management is an Organizational function that aims to enhance the quality of life of people and productivity of core business by integrating people, place, and process within the Built Environment. This function adheres to the Leading Practices established by ISO 41000.

1.6.2.9 Asset Management

Asset Management involves the coordinated activities of an Organization throughout an Asset’s entire lifecycle to achieve maximum value in meeting service delivery Objectives. This involves

balancing costs, risks, and performance benefits to realize value. The Leading Practices in Asset Management adhere to ISO 55000.

1.6.2.10 Data Management

Refers to the process of collecting, storing, and organizing Data related to the physical Assets and systems of the Project. This includes Data from sensors, devices, and other sources of truth that provide real-time Information about the Project's performance and condition.

The goal of Data management is to ensure that the Data is accurate, accessible, and secure, and to use it to optimize the Project's performance, reduce maintenance costs, and improve decision-making.

Digital Twins, which are virtual replicas of the physical Assets and systems, rely heavily on Data management to ensure that they accurately reflect the real-world conditions and can be used effectively for simulation, testing, and analysis.

Refer to BSI FLEX 260 – Built Environment – Digital Twins Overview and Principles to define Data Governance, Data Specification, business models of enterprises and Organizations, which can affect the commercial expectations of Data Sharing.

1.6.2.11 Data Governance

Development and enforcement of policies related to the management of Data[13].

1.6.2.12 Data Specification

Set of requirements covering the characteristics of Data being fit for one or more purposes[14].

1.6.2.13 Open Data

Data is considered open when not tied to specific software solutions (ex. HTML, PDF, OOTX, MP3, IFC, BCF, IDM)[15].

1.6.2.14 Proprietary Data

Data restricted to specific software.

1.6.2.15 Utility Coordination

Utility Coordination is the process of managing and coordinating the activities of various utility companies and Municipalities, such as telecommunications, gas, water, and electric, during the planning, design, and construction of a Project to ensure efficient and effective use of resources, minimize conflicts, and reduce costs and delays.

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13 Sourced from BS ISO 8000-2:2020+A1:2021, 3.16.1, modified.
14 Sourced from BS ISO 8000-2:2020+A1:2021, 3.6.3, modified.
15 The Open Data system in the Manual ingest Proprietary Data like Geographic Information Systems (GIS), as Proprietary Data are a valuable source of Information for Open Data systems.

1.6.2.16 Leading Practice

Leading Practice is the most effective and efficient method, process, or technique to achieve a goal or Objective that has been validated through research and practical application. It is considered the standard for excellence in a specific field or Industry and is used as a benchmark to improve Organizational processes. Leading Practices are constantly evolving and require Organizations to be adaptable and willing to adopt innovative approaches to remain competitive.

- For additional context, the development of this Manual integrated Leading Practices which included collecting condition precedent from a jurisdictional scan. While many jurisdictions (e.g., Singapore, Estonia, and the United States) were examined, a selective number of English speaking and Commonwealth jurisdictions were chosen as principal examples, as they share similar types of Infrastructure and federal/provincial/municipal governance models.

1.6.3 BSE Flex 260 Digital Twins Requirements for the Built Environment

The BSI Flex 260 provides a comprehensive overview of the principles and requirements for Digital Twins in the Built Environment. It emphasizes the importance of Security and Confidentiality considerations and outlines the key requirements for creating an effective Digital Twin.

Security and Confidentiality are critical considerations for Digital Twins. To ensure the security of Digital Twins, BS EN IEC 62443 is used as a framework. This standard provides guidelines for implementing a secure architecture for industrial automation and control systems. Digital Twin Confidentiality is also mandated to ensure that personal and sensitive Data is protected.

In addition to security and Confidentiality considerations, the BSI Flex 260 outlines the requirements of Digital Twins for the Built Environment. These requirements include accessibility, accuracy, Data acquisition, Data analysis, Data storage, extensibility and Interoperability, granularity, networking, representation, simulation, Security and Confidentiality considerations, synchronization, and viewpoint.

- Accessibility: Accessibility refers to the ease of access to the Digital Twin. It should be accessible to all involved Delivery Partners, including Asset Owners, operators, and maintenance personnel.

- Accuracy: Accuracy is critical for the Digital Twin to be effective. The Data used to create the Digital Twin must be accurate and up to date.

- Data acquisition: Data acquisition refers to the process of collecting Data from various sources to create the Digital Twin.

- Data analysis: Data analysis involves processing and analyzing the Data to identify patterns and insights.

- Data storage: Data storage is essential for maintaining the Digital Twin and ensuring that it is available when needed.
- Extensibility and Interoperability: Extensibility and Interoperability are important for the Digital Twin to be scalable and adaptable to future changes.
- Granularity: Granularity refers to the level of detail in the Digital Twin. It should be granular enough to provide useful insights but not so detailed as to be overwhelming.
- Networking: It is critical for the Digital Twin to be connected to other systems and devices.
- Representation: Representation refers to the visual representation of the Digital Twin.
- Simulation: A process that allows Delivery Partners to test scenarios and make informed decisions.

1.6.4 Four Data Management Pillars for Quality Digital Twins in Ontario

4 Data Management Pillars establish quality Digital Twins in Ontario. Defined in Section 1.5, Data Ingestion, Data Exploration, Data Sharing and Data Collaboration are used to enforce Data Governance for UIE and BIM in the Manual.

Section 6 and Section 7 instruct Delivery Partners on compliance and requirements according to the 4 Data management pillars.

The 4 Data Management Pillars used to enforce Data Governance for UIE and BIM in the Manual include Data Ingestion, Data Exploration, Data Sharing, and Data Collaboration.

1.6.4.1 Data Ingestion

The process of collecting and importing Data from various sources into a centralized system or platform. In the context of UIE and BIM, Data Ingestion can involve gathering Information from various sources such as GIS Data, Asset Management systems, design documents (e.g., CAD models), and construction documents, and importing them into a BIM platform to create a comprehensive Digital Model of the Infrastructure.

1.6.4.2 Data Exploration

The process of analyzing and visualizing Data to gain insights and identify patterns or trends. In the context of UIE and BIM, Data Exploration can involve using visualization tools to analyze Data from various sources and gain a better understanding of the Infrastructure's performance, maintenance needs, and potential risks.

1.6.4.3 Data Sharing

The process of making Data available to others within or outside an Organization. In the context of UIE and BIM, Data Sharing can involve making BIM models, Asset inventory Data, and other relevant

Information available to Project Proponents such as contractors, engineers, and maintenance personnel to facilitate collaboration and improve decision-making.

1.6.4.4 Data Collaboration

The process of working together to create and maintain a comprehensive and accurate Digital Model of the Infrastructure. In the context of UIE and BIM, Data Collaboration can involve different Project Proponents working together to input Data, review and validate Information, and make decisions based on the Digital Model.

1.6.5 Digital Asset Strategy for Improving Infrastructure Productivity through the Digital Twin Ontario AssetFlow Hub and Project Management Processes

By aligning with the Office of Projects Victoria, Digital Asset Strategy the Manual aligns with Leading Practice for Digital Twins policy.

The Victorian Digital Asset Strategy Project lifecycle, the ISO 19650 Project lifecycle, and the Manual Project Stages align as to be shown in Figure 1.6.9.

The Manual Project Stages align with the IO Project phases as shown in Figure 1.6.10. Please note that the "Transactions" stage of the IO Project phases can happen at multiple Manual Project Stages depending on the procurement type.

- The Manual Project Stages provide more flexibility for different procurement models of Projects and combine general concepts from traditional Project lifecycles to make stages that are applicable to any procurement type.

The DTO and municipalities will develop cohesive mechanisms to enforce adherence to Manual Data standards and ensure Asset Owners acquire sufficient Metadata to conduct enforcement activities (e.g., Administrative Monetary Penalties (AMP)). Responsibility and liability of adherence shall be shared (distribution to be determined). Reference Section 3 of the Manual for a comprehensive view of Legislative and Regulatory requirements for Delivery Partners.

The DTO AssetFlow Hub is the throughway that assists with seamless handover of Asset Information to Assets Managers. The DTO AssetFlow Hub sets a system- agnostic, public-domain, standard for classifying Asset Data, integrating Data Sources to provide a balanced Asset view.

The DTO AssetFlow Hub provides syntax and Asset-tagging structures that provide Project Teams a consistent way to search, display, compare and interrogate key Asset and maintenance Information from UIE, Utility Coordination, and BIM systems that include:

- Asset registers
- Attributes

- Operation and maintenance
- Procedures
- Technical Data sheets
- Schedules of equipment
- Briefs
- Specifications
- Reports
- Commissioning
- Warranty Information

Real-time performance Data The Manual's Project workflows are:

- Asset Information Model
- Asset Information Requirements
- Business Case
- Digital Engineering Execution Plan
- Digital Engineering Execution Response
- Exchange Information Requirements
- Handover Material
- Organization Information Requirements
- Project Stage Scope Checklist
- Project Information Model
- Responsible, Accountable, Consulted and Informed Matrix (RACI Matrix)

The Projects workstream in the DTO AssetFlow Hub contains registers of Projects in Ontario. Depending on the terms set to qualify as a Project, there may be different procurement and contracting strategies for these Projects. If so, the Manual stages can apply to any Procurement

Methodology. The Project Stages are the Briefing Concept Stage, the Defined Design Stage, the Build and Handover Stage, and the Operate and Maintain Stage.

1.6.6 Project Stages

Subsections in 1.6.5 provide context to the Project Stages for Projects to be expanded on in Section 8. The Project Stages are the Briefing Concept Stage, Defined Design Stage, Build and Handover Stage, and Operate and Maintain Stage.

1.6.6.1 Briefing Concept

The Appointing Party shall understand and clearly articulate the problem statement into a Project opportunity statement and gather existing contextually relevant Information to inform various concepts. These concepts are determined by assessing a wide range of options that meet the Business Case and Project Objectives to select a preferred procurement route. This will include complying with Data and Information requirements and considering critical legal and security Elements.

1.6.6.2 Defined Design

Develop the selected procurement option from the Briefing Concept further to inform a final Business Case. A large volume of Information is gathered at this stage, and the procurement of the Appointed Party (head contractor or contractor) commences. Then the detailed design and engineering activities can begin. This development occurs in step with community engagement, commercial reviews, onboarding, pre-works, and the development of a Digital Engineering Execution Plan including a RACI Matrix to inform construction and site activities.

1.6.6.3 Build and Handover

Translate drawings, designs, and intent from the Defined Design stage to physically construct and commission the Project. The Appointed Party and its supply chain take a pivotal role in the Project. After completing the Project in line with the Project Objectives and plan, the Appointed Party must develop Handover Material to the Asset Owner. The handover includes all designs to as-constructed or "As-Built," transferring required Information from the Briefing Concept stage to Build and Handover stage of the Project to the Asset Information Model.

1.6.6.4 Operate and Maintain

Operate the facility or Asset in line with expectations set by the Organization and business case. The Asset Information Model is maintained in line with Digital Asset Objectives set by the DTO, so that the Asset delivers benefits for Ontario.

1.6.7 Addressing Perceived Barriers and Challenges for the Manual

Perceived barriers to Digital Twins' implementation are addressed in this Manual as follows:

A. Reliance on Existing Systems

Existing systems can be retained in most cases, as the Manual values system and Information Interoperability.

B. Cost of Implementation

Qualitative and quantitative studies support a high return on investment for Digital Twins, and in many cases, the government is already paying for Industry to apply these practices without receiving the full benefits.

- Increase economic growth by as much as $8.5 Billion CAD. This estimate comes from the NUAR new digital map of underground pipes and cables being on track to grow the UK economy by £5 Billion GBP over a decade (£490 million GBP per year).

C. Making the "Change" Now vs Later

Leveraging a Leading Practice approach unlocks Organizational efficiencies through digital workflows. It is important for Industry to have time to integrate the Manual practices and standards now in anticipation of upgrades to national and global standards.

D. Prioritizing Contract Terms

There are very few contracts that preclude the use of effective practice, but future capabilities of the DTO will include the incorporation of Manual requirements into Project contracts involving Government Entities.

E. Government Mandate vs an Industry Led Initiative

Ontario has been entrusted by its constituents to develop, operate, and maintain Assets in line with Leading Practice, and Industry has a role when contracted on behalf of Ontario.

F. Roles and Upskilling

Training and professional development material is available both in Ontario and internationally, and further support is available from DTO to assist with training, guidance, and subject-matter expertise.

A lack of Digital Data Governance investments in Utilities Infrastructure are challenging the capacity of Industry and the Ontario Government's departments and Agencies to deliver and manage Projects efficiently. This is evident by the widening skills gap, increasing competition for key Project resources, informal and unstructured digital processes and requirements, and siloed approaches to Information development and management.

The Manual's requirements are intended to remove barriers to construction and improve outcomes for all Delivery Partners. Not addressing digital Data Governance needs will only increase the burden on Industry and Government Entities due to inefficient planning and decision making, duplication of effort, rework, lack of design coordination, increased design and construction errors and variations,

and under- utilized Data throughout all stages of the Project.

The challenges of Data Confidentiality, Security, and Ownership are addressed in the legislation and regulations that enable the Manual.

The Manual provides clear instructions to address a range of concerns and issues related to the effective use of digital processes. Specifically, the Manual is designed for use by Ontario's Infrastructure Industries to address key challenges related to modeling, construction, and integration of legacy systems.

- These challenges include assessing the time and cost implications of modeling to a construction level, identifying product-specific detailing and its impact on competitive supply differentials, understanding differences in contractor-preferred construction methodologies, ensuring clear and well- communicated client BIM understanding and direction, addressing the integration of legacy Computer-Aided Facility Management (CAFM) systems with new Design Models for seamless operation, and considering factors such as construction requirements pushed back into design.

- Contractors are required to use models produced by design consultants, and the Manual emphasizes the importance of product-specific detailing and its impact on competitive supply differentials.

- Additionally, the Manual addresses differences in contractor-preferred construction methodologies and client BIM understanding and direction, as well as the integration of legacy CAFM systems.

Overall, the Manual provides instructions to addresses all stated issues and concerns, supporting the transition towards the effective use of digital processes.

1.6.8 Benefits for Utilities Infrastructure Productivity and Decision-Making through the Manual

The DTO and Manual form a Federated System[16]. Creating a Federated System for the DTO and its Manual, which relies on shared standards and a high-level framework, may require more time and resources than bilateral or utility-service- specific sharing arrangements. However, this approach offers the greatest potential for scalability and achieving long-term benefits. While it may be more costly and time-consuming initially, a Federated System provides a solid foundation for future growth and expansion.

Decisions made at the beginning of an Asset's life have a significant impact on its outcomes and its influence on societal performance. The Manual aims to optimize the use and sharing of Information related to Ontario's Utilities Infrastructure at the start of a Project to deliver maximum societal

16 A Federated System is a decentralized system in which multiple entities or Organizations cooperate and share resources while maintaining their own autonomy. An expanded definition is provided in the Glossary.

benefit in the end. The goal is to ensure that decisions made at the front-end of a Project lead to the best possible outcomes for society. Using optimized Information, the Manual aims to improve the decision-making process and maximize the benefits of the Asset for the community.

Benefits of Manual Data Governance and Utility Coordination strategy for Projects:

- Informs better and more transparent Project solutions earlier in the Project lifecycle, which can help to identify potential issues or risks and address them before they become major problems.
- Leads to better outcomes in terms of Project quality, efficiency, and effectiveness, which can result in cost savings and improved performance.
- Enables Asset leveraging by allowing Organizations to leverage existing resources and expertise to achieve Project goals more efficiently.
- De-risks Projects by sharing risks and responsibilities among Project Proponents, which can help to reduce the likelihood of Project failure or delays.
- Provides transparency throughout the Project lifecycle by making Project Information and progress visible to all Project Proponents, which can improve communication and collaboration.
- Ensures security by implementing appropriate measures to protect Project Data and Information from unauthorized access or disclosure.
- Is open and accessible, allowing Project Proponents to participate and contribute to the Project regardless of their location or role.
- Considers the whole of life of the Project, considering long-term sustainability, maintenance, and operational requirements.
- Builds capability and capacity by developing skills, knowledge, and expertise among Project Teams and Project Proponents.
- Is integrated and repeatable, using standardized processes and tools to ensure consistency and efficiency across Projects.
- Uses an innovative approach to problem-solving and decision-making, encouraging creativity and experimentation to find the best solutions.
- Is future-enabled, considering emerging trends and technologies to ensure that Projects are adaptable and resilient to change.

Benefits of Manual Information Management strategy for Projects:

- Helps manage Assets, processes, and systems effectively ensuring that they are optimized to achieve the best outcomes.
- A developed, planned, and validated strategy to ensure that all Delivery Partners are aligned, and that the strategy is optimized for success.
- Provides assurance to Delivery Partners that the Manual has the necessary Information and resources to complete their Project tasks efficiently.
- Enhances the understanding of Digital Twin systems and their needs. The Manual allows Delivery Partners to better understand how Digital Twins work and how they can be optimized.
- Forms the foundation to connect Digital Twins for efficient Utility Coordination in the future.
- Deliver valuable insight to make faster, more efficient, decisions.
- Has the potential to affect outcomes for the whole Built Environment.
- Can be expanded to an extensive number of use cases, such as disaster response, emergency management, responses to extreme weather events, upstream capital planning, and integrated transport planning.

Benefits of the Manual's Data Ingestion and Exploration requirements for Projects:

- Identifies problems early in the Project, allowing for timely resolution and avoidance of rework, delays, and their attributed costs.
- Tracks key Elements of the Project, providing visibility and insight into progress and/or potential issues.
- Improves record-keeping to ensure Project Data is accurate and up to date.
- Requires capturing "As-Built" conditions, which can limit claim discussions and disputes.
- Holds subtrades accountable to meet Project requirements through real-time progress visibility.

Benefits of the Manual's Data Sharing and Collaboration requirements for Projects:

- Standardizes protocol and tools to facilitate effective collaboration and ensure Data quality.

- Improving communication and collaboration improves decision-making processes.
- Efficient sharing and collaboration practices reduce the time and effort required for Manual processes.
- Data Sharing and collaboration enables a more streamlined and optimized Project workflow, meaning improved resource utilization.
- Data Sharing and collaboration are part of the necessary building block for the development of a province-wide Digital Twin.

Benefits of the Manual's BIM integration requirements for Projects:

- Use BIM to link coordination and planned additions/upgrades to existing networks, understand impacts on users, and update models with non- graphical Asset Information during construction.
- Leverage primary BIM uses such as existing conditions modeling, cost estimation, phase planning, site analysis, design review, design authoring, 3D coordination, Record Modeling, and Asset Management.
- Realize benefits of a well-structured BIM Process for building owner/operators, including faster population of AMS and CAFM systems with Asset Data, transparent commissioning processes, and improved building operating efficiency through energy analysis using BIM.
- Review BIM models at each design and construction stage to confirm facility's maintainability.
- Use "As-Built" BIM model to faster populate AMS and CAFM systems with Asset Data.
- Link operating and maintenance (O&M) Manuals to specific components in the "As-Built" BIM.
- Enable the Facility Manager to assess future building amendments using an
- "As-Built" BIM.
- Use the final BIM for Space management and energy analysis to improve building operating efficiency.
- Reduce unexpected changes in construction due to heavily serviced nature of these Assets.
- Leverage BIM model and Information to assist with network maintenance by linking coordination and planned additions and upgrades to existing network.
- Primary BIM uses include existing conditions modeling, cost estimation, phase planning,

site analysis, design review, design authoring, 3D coordination, Record Modeling, and Asset Management.

Broader economic and social benefits of the Manual:

- Improve public sector efficiency by streamlining process and reducing the bureaucratic red tape. This can lead to faster and more effective service delivery for Ontarians.
- Drive commercial effectiveness by enabling businesses to access government services and Utilities Industry Data in a more efficient and streamlined manner.
- Increase productivity by reducing the time and resources required to access government services and Utilities Industry Data. This can free up resources for Delivery Partners, allowing them to focus on other areas of their work.
- Increase safety for Project delivery teams (e.g., technicians, contractors) and the public near Project sites.
- Decrease disruption for small businesses and communities through digitized processes and digital confirmation for Project delivery.
- Increase economic growth by billions of dollars. This estimate comes from the
- UK's National Underground Asset Register (NUAR) digital map of underground pipes and cables which is estimated to grow the UK economy by £5 Billion GBP over a decade (£490 million GBP per year).

Figure(s)

Yes☒ No☐

- Figure 1.6.1: Referenced ➔ British Standards Institution (BSI) Flex 260 – Built Environment: Digital Twins Overview and Principles – Figure 4 – An ecosystem of connected Digital Twins
- Figure 1.6.2: Referenced ➔ British Standards Institution (BSI) Flex 260 – Built Environment: Digital Twins Overview and Principles – Figure 3 – "What is a Digital Twin?" Visual Descriptor
- Figure 1.6.3: Referenced ➔ British Standards Institution (BSI) Flex 260 – Built Environment: Digital Twins Overview and Principles – Figure 1 – Digital Twin domains (Built Environment, manufacturing, healthcare, automotive, other domains)
- Figure 1.6.4: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy – Page A.3 – Demonstrate value of Data' Information from the Manual versus traditional utilities Project strategies throughout the Projects lifecycle and operations

- Figure 1.6.5: Referenced ➔ BSI Flex 260 – Built Environment – Digital Twins Overview And Principles – Figure 6 – Steps in Information Management.
- Figure 1.6.5: Referenced ➔ BSI Flex 260 – Built Environment – Digital Twins Overview And Principles – Figure 5 – Market models for Data Sharing
- Figure 1.6.6: Referenced ➔ BSI Flex 260 – Built Environment – Digital Twins Overview And Principles – Figure 4 – An ecosystem of connected Digital Twins
- Figure 1.6.7: Referenced ➔ BSI Flex 260 – Built Environment – Digital Twins Overview And Principles – Figure 1 – Digital Twin's domains
- Figure 1.6.8: Referenced ➔ Project of Victoria – Digital Asset Strategy – Page
- B.27 and Page B.28 – How strategy stages align with procurement and contracting types
- Figure 1.6.9: Referenced ➔ Project of Victoria – Digital Asset Strategy – Page
- B.39 – How the Victorian Digital Asset Strategy Information Process is aligned to ISO 19650, Adapted from ISO 19650, and align with the Manual Project Stages
- Figure 1.6.10: Not referenced ➔ Alignment of Manual Project Stages, with typical Project phases

References

- Digital Twin Ontario Program Strategy: Report-Back to government
- CDBB – The Pathway Towards an Information Management Framework
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy

2. Designated Priority Projects

2.0 Section Objective

To determine a Project, it is important to define the high-level rationale and process. This will help in identifying the purpose of the Project and how it will be executed.

Establishing a clear rationale and process can help ensure that the Project is aligned with the Organization's goals and Objectives, and that it is completed successfully.

2.1 Designating a Priority Project

Outcome(s)

To effectively manage Projects, it is important to establish clear parameters and a process for identifying Designated Priority Projects. Additionally, it is crucial to define the specific characteristics that make a Project distinct from other initiatives. By doing so, Delivery Partners can ensure that Projects are properly identified and managed to achieve successful outcomes.

Considerations

The Manual focuses on illustrating parameters for selecting Projects and what is involved in executing Projects so Delivery Partners can align on expectations for this type of Project. It does not highlight specific Projects under consideration by Ontario.

Content

2.1.1 Designating Authority for Designated Priority Projects

The authority to designate a Designated Priority Project lies with the Minister of Infrastructure (Minister). The Minister will have the power to designate Projects as per the provisions laid out in the Manual.

All Delivery Partners are required to review Section 3.6 for further details on the Minister's Designating Authority.

2.1.2 Features of a Designated Priority Projects

Privileges granted to Projects are as follows:

- Priority access to resources, funding, and support from and for Delivery Partners.
- Receive specific standards in Phase 2 of the Manual for Data Sharing and Utility Coordination that would help facilitate the successful implementation of the Project.

The Manual outlines specific goals for Projects that will contribute to the Digital Twins of Ontario's Infrastructure.

It is crucial for all Delivery Partners involved in Projects to have a comprehensive understanding of the designation process. The Minister will consider several factors when designating Projects, including but not limited to:

- Ministries and Agencies of the government
- Impact on Ontarians/community in the Project area
- Alignment with government priorities
- Time to impact, balancing both short- and long-term impacts to enable quick wins while working to solve long term challenges
- Value at stake, the measured financial impact available that a Digital Twin can support in capturing
- Other potential considerations, such as change management feasibility, technical feasibility, Data feasibility, potential for innovation, amount of preparation required, process or technical complexity, location, schedule and timelines, level of scope definition, site conditions, distance from supply chain, cost targets, Asset type and existing Information, Data accessibility, Data availability, Data quality, number of Project Teams to consider, opportunities for repeatability in the design and construction of the Asset, and Organizational experience.

It is essential to consider these factors when proposing Projects to ensure their successful designation and implementation. Failure to comply with the Manual may result in delays or other complications. Additionally, failure to adhere to the Means and Methods prescribed in the Manual may impair the ability of Delivery Partners to claim for Damages. Therefore, it is strongly recommended that all Delivery Partners review the relevant sections of the Manual thoroughly and seek clarification from the appropriate authorities if necessary.

2.1.3 Requirements and Expectations for Designated Priority Projects

Subsections in 2.1.3 define the requirements and expectations for Projects concerning Utilities Industry requirements, delegated tasks, and steps to initiating a Project.

2.1.3.1 Define Utilities Industry requirement for Designated Priority Projects

The Utilities Industry must help Government Entities meet commitment to deliver Projects on accelerated timeline.

2.1.3.2 Delegated Tasks for Designated Priority Projects

As per the Manual, it is important to clarify that all delegated tasks for Projects will reference the Proposed Delegation under the Building Transit Faster Act (BTFA), 2020.

The Utilities Industry is required to notify the Minister of Infrastructure of permit matters related to corridor development permits in accordance with any Ministerial direction.

For obstruction removal and preview inspections, the Utilities Industry must notify the Minister of Infrastructure when entering lands without the agreement of the property owner. For construction danger inspection and elimination, the Utilities Industry must notify the Minister of Infrastructure after land is entered without notice, after police assistance is requested and to report back on outcomes.

The Utilities Industry can provide compensation to property owners for any Damages and the alteration/removal of an obstruction caused by entering lands, including the discretionary ability to compensate municipalities.

In the event of a stop-work order, the Utilities Industry must notify the Minister of Infrastructure after a stop-work order is issued and before a stop-work order is filed in the Courts.

The Utilities Industry must notify the Minister of Infrastructure when an inspection for compliance with a stop-work order reveals a failure to comply.

Before seeking a warrant to carry out an inspection on any land, the Utilities Industry must notify the Minister of Infrastructure; before police assistance is requested; and must report back on outcomes.

The responsibility to register a notice of land designation with the land registry office and make reasonable efforts to notify landowners and occupants of land that is designated as utilities Infrastructure land under the BTFA falls under the administration of the Utilities Industry.

2.1.3.3 Steps to Initiate a Designated Priority Project

The Manual provides a comprehensive guide on the steps required to initiate a Project for all Parties involved. These steps include:

1. Selecting a Project
2. Determining executive sponsorship
3. Establishing governance and vision
4. Understanding how Information Management currently works in the Organization
5. Assembling and empowering the team
6. Communicating the intention
7. Executing and documenting each stage from the Manual for Projects (Briefing Concept, Defined Design, Build and Handover, Operate and Maintain)
8. Reviewing, correcting, and improving

It is important to note that specific standards for Data Sharing and Utility Coordination of Project types will be established. These Manuals/standards are the focus of the Manual Phase 2, which is introduced in Section 5.

To provide a practical example of Project privileges in action, **Appendix L** presents a use case of water utilities services.

2.1.3.4 Essential Elements for Project Payments

When it comes to payment specific to Project procurement agreements for public and private sector engagements, there are several essential Elements that the sector should consider. These include:

1. Payment structure: The payment structure should be clearly defined in the agreement, including the payment schedule, payment method, and payment terms.
2. Performance-based payment: The agreement should include performance-based payment mechanisms that incentivize the Delivery Partners to meet or exceed Project Objectives, timelines, and quality standards.
3. Payment security: The agreement should include provisions for payment security, such as performance bonds, letters of credit, or escrow accounts, to protect all Parties in case of default or breach of contract.
4. Payment adjustments: The agreement should include provisions for payment adjustments,

such as change orders, price escalation clauses, or deductions for delays or defects.

5. Payment dispute resolution: The agreement should include a clear process for resolving payment disputes, such as mediation, arbitration, or litigation.

6. Transparency and accountability: The agreement should ensure transparency and accountability in the payment process, including the use of auditable financial records, independent verification, and reporting requirements.

7. Compliance with regulations: The agreement should ensure compliance with applicable laws, regulations, and standards related to payment, such as tax laws, anti-corruption laws, and procurement rules.

Figure(s)

Yes☒ No☐

- Figure 2.1.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy – Risk Profile (low to high on x-axis) versus Total estimated investment (0-250+ million on y-axis) to determine which Projects are essential to apply the (Manual) to [Page C.7]

References

- Digital Twin Ontario Program Strategy: Report-Back to government
- CDBB – The Pathway Towards an Information Management Framework
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

3. Legislation and Regulations

3.0 Section Objective

This section presents the enabling legislation that grants DTO authority over all Infrastructure related to Designated Priority Projects, including as it relates to Utilities Industry Data Sharing and Utility Coordination standards and practices. As such, this section offers Delivery Partners insight into the ways in which legislation and regulations will affect their operations.

3.1 Relevant Legislation and Regulations

Outcome(s)

This section of the Manual provides an overview of existing relevant Ontario and federal legislation and regulations. It also acknowledges the relation between municipal bylaws and provincial legislation.

This section also provides an overview of the provisions granting DTO powers as an Administrative Authority, and their associated powers and the responsibilities.

Considerations

This section informs the reader about the legislative context in Ontario and how it relates to municipal bylaws and federal laws.

The Manual presumes that the Digital Twin Ontario Act has been enacted, providing enabling legislation for legislative and regulatory measures. Including presumptive legislation in the Manual is intended to assist Industry consultations by building an understanding the expectations of Appointing Parties, Lead Appointed Parties, and other Appointed Parties in supporting Digital Twins to accelerate Infrastructure deployment.

Note that the Province of Ontario has yet to adopt any legislation or regulation officially, and any discussions regarding regulatory tools are solely for authorized discussion purposes to inform policy recommendations. Digital Twin Ontario (DTO) cannot be held liable for any incidental, special, exemplary, or consequential Damages resulting from any Party's reliance on the Information contained in this Manual.

Content

3.1.1 Pre-existing Legislation and Regulations

Utility Coordination is subject to both federal and provincial legislation, which are relevant for the implementation of Digital Twins. This section aims to provide an overview of the pertinent laws and regulations that govern Utility Coordination, including federal and provincial Organizations and enabling legislation. It is essential to understand these laws and regulations to gain a comprehensive view of the regulatory framework governing the coordination of utilities Infrastructure and to successfully implement Digital Twins.

3.1.1.1 Federal Laws and Regulations

A. Canada Energy Regulator (CER)

Interprovincial and international oil, gas, and electric facilities are regulated by the Canadian Energy Regulatory (CER). There are distinct safety protocols, legal requirements, and processes mandated by the CER that can affect both Utility accommodation and Utility Coordination as defined by the Canada Energy Regulator Act, 2019 and five (5) other acts that the CER is responsible for. All work across or near CER-regulated facilities must adhere to the acts, regulations, and policies administered by the CER. These facilities need to be identified in the Briefing Concept Stage, and the rules must be followed in the next three (3) stages – see Section 8.

B. Canadian Radio-television and Telecommunication Commission (CRTC)

Wireline telecommunications in Canada are licensed by the Canadian Radio- television and Telecommunications Commission (CRTC) through the Telecommunications Act. While some designated broadband Projects are directed by the Province of Ontario, all telecommunication Infrastructure located within public or private lands are under the authority of the CRTC. There are no mandated Utility Coordination requirements by the CRTC, but telecommunication facilities must be accommodated on public lands such as road rights-of-ways.

C. Transport Canada

Transport Canada develops and implements policies and regulations and administers the Railway Safety Act. Heavy rail operators (i.e., CN, CP, Metrolinx, etc.) have requirements and policies regarding Utility work near or across their rail lines. All Utility accommodation and Utility Coordination efforts for Utility work near these Transport Canada regulated rail networks must conform to those regulations, so identification in Briefing Concept Stage, and the adherence in the next three (3) stages is required – see section 8.

D. Innovation, Science and Economic Development Canada (ISED)

Innovation, Science and Economic Development Canada (ISED) is accountable for the

Radiocommunications Act, 1985 and certain sections of the Telecommunications Act. Their mandate encompasses numerous aspects of Canadian life. However, with regards to Utility accommodation and Utility Coordination, Appointed Parties are required to collaborate with ISED regarding cell towers, antennas (including 5G and Small Cell antenna), as well as any work related to the relocation, installation, or adjustments of such facilities.

E. National Research Council of Canada (NRC)

The National Research Council of Canada (NRCC) is a key player in supporting construction standards in Canada through the development of the National Building Code (NBC). While the regulation of building codes is the responsibility of the provinces, the NBC serves as a model building code that forms the foundation for provincial building codes, including as it relates to technical provisions for the design and construction of new buildings, as well as for the alteration, change of use, and demolition of existing buildings.

F. Canadian Standards Association (CSA)

The Canadian Standards Association (CSA) is an Organization that develops and publishes standards for a wide range of industries in Canada. Although not a regulatory body, CSA's standards are often adopted by regulatory bodies and impact Utility Coordination and Digital Twin efforts. It is important to note that CSA standards may be relevant to a variety of Infrastructure work, including electrical, mechanical, and construction work.

To ensure adherence to CSA standards, Appointed Parties should consult CSA's standards when planning and executing Utility work in Canada.

Specifically, Appointed Parties should identify CSA standards that may be relevant during the Briefing Concept Stage and ensure compliance with these standards (or equivalents) throughout the remaining three stages of Utility Coordination - as outlined in Section 8 of the Utility Manual.

3.1.1.2 Provincial Laws and Regulations

All Acts pertinent to utility accommodation and coordination efforts, including legislation, regulations, and associated authorities referenced below, must be adhered to by Delivery Partners while implementing a Digital Twin.

A. Building Transit Faster Act, 2020 (BTFA)

On July 8, 2020, Bill 171, Building Transit Faster Act, 2020 (BTFA) received Royal Assent. The Act created a suite of new legislative measures to streamline Project delivery and support successful completion of the government's four priority subway Projects. These priority subway Projects include:

- Ontario Line
- Yonge North Subway Extension
- Scarborough Subway Extension
- Eglinton Crosstown West Extension
- Hamilton Light Rail Transit

Part IV of the Act ("**Utility Company Cooperation**") sets out authorities that enable stronger co-ordination of Utility relocation works. This includes authority for Metrolinx or IO to require utilities to relocate Infrastructure within a specified timeframe. Additionally, this includes a process for escalation and enforcement to safeguard against costly Project delays. By targeting steps in the planning and construction process that have previously delayed major Projects, the BTFA provides the Province with the tools required to deliver priority transit Projects faster by enabling more effective coordination using a Digital Twin, avoiding delays, and mitigating risks.

B. Building Broadband Faster Act, 2021 (BBFA)

In April 2021, the Building Broadband Faster Act (BBFA), 2021 was enacted, accompanied by changes to the Ontario Energy Board Act (OEBA), 1998. The primary Objective of the BBFA and changes to the OEBA was to accelerate the implementation of designated broadband Projects by eliminating barriers to construction.

C. Electrical Safety Authority (ESA)

The Electrical Safety Authority (ESA) is a regulatory Organization that is responsible for the administration and enforcement of regulations related to electrical safety, including the Ontario Electrical Safety Code. The Ontario Electrical Safety Code, Ontario Regulation 777/21 is composed of the Canadian Electrical Code Part I (CEC) along with specific Ontario Amendments. The development of the CEC Part I is spearheaded by the Canadian Standards Association (CSA). It is created in close collaboration with volunteer technical committees and subcommittees that reflect expertise from across Canada, including ESA. After review, the provincial government then adopts the CEC with additional amendments specific to Ontario.

The Ontario Electrical Safety Code is a technical document and follows a prescriptive approach. It provides a detailed description of the standards for electrical installations, products, and equipment in Ontario.

The Electrical Distribution Safety Regulation, Ontario Regulation 22/04 sets out Objective-

based electrical safety requirements for distribution systems. These requirements cover the design, construction, and maintenance of electrical distribution systems owned by distribution companies licensed by the Ontario Energy Board. The Regulation mandates distribution companies to obtain approval of equipment, plans, specifications, and inspection of construction before putting systems into service. It also provides options for obtaining these approvals.

D. Technical Standards and Safety Authority (TSSA)

The Technical Standards and Safety Authority (TSSA) is responsible for the administration and enforcement of regulations related to technical safety in Ontario. Relevant to Utility Coordination, TSSA enforces the Oil and Gas Pipeline Systems Regulation (Ontario Regulation 210/01) as well as the Boilers and Pressure Vessels Regulation (Ontario Regulation 220/01). TSSA's role includes approving designs, issuing certificates of inspection, and conducting audits of facilities and installations. Compliance with TSSA regulations is mandatory for all equipment, products, and installations in Ontario, and failure to comply can result in administrative monetary penalties.

E. Ministry of Transportation (MTO)

The Ontario Ministry of Transportation's (MTO) Ontario Provincial Standards serve as a set of design guidelines and standards pertaining to highway, bridge, and other Infrastructure development. To support the successful development and construction activities in the vicinity of provincial highways, MTO encourages pre-consultation and continued engagement throughout the review process.

In accordance with the Planning Act, 1990, MTO reviews municipal and development plans within MTO Controlled Areas to assess their impacts on the highway system. MTO then provides comments to the relevant planning authority.

If construction on or adjacent to a provincial highway is planned, an MTO Permit may be required under the Public Transportation and Highway Improvement Act. For proposed land development, construction, or other activities within MTO Controlled Areas, the Highway Corridor Management Office manages the review process. This includes MTO Permit issuance and administration.

The Public Service Works on Highways Act, 1990 regulates cost allocations for certain Utility works, which fall under MTO's authority.

F. Ontario Energy Board (OEB)

The Chief Commissioner, with the approval of the Chief Executive Officer and under the authority of section 6 of the Ontario Energy Board Act, 1998, has delegated certain powers and duties to OEB staff, subject to the conditions and restrictions set out in the delegations including licences, codes, rules and associated approvals found here: https://www.oeb.ca/sites/default/files/delegated- powers-and-duties-2-Licences-20230717.pdf

G. Ontario One Call

In 2012, the Ontario Underground Infrastructure Notification System Act, 2012 was passed, which stipulates that by law, anyone in the province of Ontario must contact Ontario One Call before they dig.

Ontario One Call does not physically mark the lines, pipes, or cables, but instead serves as a conduit for all dig Information to be transmitted to the buried Utility Infrastructure Owners who are members of the system. This enables the utility owners to provide locates based on the request that is submitted, thereby reducing the risk of Infrastructure damage, loss of service, and injury.

Additionally, Ontario One Call provides planning tickets to facilitate the provision of Utility records by their members during the Briefing Concept Stage.

H. Ontario Building Code Act, 1992

The Building Code Act, 1992 and the Ontario Building Code govern the construction and renovation of buildings in Ontario. The Building Code Act, 1992 sets out the legal framework for building codes in Ontario, while the Ontario Building Code provides the technical requirements for building design and construction.

The OBC covers a wide range of topics, including structural design, fire safety, plumbing, and electrical requirements. It also includes specific requirements for accessibility, energy efficiency, and environmental protection. Compliance with the OBC is mandatory for all construction Projects in Ontario, and failure to comply can result in fines, penalties, or legal action, as enforced by municipalities.

3.1.1.3 Municipal Bylaws and Regulations

Each of the 444 single-tier or two-tier Municipalities and the First Nations communities in Ontario has their own bylaws, policies, franchise agreements, and/or Municipal Access Agreements. There is no repository for the agreements or the complex web of laws and regulations that govern the activities of utility owners at this level. Appointed Parties must approach the affected Municipalities and First Nations communities for Information on these matters during the various phases of the Utility accommodation and Utility Coordination work.

3.1.1.4 Indigenous Self-Governments and Duty to Consult

In the deployment of designated broadband Projects in Ontario, the Appointing Parties are required to secure a Band Council Resolution (BCR) for Projects that occur on First Nation reserves per s.28.2 of the Indian Act. Without a BCR or a formal written agreement from Chief and Council the proponent will not be allowed to enter the First Nation community. For Projects that occur outside

First Nation reserves, the Crown has legal obligation to consult with Indigenous peoples where it contemplates decisions or actions that may adversely impact asserted or established

Aboriginal or treaty rights. The assessment will determine whether each Project triggers the Crown's duty to consult (DTC) and must endure its duty to consult has been met. No construction can take place and no construction costs will be reimbursed before DTC obligations are met.

3.1.2 New Legislative and Regulatory Authorities

The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding partner obligations. However, as previously stated, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

The Digital Twin Ontario Act (DTO Act) grants the Minister of Infrastructure specific powers to create new regulations related to Data standards and sharing to enable Digital Twin Technology and accelerate the deployment of critical Infrastructure in Ontario. The DTO Act designates DTO as an Administrative Authority, which empowers DTO to develop its own regulations and tactical guidance to enable Digital Twins. The DTO Act aims to ensure the regulatory framework supports the collection and sharing of required Data to equip DTO, while keeping in mind the need to:

1. Promote agility through the appropriate mix of regulatory instruments.
2. Avoid unnecessary burden on Delivery Partners.
3. Require the necessary Data to support the enablement of DTO.

The DTO Act assigns the following powers to DTO as an Administrative Authority:

1. Prescribe that the Minister may make regulations related to enumerated matters concerning the implementation of DTO.
2. Require Ministries and Agencies of the Government of Ontario to comply with the requirements outlined in the DTO Act as the Appointing Party for Projects.
3. Delegate any authority provided under the DTO Act to DTO as the Administrative Authority.

There are various regulations that pertain to the subsections outlined in Section 3 of the Manual; yet an overall enabling provision is required to directly support the enablement of the Manual. Through regulations, DTO is legally empowered to:

1. Require Appointing Parties to comply with the Manual.

Figure(s)

Yes☐ No☒

References N/A

3.2 Applying Data and Construction Standards

Outcome(s)

The section offers an overview of how legislative requirements pertaining to Data and construction standards can impact the Project. Delivery Partners should understand how stamped plans may be required, how specific construction requirements must be followed, how electronic identifiers (or reasonable alternatives) must be installed, and how Infrastructure Data should be digitized. It also describes how legislative instruments are interconnected with specific standards and mandate compliance from Project Teams and external parties.

Considerations

Section 3.2 provides comprehensive guidance on the role of legislation in defining requirements and mandates for Digital Twins. It encompasses a broad spectrum of topics, such as Subsurface Utilities and Building Information Models. The section elaborates on the specific standards that Project Teams and external parties must observe to comply with Digital Twin enabling legislation. It is imperative that all Project Proponents adhere to the guidelines outlined in this section to enable the successful implementation of Digital Twins.

Content

3.2.1 Mandate Adherence to Data and Construction Standards

The implementation of Digital Twins during Projects requires Appointing Parties to adhere to Data and construction standards, which are mandated by regulatory instruments.

To achieve adherence to these standards, the following measures must be taken.

1. DTO may enact new regulations that require Appointing Parties to comply with the most current version of the standards outlined in Sections (5) and

2. (7) through new legislative provisions in standalone legislation.[17]

3. DTO may update existing regulations to apply Data-relevant standards through the following acts and associated regulations:

    a. The Building Code Act, 1992 and the associated Building Code regulation (O. Reg. 332/12).

    b. The Technical Standards and Safety Act, 2000 and associated regulations (O. Reg. 223/01).

    c. The Ontario Underground Infrastructure Notification System Act, 2012.

    d. The Ontario Energy Board Act, 1998, and the associated regulations (O. Reg. 410/22).

    e. The Infrastructure for Jobs and Prosperity Act, 2015 and associated regulations (O. Reg. 588/17).

3.2.2 Digitization of Infrastructure

The DTO Act[18] establishes legislative provisions to describe specific construction requirements which form the basis of digitization of Infrastructure and enabling Data to support Digital Twins. As such, the DTO Act seeks to enables the Due Diligence Process to better enable the deployment of Infrastructure.

Appointing Parties are required by legislation to:

1. Notify external parties as Infrastructure Owners when subsurface Infrastructure has been physically located during an excavation.

2. Create a Digital Asset and record in accordance with the standards outlined in the Manual, as well as those required by regulation, upon notification by the Appointing Party who is acting as the Project Proponent that a Subsurface Utilities Infrastructure belonging to the relevant owner has been located.

Appointing Parties are required through regulation to:

1. Ensure that underground utilities installed, repaired, or altered after a specified date include radio frequency identification Technology or a suitable alternative (as defined by regulation), such as Global Positioning System (GPS) with sub-hectometer level accuracy and the ability to provide latitude, longitude, and elevation Information.

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17 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

18 Idem

The above requirements are mandated in legislation and regulation, which places the onus on Appointing parties to digitize utilities Infrastructure that can be expected to support the enablement of Digital Twins.

Figure(s)

Yes☐ No☒

References N/A

3.3 Sharing Data, Systems of Reference, and E-Permitting Platform

Outcome(s)

Explain the legal requirements for sharing Data in a Digital Twins Information Management framework by Delivery Partners, including uploading Data records, sharing Data with the government's central repository, and providing Information within a specified timeline. Additionally, Delivery Partners will better grasp the legislative provisions related to sharing complete and accurate Data as an interim or final product.

Considerations

Offer direction on the legislative structure for sharing Data within an Information Management system for Digital Twins, encompassing the legal obligations linked to Data Sharing, notification requirements, Data upload schedules, and to clarify the extent of flexibility in Data Sharing.

Content

3.3.1 Issuance of Digital Assets as Locate Records in Projects

The DTO Act[19] enables the Due Diligence Process through legislative provisions to support Appointing Parties in issuing Digital Assets as locate records, which in turn will enable Data Sharing for Digital Twins.

Appointing Parties are required to comply with the following provisions under the DTO Act:[20]

1. Provide a Digital Asset as per the standards required under the Manual upon a Locate Request, where a Digital Asset and record of Infrastructure exists.

2. Provide the Digital Asset and record to the Appointing Party acting as the Project Proponent through the DTO AssetFlow Hub within the time period mandated for a Locate Request as per the Ontario Underground Infrastructure Notification System Act, 2012.

3. Maintain a Digital Asset and record of the Infrastructure where legislation has required the digitization of Infrastructure as per required standards in a local repository internal to the Appointing Party.

4. Be exempted from the requirement to receive a marking of the location of an Infrastructure Owner's underground Infrastructure upon a Locate Request, where a Digital Asset is provided to the Appointing Parties within the timelines prescribed for Locate Requests under the Ontario Underground Infrastructure Notification System Act, 2012.

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19 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

20 Idem

Appointing Parties are required to comply with the following regulations enabled under the DTO Act:[21]

1. Maintain Digital Assets and records of Infrastructure for a specified period of time in a local repository internal to the Appointing Party.

2. Make Digital Assets and records available through the DTO AssetFlow Hub within a specific period of time following the identification of the Utility Infrastructure.

3.3.2 DTO AssetFlow Hub

To facilitate Data Sharing as part of the Due Diligence Process, the DTO's AssetFlow Hub has been enabled through legislative and regulatory instruments to facilitate the flow of Digital Assets and records from and to Appointing Parties.

As per the DTO Act,[22] the following provisions have been established by law to enable the DTO to:

1. Administer a single Data capture and sharing system that will allow for the issuance of Digital Locate records and facilitate the flow of Information between Infrastructure Owners using Building Information Modeling.

2. Create regulations that define the specific Data requirements to be shared with the Asset Flow Hub.

3. Create regulations that specify circumstances under which Data requested to be shared with the DTO does not need to meet the Data Specifications referenced in regulation and the Manual.

3.3.3 DTO Central E-Permitting Platform

To ensure visibility into Projects, Appointing Parties must comply with the following requirement:

1. Submit all permits related to Projects through a centralized E-Permitting Platform.

The DTO Act[23] grants DTO the following legislative powers:

1. Administer an E-Permitting Platform that would be mandatory for all Appointing Parties involved in Projects.

2. Require all contractors, excavators, utilities, municipalities, Provincial Ministries and Agencies, and third-party Delivery Partners to submit all municipal and provincial permits required for/in proximity to Designated Priority Project through the E-Permitting Platform.

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22 Idem

23 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

Figure(s)

Yes☐ No☒

References N/A

3.4 Creating Enforcement Mechanisms

Outcome(s)

This section outlines the legislative framework surrounding the DTO enforcement functions to support Digital Twin implementation. Delivery Partners will be guided on the legislative mechanisms related to the following topics:

- Submission process to a designated government body.
- Investigation and adjudication of complaints.
- Data standard enforcement.
- Metadata for external parties.
- Resolution of competing Data Sources.
- Complaint review mechanisms.

Considerations

The reader will have a comprehensive understanding of the legal requirements surrounding the enforcement functions of a Digital Twin implementation and the procedures that must be followed to support compliance.

Content

3.4.1 Information Submission, Investigation and Adjudication of Complaints

DTO is legally authorized[24] to support the collection of Information to support complaints arising from non-compliance with legislative and regulatory provisions related to DTO. Under the DTO Act, DTO as an Administrative Authority is enabled by law to:

1. Receive complaints that construction proponents submit to a specified arm of DTO in the event of inaccurate, incomplete, or delayed Data from Appointing Parties.
2. Review complaints related to non-adherence to relevant legislation and regulations.
3. Request Information be shared by all relevant parties, including but not limited to Appointing Parties and relevant subcontractors.

24 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

4. Empower municipalities to investigate complaints related to standards that are related to requirements under the Building Code Act.

In addition, DTO has the authority to issue Administrative Monetary Penalties (AMPs), to enable necessary punitive measures to establish a Digital Twin ecosystem that is complete, accurate, timely, and trustworthy. Under the DTO Act,[24] DTO as an Administrative Authority has the legislative powers to:

1. Examine and issue any AMPs based on the specific circumstances of a violation of any legislative or regulatory mandates up to a maximum amount.

2. Empower municipalities to issue AMPs under circumstances where standards are related to requirements under the Building Code Act.

Figure(s)

Yes☐ No☒

References

N/A

3.5 Assigning Cost & Liabilities

Outcome(s)

Align readers on the establishment of a legislative framework that allocates costs and insurance liabilities for a province-wide Digital Twin implementation. Delivery Partners will need to understand how legislation would allocate expenses for digitizing newly built Infrastructure, identify responsible parties for inaccurate Data and accidents, and determine the level of government responsibility in case of accidents resulting from inaccurate Data.

Considerations

Aims to make Delivery Partners aware of their costs and insurance and security responsibilities, which will provide clear direction for dealing with any issues that may arise and help prevent accidents and inaccuracies.

Content

3.5.1 Prescribing Responsibility for Damages in the Event of Inaccuracy

The DTO Act[25] contains provisions that attribute responsibility for damage claims to the Appointing Party that provided incorrect, inaccurate, or late locate records to Infrastructure Owners acting as the Project Proponent. Specifically, the Act:

1. Reinforces the Appointing Party's right to seek direct and indirect Damages in the event of an inaccurate locate, whether physical or digital, by another Infrastructure Owner.

2. Clarifies that a minimum level of insurance must be required in the event of an accident on a Designated Priority Project, in order to ensure adequate protection for all parties involved.

3.5.2 Charging for Locate Fees

The following are legislative provisions under the DTO Act[26] that further clarify that:

1. Infrastructure Owners are prohibited from charging for a Locate Request required under the Ontario Underground Infrastructure Notification System Act, 2012by an Appointing Party acting as a Project Proponent.

2. Exemptions to the prohibition on charging for locates would be provided to municipalities, including in circumstances where a Digital Locate is provided in the form of a Digital Asset and record of Infrastructure at a specified standard level.

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25 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

26 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

3.5.1 Providing Funding for Costs Associated with E-Permitting

To integrate the permitting processes from municipalities and other government Agencies into the DTO E-Permitting Platform, financial investments from the Province of Ontario are required to support the necessary resourcing needs. The Minister has developed regulations that prescribe the circumstances under which the Province of Ontario may provide funds to municipalities or other third-party Agencies to support the costs of integrating their permitting platform with the DTO E-Permitting Platform.

Figure(s)

Yes☐ No☒

References

N/A

3.6 Application and Designated Priority Projects

Outcome(s)

This section prescribes the application of relevant Manual and legislative provisions for construction Projects in a defined set of Projects through categorization by structure type, location, specific Project types, or funding. Delivery Partners will be provided Information on the details on the use of the Manual to facilitate collaboration between the Government of Ontario, municipalities, and Partners to support the implementation of Projects.

Considerations

The section seeks to consider the need to balance mandates with flexibility in enabling Digital Twin Projects to ensure the most appropriate application of requirements for specific Projects.

Content

3.6.1 Application of Legislation, Regulations and Tactical Guidance

To promote adherence to the legislative and regulatory provisions for Projects, it is necessary to establish mechanisms that define a general "Project" as a Designated Priority Project and determine the corridor surrounding the Project where the relevant legislative and regulatory requirements would apply. This can be achieved through the following steps.

Under the DTO Act,[27] DTO as an Administrative Authority is granted authority to:

1. Mandate that the Manual and relevant legislative provisions and associated regulations related to construction proponents and external parties would apply to a defined set of Projects.

2. Require the Government of Ontario to collaborate with municipalities to apply the Manual and relevant Data standards to municipal ROWs / non- provincially funded designated Projects.

In addition to the legislative powers outlined above, regulations have been enacted to:

1. Define Projects by considering criteria outlined in Section 2 of the Manual.

Figure(s)

Yes☐ No☒

27 The Manual assumes that the Digital Twin Ontario Act is in place to assist Industry consultations in understanding Delivery Partner obligations. However, no legislation or regulation related to this matter has yet to be implemented by the Province of Ontario.

References

N/A

4. Digital Twin Ontario

4.0 Section Objective

The Utility Manual is one of Digital Twin Ontario's (DTO) initiatives that aims to promote efficient, cohesive, and innovative Infrastructure practices. This section provides an overview of the DTO vision, as well as the Objectives and implementation path of the DTO and the Manual in Ontario. Utilities Infrastructure Engineering (UIE) and Building Information Modeling (BIM) are key aspects of DTO Objectives for the Manual.

4.1 Definition of Digital Twin Ontario

Outcome(s)

This section outlines the scope of the DTO (Digital Twin Ontario) for Infrastructure in Ontario, with a focus on the Utilities Industry. Delivery Partners should be aware of the next stages in the DTO development process and the implementation of the DTO Framework. This Manual is designed to fit into the DTO Framework and provides valuable Information for Delivery Partners on how to successfully navigate the DTO process.

Considerations

The purpose of this section is to guide Delivery Partners on the Report-Back to the Ministry of Infrastructure (MOI) for a Digital Twin strategy. It is crucial to identify the Mandate's scope and Infrastructure Ontario's vision to ensure Delivery Partners understand the goals and Objectives. Additionally, Delivery Partners should be aware of current and future Industry standards enabled through DTO. This knowledge will help them prepare accordingly and meet Mandate requirements. To align with Industry Leading Practices, the Office of Projects Victoria Digital Asset Strategy has been adapted for Ontario's needs, considering ASCE 38-22, ASCE 75- 22, and CSA S25020 standards. This adaptation ensures that Delivery Partners meet necessary requirements.

Relevant Legislation and Regulations

Precedent for DTO as an Administrative Authority

In Ontario, there are several acts that establish standalone Administrative Authorities to administer an act. These Administrative Authorities are responsible for the administration and enforcement of various laws and regulations in their respective areas. For instance, the Technical Standards and Safety Act, 2000 creates the Technical Standards and Safety Authority, while the Ontario New Home Warranties Plan Act, 1990 establishes Tarion. Other examples of Administrative Authorities in Ontario

include those under the Safety and Consumer Statutes Administration Act, 1996, and the Ontario Energy Board Act, 1998.

In line with the Leading Practices of establishing Administrative Authorities in Ontario, DTO has been established as an Administrative Authority for Digital Twins in Ontario as it relates to Infrastructure development. The aim is to support Delivery Partners in adapting to the regulatory landscape in Ontario and how it relates to Digital Twin Technology.

Measures for Establishing DTO as an Administrative Authority

The DTO Act assigns specific powers to DTO as an Administrative Authority. These powers include the ability to prescribe regulations related to the implementation of DTO, as well as the authority to require Ministries and Agencies of the Government of Ontario to adhere to the Act's requirements as Appointing Parties for Projects.

Additionally, the Minister of Infrastructure can delegate any authority provided under the Act to DTO as the Administrative Authority.

There are various regulations that pertain to the subsections outlined in this section of the Manual. However, there are some broad provisions that directly support the enablement of the Manual. Through regulations, DTO is enabled by law to require Appointing Parties to adhere to the Manual. This means that Appointing Parties for Projects must follow the Manual's guidelines and standards to ensure the successful implementation of DTO in Ontario. Greater specificity for instructions will be provided in the form of Bulletins for specific use cases.

To ensure compliance with legislative and regulatory provisions related to DTO, the DTO Act provides legal authority for enforcement mechanisms. As an Administrative Authority, DTO is empowered to receive and review complaints related to non- adherence to relevant legislation and regulations, and to request Information from all relevant parties, including the Appointing Party, Lead Appointed Party, and all Appointed Parties. Additionally, municipalities are authorized to investigate complaints related to standards nominally related to requirements under the Building Code Act.

The issuance of administrative monetary penalties is a critical measure to ensure the establishment of a complete, accurate, and trustworthy Digital Twin ecosystem.

Under the DTO Act, DTO as an Administrative Authority has the power to examine and issue administrative monetary penalties based on the specific circumstances of a violation of any legislative or regulatory mandates, up to a maximum amount.

Using the Ontario Dispute Adjudication for Construction Contracts (ODACC) as condition precedent, the DTO has the power to appoint adjudicators, conduct adjudication hearings, issue binding decisions, and enforce those decisions. DTO also has the authority to make rules and procedures for the adjudication process and to provide guidance to Parties on how to resolve their disputes.

Using the ODACC as condition precedent for disputes between Delivery Partners, DTO provides a dispute resolution process that involves adjudication. This process is designed to help Parties resolve their disputes in a timely and cost-effective manner. Adjudicators are appointed by DTO and are typically experienced in the construction Industry. DTO shall conduct hearings and issue binding decisions on disputes related to payment, non-payment, and other issues related to construction contracts.

Content

4.1.1 What is Digital Twin Ontario

The DTO Mandate is designed to mandate and standardize Information and Data Management to help build all of Ontario. The Mandate's management system is called the DTO Framework, which is used to manage the Mandate's operations.

4.1.1.1 Introduction to Digital Twin Ontario Mission and Priorities

Enabling legislation and regulations (Section 3) appoint the DTO authority to centralize and standardize Ontario's Infrastructure practices, starting with the Utilities Industry.

DTO's mission is to provide a centralized platform for managing Ontario's Infrastructure Data and Information. This platform will enable the creation of Digital Twins, which are virtual representations of physical Assets. By standardizing Infrastructure practices, DTO will help to improve the quality and reliability of Ontario's Infrastructure.

A. DTO Mission

DTO's Mission includes the following:

1. Inform and enable Digital Twins for Ontario. DTO facilitates the development of Digital Twins, providing access to relevant resources and Leading Practices.

2. Establish requirements for Data quality, granularity, fidelity, and timeliness.

3. Establish development standards, Data standards, and guidelines to ensure the reusability of the Assets developed, while fostering collaboration between Project sponsors and other involved Project Teams.

4. Set up the required capabilities in terms of talent, solution architecture and Technology, delivery model, Data, and change management processes to support the Digital Twin ecosystem.

5. Operate and maintain the overall Digital Twin ecosystem, maximizing value for involved Mandate proponents, and delivering benefits to the provincial government.

6. Enable the secure, resilient, and reliable integration of Digital Twins in different domains, allowing for greater Data Sharing across Ontario.

B. DTO Priorities

DTO's Priorities include the following:

1. Create and manage Digital Engineering Data and Information effectively to ensure efficient and sustainable physical Asset delivery and whole-life management across Ontario.

2. Standardize how Data is captured, collected, and used for Digital Twins in Ontario to accelerate construction for Projects.

3. Maximize the use of Digital Engineering Data and Information to enhance efficiency.

4. Inform and support Ontario government department Industry and practitioners on key aspects of Digital Engineering, including the value of digital Data and Information creation and management.

5. Innovate and provide insights to ensure efficient and effective implementation of Digital Engineering.

6. Deliver and manage major Assets across Ontario effectively and efficiently while embracing the sustainability of Digital Engineering.

4.1.2 Digital Twin Ontario's Service Offering

This section provides an overview of the services offered by DTO to support the adoption of Digital Twins and capture the value at stake. DTO offers Digital Twin Development, Digital Twin Operations and Maintenance, and Digital Twin Change Management capabilities.

A. Digital Twin Development

DTO can support the development of a Digital Twin for prioritized use cases. This development could include input from Mandate proponents and end users to ensure it meets user needs. Mandate proponents would be responsible for providing relevant Data and guidance.

B. Digital Twin Operations and Maintenance

DTO can provide the maintenance and small evolutions required for Digital Twins to continue delivering value to Mandate proponents. Sponsors could have two options for this ongoing maintenance, the decision of which can be made on an ad hoc basis depending on the capabilities of the end user Organization. These options are DTO Support and End-User Ownership.

C. DTO Support

DTO provides users deployment and maintenance team for Digital Twins, with the original build team accessible for technical support.

D. End-User Ownership

Digital Twin sponsors can choose to own the capabilities associated with the maintenance of the Digital Twin within their teams. Transition planning and DTO sign-off is required for this.

E. Digital Twin Change Management

DTO teaches and coaches Delivery Partners and end user Organization on how to use Digital Twins for better informed decision-making. This support begins during development and continues after the Digital Twin is live and in use.

4.1.3 Digital Twin Ontario's Approach, Core Team, and Focus

DTO's current approach is to start small with reusable Assets to demonstrate the Mandate's value and pave the way for scaling in Ontario. This approach maximizes the return on investment and demonstrates Ontario's innovation as a jurisdiction and an investment destination. However, initial targeted investment in foundations and capabilities is required to achieve this.

The DTO Mandate is built on Leading Practices for Data management and Digital Twins. As such, the Mandate will be assessed and updated regularly to keep up with evolving standards and innovations.

Open Data is at the core of the DTO Mandate. The use of open shareable Asset Information can result in significant improvements in cost, value, and operational performance.

The DTO Core Team provides strategic leadership and coordination for the DTO Mandate. While not addressed in this Manual, the DTO Core Team may interact with Delivery Partners in their role:

A. Use Case Lead(s)

The Use Case Lead(s) own the relationship with the end user entity and actively support the Product Owner in developing the vision and prioritizing the user stories for the Digital Twin.

B. Technology Lead

The Technology Lead designs and owns the platform architecture decisions and coordinates Technology decisions across external Partners.

The DTO's focus is on enabling the Manual Phase 1, defining criteria for Delivery Partner Proposals, and creating use cases for the Manual that require further specification (Phase 2). Aspects of the Digital Twin Ontario Framework for Implementation

The DTO implementation approach, which is called the DTO Framework, consists of three key aspects.

A. Information Management

The first aspect, Information Management, will be addressed through the implementation of a handbook and rulebook. This will establish a common language for Digital Twins to communicate with each other in the context of the DTO.

B. Skills and Roles Development

The second aspect, the development of skills and roles, will be addressed to ensure that the necessary skills and roles are in place to develop and adopt Aspect 1 of the DTO.

C. Security and Confidentiality Requirements

The third aspect, Security and Confidentiality requirements, will be addressed through the implementation of security measures and Confidentiality requirements. Compliance with these requirements will be ensured through portals for processes and provided resources.

The Manual specifies that cybersecurity measures will follow BS EN IEC 62443, a series of widely recognized international standards for industrial automation and control systems security.

4.1.3.1 Training Materials and Templates for Designated Priority Project Teams

Training materials and templates that are available to Delivery Partners as part of the DTO Framework. These resources are provided to Delivery Partners as part of their Project contract agreements.

The training materials offered through the DTO Framework are designed to provide Delivery Partners with the knowledge and skills necessary to effectively contribute to the Mandate's success. These materials cover a range of topics, including Mandate Objectives, Industry standards, and Leading Practices.

In addition to the training materials, the DTO Framework also includes templates that Delivery Partners can use to streamline their work processes. These templates are designed to ensure that Delivery Partners are meeting the Mandate's requirements and are aligned with Industry Leading Practices.

It is important for Delivery Partners to take advantage of these resources to ensure that they are meeting the Mandate's expectations and contributing to its success.

Figure(s)

Yes☒ No☐

- Figure 4.1.1: Referenced ➔ CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
    - Figure 1 – ISO 19650 Guidance Framework

References

- Digital Twin Ontario Program Strategy: Report-Back to government
- CDBB – The Pathway Towards an Information Management Framework
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

5. Data Ingestion and Data Exploration

5.0 Section Objective

This section outlines the requirements for Data Ingestion and Data Exploration in the context of Data Sharing, Digital Twins, and Utility Coordination for Projects. It provides instructions on how to implement DTO standard practices for these processes in UIE and BIM Projects. Section 5 is the detailed minimum requirement for proper execution of Data Ingestion and Data Exploration. It outlines the necessary steps for successful implementation and should be followed closely.

Additionally, it is important to note that these requirements are relevant to other necessary steps, such as the creation of Asset Information Requirement for a Project, which can be found in Section 8.

5.1 Introduction to Data Ingestion and Data Exploration

Outcome(s)

To easily navigate through the content included in Section 5, it is recommended to start by providing an overview of the content. This will help Delivery Partners understand the main topics covered and allow Delivery Partners to efficiently locate the Information they need.

Considerations

During the implementation of requirements, Delivery Partners may require additional context to understand the purpose and intended outcomes of the requirement(s). This Information was brought to our attention during a technical expert review, and it is important to note its significance.

Relevant Legislation and Regulations

Precedent for Data Ingestion and Data Exploration

Delivery Partners are required to adhere to the appropriate Data Ingestion and exploration process to generate new Data that is structured according to Open Data standards to enable Digital Twins and accelerate Infrastructure construction in Ontario. There is a precedent in Ontario for establishing standards for the Data creation process, as is evident from the Building Code Act, 1992, Technical Standards and Safety Act, 2000, and the Ontario Provincial Standards.

The Building Code Act, 1992 lays out the building construction and design Data requirements, which include standardized forms and Information Management systems. The Technical Standards and Safety Act establishes the Technical Standards and Safety Authority (TSSA), which has set Data

standards for the safe operation and maintenance of different equipment and systems, such as elevators, boilers, and pressure vessels.

Moreover, the Ontario Provincial Standards provide guidance on the design, construction, and maintenance of several Infrastructure Assets, such as roads, bridges, and water systems. These standards encompass Data collection and management requirements throughout the Asset lifecycle, from planning and design to construction and maintenance.

DTO Measures to Support Data Ingestion and Data Exploration

For the successful implementation of Digital Twins, strict adherence to Data and construction standards during Projects by Appointing Parties is crucial and mandated through regulatory instruments. Legislative provisions have been established under the DTO Act to guarantee specific construction requirements that serve as the foundation of digitizing Infrastructure and enabling Data to support Digital Twins.

Appointing Parties are obligated by legislation to notify external parties when subsurface Infrastructure has been located during an excavation and create a Digital Asset and record according to the standards outlined in the Manual if the existing Infrastructure Data does not already meet the standards. Additionally, Appointing Parties are required through regulation to ensure that underground utilities installed after a specific date include radio frequency identification Technology or a suitable alternative. By mandating these requirements in legislation and regulation, the responsibility is placed on Appointing Parties to digitize utilities Infrastructure to support the enablement of Digital Twins.

Content

5.1.1 Purpose and Definition of Data Ingestion and Data Exploration

Ingesting Data is a critical process that involves the collection and importation of Data from various sources into a connected system or platform. To ensure a comprehensive understanding of this process, it is important to:

1. Provide examples of Data Sources such as GIS Data, Data from Asset Management systems, construction documents, and drawings; and

2. Note that Data for a Project can be related to works, structures, or appliances placed over, on, or under land or water by any company or Organization.

3. This includes, but is not limited to, records of the Infrastructure and associated rights of way, Data related to the location and Attributes for all Infrastructure that may be affected by a proposed excavation related to the Project, records of communications and agreements related to the Infrastructure, and any other Information that the Ministry of Infrastructure may deem necessary for the purposes of Projects.

This Manual defines Data Exploration as the crucial process of analyzing and visualizing Data to gain valuable insights and identify patterns or trends. This process is essential to the development of Digital Twins, as it enables the ability to run scenarios, inform detailed design, and consult and coordinate with Delivery Partners.

The Manual establishes that Data Ingestion and Data Exploration are integral components of UIE and BIM, serving the purpose of collecting and analyzing Data to inform decision-making. To achieve this, the Manual outlines the following requirements for Project Teams:

1. Consolidate all Data Types and sources and import them into a BIM platform to create a comprehensive Digital Model of the Project. This ensures that all Data related to the Project is consolidated and synchronized, as intended by Data Ingestion.

2. Utilize the BIM platform to access and analyze Data from various sources of truth.

3. Use visualization tools to analyze Data housed in the BIM platform.

4. Analyze the Project's progress performance in terms of progress vs. timeline, identify potential maintenance needs, and potential risks during various stages of the Project's lifecycle, as intended by Data Exploration. By following these guidelines, Delivery Partners can effectively leverage Data to inform decision-making and improve Project outcomes.

5.1.2 The Iterative Cycle of Sense/Ingest, Classify, Refine, Decide, and Act/Optimize

Use the Iterative Cycle is to refine and optimize Data throughout stages of a Project.

A. Sense/Ingest

Identifying and collecting Data from various sources, such as sensors, Databases, and other relevant systems. The Manual identifies parameters to be monitored and the frequency of Data collection.

B. Classify

Organize and classify collected Data based on specific Manual criteria such as location, type, and time.

C. Refine

Analyze and clean Data to remove any errors or inconsistencies. The Manual provides instructions on the minimum identification of missing Data, outliers, and other issues that may affect the accuracy of the Data.

D. Decide

Utilize refined Data to identify potential issues, opportunities, and trends to make informed decisions about the Project.

E. Act/Optimize

Implement decisions made in the previous phase, and/or optimize the Project based on insights gained from the Data analysis.

5.1.3 Required Roles for Data Ingestion and Data Exploration

The Manual requires the identification of the Organizational role of the Assets Manager, as they are necessary for ensuring compliance with the Manual's standards across their respective Organizational Teams. It is important to note that the Assets Manager plays a key role in both Data Ingestion and Data Exploration requirements.

Additionally, the Manual requires the identification of Project Team roles, specifically the BIM Specialist and Data Custodian, as they are also crucial to ensuring successful Data Ingestion and Data Exploration.

While the Assets Manager, BIM Specialist, and Data Custodian have primary roles in these processes, it is important to acknowledge that both Organizational and Project Team roles contribute to the Data processes.

5.1.4 Cost Attribution

The Manual emphasizes the importance of establishing cost attribution in the Data Ingestion and Data Exploration Process. This involves identifying and attributing costs associated with collecting, processing, and analyzing Data.

Without cost attribution, it becomes difficult to determine the true value of the Data and make informed decisions about its use. Additionally, tracking the Return on Investment (ROI) is an important aspect of cost attribution to ensure effective use of resources during the Project.

To ensure clarity on the requirements for cost attribution, the Manual outlines specific steps to follow. These include:

1. Understanding the Iterative Cycle and identifying all activities involved in the process.

2. It is also necessary to determine the costs associated with each activity, including labor costs, equipment costs, and any other expenses. Activity- Based Costing is used to assign costs to specific activities based on their use of resources. During a Project, multiple Delivery Partners will contribute to this process.

3. The Appointing Party will provide the initial estimate, and the Lead Appointed Party may also be involved in this task.

5.1.5 Distinguishing UIE and BIM Requirements

There is a distinction between UIE and BIM requirements to ensure that all identified key Elements of Projects are covered.

UIE requirements primarily address Horizontal Structures in Projects, such as water and gas pipelines, electrical and communication cables, and sewer lines.

In contrast, BIM requirements primarily address Vertical Structures in Projects, including power lines, transmission towers, cell phone towers, and water towers.

Regardless of this separation, both UIE and BIM practices follow Uniclass 2015 for Asset classification standards and Industry Foundation Classes (IFC) for software interactions.

5.1.6 Housing Data in a Common Data Environment

The Common Data Environment (CDE) is a centralized digital platform that facilitates the sharing and management of Project Information throughout the entire lifecycle of a Project. It is an essential tool for ensuring effective collaboration and communication among Delivery Partners and streamlining Project workflows. By utilizing the CDE, teams can access and share critical Project Information in real-time, ensuring that everyone is working from the same set of Data and minimizing the risk of errors or miscommunication.

The Manual recommends utilizing Autodesk BIM 360, Procore, or Aconex for Project operations.[28]

The Manual recommends that Projects operate on Autodesk BIM 360, Procore, or Aconex until the DTO establishes its own CDE digital platform in accordance with the Province's Digital Service Standard, 2021. The decision between the named software should be based on the size, type, and additional needs of the Project (beyond the minimum requirements outlined in the Manual), as well as the preferences of the Project Team.

This Manual establishes requirements for a CDE in the context of Projects, specifically for Data Ingestion and Data Exploration. To meet these requirements, the CDE must:

1. Be capable of ingesting and storing large volumes of Data from various sources, including survey Data, geospatial Data, geotechnical Data, CAD drawings and models (e.g., Revit), and BIM models. It must also support different file formats and Data Types.

2. Provide tools for Data Exploration and analysis, such as visualization, filtering, and querying.

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28 Chosen software are currently widely used and readily available internationally. Please note, "required" software may be stated as a "recommended" software instead for v1.0 of the Manual.

3. Enable collaborative working and allow multiple users to access and work on the same Data simultaneously.

4. Have robust security measures in place and provide role-based access control to ensure the Security of confidential Project Data.

5. Maintain version control of all Project Data, ensuring the latest version is always available and changes are tracked and recorded.

6. Integrate with other systems used in the Project, such as Project management tools, scheduling software, and financial management systems, must also be ensured.

7. Have mechanisms in place to ensure Data quality, including validation checks, Data cleansing, and Data normalization.

8. Maintain an audit trail of all activities related to Project Data, providing a complete history of changes made to the Data.

5.1.7 Distinguishing Uniclass 2015[29] and Industry Foundation Classes

The Manual recommends utilizing Uniclass 2015 as a consistent approach to organizing and structuring construction Information. Uniclass 2015 should be applied throughout the Project lifecycle, from initial briefing and design through to construction, operation, and maintenance, with a focus on the classification of construction Objects such as building components, Spaces, and activities.

In regard to software interactions and Data exchanges, the Manual suggests using IFC to facilitate Interoperability between different software applications used in the construction Industry. IFC allows for the representation and exchange of building Information digitally.

It is important to note that IFC is an Open Data format managed and maintained by BuildingSMART International that is published freely without limitation. This provides and promotes Interoperability as the schema is available to users for free.

It is essential to understand that IFC is primarily focused on the exchange of Information between different software applications and is not a classification system.

To effectively utilize Uniclass 2015 and IFC, it is important to understand how these two systems interact. When Uniclass 2015 and IFC are utilized together, the Uniclass 2015 classification system efficiently organizes and manage Project-related Information, such as bridges, roads, and tunnels while the IFC is utilized to seamlessly exchange this Information between various software applications. This enables smooth collaboration and communication between different Project Proponents, including architects, engineers, and contractors.

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29 There is the option to switch Uniclass 2015 with OmniClass (defined in Glossary) as the classification system, depending on Industry preference(s). The recommendation is to mandate one or the other to prioritize alignment of all Project Databases.

5.1.8 Asset Classification Standard Based on Uniclass 2015

The Manual's Asset classification standard is based on Uniclass 2015. To assist with understanding this classification, **Appendix M** lists the eleven tables referenced from ISO 12006-2:2015 Building Construction – Organization of Information about Construction Works. These tables include:

1. Co – Complexes
2. En – Entities
3. SL – Spaces/Locations
4. EF – Elements/Functions
5. Ss – Systems
6. Pr – Products
7. Ac – Activities
8. FI – Form of Information
9. PM – Project Management
10. TE – Tools and Equipment
11. Zz - CAD

It should be noted that there is a 12th table, Ro – Roles, which has not been provided, as roles have been modified to fit within the context of the Manual throughout Section 5.

Where Uniclass 2015 does not fulfill a specific classification need, the Appointed Party should work with the Client to develop an appropriate standardized classification system.

5.1.9 Relevant Industry Foundation Classes Schema for Projects

It is important to identify the relevant IFC schemas based on 2022 IFC 4.3 and the ISO 16738-1:2018 (IFC for Data Sharing in the Construction and Facility Management Industries Part 1: Data Schema). For a Project, the relevant IFC schemas include the following:

1. IFC Infrastructure Alignment: This schema represents the alignment of Infrastructure components, such as roads, railways, and waterways.
2. IFC Infrastructure Bridge: This schema represents bridges and viaducts.
3. IFC Infrastructure Tunnel: This schema represents tunnels.

4. IFC Infrastructure Building Service: This schema represents building services, such as heating, ventilation, and air conditioning (HVAC), plumbing, and electrical systems.

5. IFC Infrastructure Site: This schema represents the site and its features, such as topography, landscaping, and utilities.

5.1.10 Common Information Model for Electric Utilities

The Electric Power Research Institute (EPRI) International Electrotechnical Commission (IEC) standard for Common Information Model (CIM) using Unified Modeling Language (UML) for electric utilities integrates well with Manual requirement to use a CDE and IFC.

The UML models and describe the CIM, providing a common language and visual representation for understanding and communicating the structure and behavior of power system components.

The CIM is a set of open standards that define a common representation of power system components. It was originally developed by EPRI and is now maintained by IEC Technical Committee 57. The CIM standards (61970, 61968, and 62325) cover various aspects of power system software Data exchange, including energy management systems, Asset tracking, work scheduling, customer billing, and electricity markets.

The CIM's standardized representation of power system components must be integrated into the Project CDE, allowing for consistent and interoperable exchange of Data between different applications and Delivery Partners involved in Project.

Figure(s)

Yes☒ No☐

- Figure 5.1.1: Referenced ➔ West Cambridge – Data Ingestion + IM5.2.3: Infographic Support Document
    - Visualize how Building Management System Data, dynamic sensor Data, and static BIM Data contribute to the Iterative Cycle for a Digital Twin
- Figure 5.1.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy – Page C.76

References

- Diagram mapping the flow and interactions of the cloud-based service, model federation, design reviews and assurance, scripts and automation, and Asset handover for the CDE
    - Office of Projects Victoria – Digital Asset Strategy
    - West Cambridge – Data Ingestion + IM5.2.3: Infographic Support Document

- NUAR – Data Ingestion Specification
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 1: Concepts

5.2 Data Types, Sources, & Taxonomy

Outcome(s)

To easily reference Data Types, Data Sources, & taxonomy for all Delivery Partners.

Considerations

Important to align Delivery Partners on understandings of taxonomy, nomenclature, and key terminology for Data Types and Data Sources.

Content

Note: A subsequent version of the Manual will include requirements and key understandings for Data Types, Data Sources, and the attributed taxonomy.

Figure(s)

Yes☐ No☒

References

N/A

Utilities Infrastructure Engineering

5.3 Utilities Infrastructure Engineering RACI Matrix for Delivery Partners in Data Ingestion and Data Exploration

Outcome(s)

Outlines the guidelines for effective management of UIE in Projects. One key aspect of UIE management is identifying who is responsible, accountable, consulted, and informed (RACI) for each Delivery Partner.

Considerations

The Manual provides tables of the RACI Matrices for Delivery Partners in v1.0, an example of said table is provided in this section. The Manual emphasizes the importance of clearly defining the roles of each Delivery Partner, which is a recurring theme across Reference Documents. This has been confirmed by technical expert review, as it improves communication, accountability, and efficiency within an Organization and Project Team.

Content

5.3.1 RACI Matrix Defined

The RACI Matrix is a tool utilized to clarify roles and responsibilities within a Project or Organization, as specified in the Manual.

The RACI Matrix helps to identify who is Responsible, Accountable, Consulted, and Informed for each task or decision, as described in the Manual.

1. Step 1: The RACI Matrix is typically organized into rows and columns, with tasks or decisions listed in the rows and roles listed in the columns, as outlined in the Manual.

2. Step 2: Each cell in the matrix contains a letter (R, A, C, or I) that corresponds to the role's level of involvement for that particular task or decision, as detailed in the Manual.

3. Step 3: The RACI Matrix can be used to improve communication, accountability, and efficiency within an Organization and Project Team, as highlighted in the Manual.

4. Step 4: If there is more than one Party as the Responsible or Accountable role, their roles cover specific aspects or domains within that task, as specified in the final Matrix table, as detailed in the Manual.

5. Step 5: The Manual distinguishes between Organizational and Project Team roles for the RACI Matrix. Organizational roles are responsible for the overall adoption of the Manual and its

standards across the Organization's Projects, while Project Team roles are responsible for the implementation of the Manual and its standards within the Project.

To ensure that the RACI for each Delivery Partner is clearly defined and understood, the Manual recommends the following steps:

1. Step 1: Identify all Delivery Partners involved in the Project and their respective roles and responsibilities, as specified in the Manual.

2. Step 2: Determine the scope of UIE management for each Delivery Partner, as detailed in the Manual.

3. Step 3: Assign RACI designations for each Delivery Partner based on their scope of UIE management, as outlined in the Manual.

4. Step 4: Communicate the RACI designations to all relevant parties, including Delivery Partners, Project Managers, and Delivery Partners, as specified in the Manual.

5. Step 5: Review and update the RACI designations as necessary throughout the Project's lifecycle, as recommended in the Manual.

By following these steps, Delivery Partners can ensure that the Project is effectively managed, and that all parties involved in the Project are aware of their roles and responsibilities, as detailed in the Manual.

5.3.2 RACI Matrix for Organizational Roles

The RACI Matrix is defined by tasks found in Section 5.4.

Information Management RACI Matrix for a Project		
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Implementation Lead	Assets Manager
Application of Data integration techniques		
Implement Data integration techniques and ensure alignment with Organization goals and Objectives	R	A
Align integration techniques with the Organizations Asset Management strategy	A	R
Addressing classification challenges		
Oversee the automation of Data collection and classification techniques and ensuring they align with the Organization's goals and Objectives	R	A
Ensure that automation technique align with the Organization's Asset Management strategy	A	R
Standards for Deliverables formatting		
Oversee the implementation of the standards for deliverable formatting and ensuring that they align with the Organization's goals and Objectives	R	A
Ensure that the standards for Deliverables formatting align with the Organization's Asset Management strategy	A	R

5.3.3 RACI Matrix for Project Team

The RACI Matrix is defined by tasks found in Section 5.4.

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/ task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Application of Data integration techniques								
Appoint the appropriate personnel to oversee the implementation of Manual Data integration techniques	R	C	C	I	I	A	I	I
Use IFC and capture geometry Information for underground utilities and geological zones	I	R	A	C	C	C	I	I

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Ensure accuracy and security of the Data collected	C	C	R	I	I	A	I	I
Ensure Data integration techniques align with the Project's design requirements	I	C	C	R	C	A	I	C
Ensure Data integration techniques align with the Facility Management strategy	I	C	C	C	R	A	C	I
Ensure Data integration technique align with the Project's cost management strategy	I	C	C	I	I	A	R	I
Coordinate the implementation of the Data integration techniques with the124 various Utility Providers involved in the Project	I	C	C	C	I	A	I	R

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/ task I – Informed following activity/ task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Ensure integration techniques are implemented within the Project's timeline and budget	I	C	C	I	I	A	R	I
Addressing classification challenges								
Oversee the automation of Data collection and classification techniques	R	C	A	I	I	C	I	I
Implement automation techniques for Data collection and classification	C	R	A	I	I	C	I	I

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Ensure accuracy and security of the Data collected through the automation techniques	I	C	R	I	I	A	I	I
Ensure automation techniques align with the Project's design requirements	I	C	C	R	I	A	I	I
Ensure automation techniques align with facility management strategy	I	C	C	C	R	A	I	I
Ensure automation techniques are implemented within the Project's timeline and budget	I	C	C	I	I	A	R	I

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Ensure automation techniques align with the Project's cost management strategy	I	C	C	I	I	A	R	I
Coordinate the automation of Data collection and classification techniques with the various Utilities Providers involved in the Project	I	C	C	I	I	A	I	R
Standards for Deliverables formatting								
Appoint the appropriate personnel to oversee the implementation of the standards for Deliverables formatting	R	C	C	I	I	A	I	I

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Implement standards for Deliverables formatting for Utilities using the ASCE 38-22, ASCE 75-22, and CSA S25020, and BIM Deliverables identified in the Manual	I	C	R	I	I	A	I	C
Ensure accuracy and security of Data collected through the standards for Deliverables formatting	I	C	R	I	I	A	I	I
Ensure that the standard for Deliverables formatting align with the Project's design requirements	I	C	C	R	C	A	C	C

Information Management RACI Matrix for a Project								
Key R – Responsible for undertaking activity/task A – Accountable for activity/task completion C – Consulted during activity/task I – Informed following activity/task completion **Activity/Task**	Appointing Party	Lead Appointed Party and/or Appointed Party/Parties						
		BIM Specialist	Data Custodian	Design Manager	Facility Manager	Project Manager	Quantity Surveyor	Utility Coordinator
Ensure standards for Deliverables formatting align with the facility management strategy	I	C	C	C	R	A	I	C
Coordinate the implementation of the standards for Deliverables formatting with the various Utilities Providers involved in the Project	I	I	I	C	C	A	I	R
Ensure that the standards for Deliverables formatting are implemented within the Project's timeline and budget	I	I	I	C	C	A	R	I

Figures

Yes☐ No☒

References

N/A

5.4 Utilities Infrastructure Engineering Requirements for Data Ingestion and Data Exploration in Projects

Outcome(s)

State the steps and processes involved in integrating Data from various sources into a CDE using Manual standards. The goal is to improve accuracy and efficiency in Data management.

Considerations

The United Kingdom's Reference Documents were prioritized as they have the greatest similarity in available Data Types and Data requirements when building the CDE.

This Manual combines ASCE 38-22, ASCE 75-22, and CSA S25050 standards with international standards related to Data Ingestion and Data Exploration.

Content

5.4.1 Techniques for Data Integration

The Manual provides guidance on techniques for Data Integration required for Data Ingestion and Data Exploration. The use of IFC in the context of UIE is reiterated to maintain consistency in Data Ingestion and Data Exploration. The following steps should be taken:

1. Utilize the IFC schema identified in Section 5.1.9.
2. Encode IFC Data in XML, JSON, and/or STEP to transmit Data over web services, to import/export files, and manage in centralized or linked Databases.
3. Address concerns about lack of Data readability or Interoperability with specific tools or purposes.
4. Establish that in this case, native files can be shared together with IFC files in the CDE.

Capture geometry and Attributes Information for underground utilities and geological zones.

To improve communication and collaboration for a clear understanding of Project requirements and Objectives, the Manual recommends using domain vocabulary and taxonomy to describe building services systems. The following should be noted:

1. The domain is building services systems.
2. Building services systems refer to the various systems that provide essential services and utilities within a building or structure, such as electrical, plumbing, heating, ventilation, and air conditioning (HVAC), as well as fire protection systems.

5.4.2 Addressing Classification Challenges

The Manual requires the use of at least one identified automation technique for Data collection and classification. This is to reduce the time required for the process and improve the accuracy and consistency of the results. The following are recommended techniques:

1. Train Machine Learning Algorithms: The Manual recommends training machine learning algorithms to recognize patterns in Data and classify them accordingly. It is important to ensure that the algorithms are trained to recognize several types of building systems and automatically classify them according to the IFC schema or Uniclass 2015.

2. Use Natural Language Processing (NLP): The Manual recommends utilizing NLP to extract relevant Information from unstructured Data Sources such as Project documentation, emails, and other text-based sources. It is important to train NLP algorithms to recognize keywords and phrases that are relevant to the IFC schema or Uniclass 2015, and automatically classify Data accordingly.

3. Align Data with Data Mapping: The Manual recommends aligning Data from one schema or taxonomy to another using Data mapping. Automated tools should be used to map Data from the source schema or taxonomy to the IFC schema or Uniclass 2015. It is important to ensure that the tools can identify and map Data Elements between different schemas or taxonomies.

4. Develop Scripts for Automation: The Manual recommends developing custom scripts to automate the classification and Organization of Data. Scripts should be created that can automatically extract and classify Data from various sources and map them to the IFC schema or Uniclass 2015. It is important to ensure that the scripts are tailored to the specific needs of the Project and that they are thoroughly tested and validated before implementation.

5.4.3 Standards for Deliverables Formatting

Ensure compliance with the requirements for UIE deliverable formatting and recording for the CDE, as outlined in the Manual's sections on ASCE 38-22, ASCE 75-22, and CSA S25020.

1. Comply with ASCE 38-22, specifically Chapter C5, by adhering to the guidelines for utility mapping and documentation provided in the Manual.

2. Follow the general guidelines for utility mapping and documentation as outlined in ASCE 75-22, which include using absolute spatial positioning, achieving positional accuracy, and using trenchless Technology where possible.

3. Comply with CSA S25020 Mapping by establishing a records management system, assigning clear accountability and responsibilities, and ensuring mapping records possess all required characteristics.

For Data Exploration, refer to Section 8 of the Manual for specific questions and requirements that are specific to the stage of the Project.

The Appointing Party, Lead Appointed Party, and Appointed Party or Parties must sign the Data Exploration Agreement, which can be found in **Appendix N** of the Manual.

- Note that the Data Exploration Agreement template is based on the NUAR Reference Document – Appendix B – Data Exploration Agreement.

Figure(s)

Yes☐ No☒

References

- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure
- Productivity Through Data
- NUAR – Data Distribution Agreement
- CDBB – UK BIM Framework + Guidance
- Construction Innovation Hub – Smart Standards – An Approach to Implementing ISO 19650-2 Using Tasks in a Digital Process
- ASCE – ASCE 38-22: Standard Guideline for Investigating and Documenting Existing Utilities
- ASCE – ASCE 75-22: Standard Guideline for Recording and Exchanging Utility Infrastructure Data
- CSA Group – CSA S25020: Mapping of Underground Utility Infrastructure
- West Cambridge – Data Ingestion + IM5.2.3: Infographic Support Documentation

Building Information Modeling

5.5 Building Information Modeling RACI Matrix for Delivery Partners in Data Ingestion and Data Exploration

Outcome(s)

Outlines the guidelines for effective management of BIM in Projects. One key aspect of BIM management is identifying who is responsible, accountable, consulted, and informed (RACI) for each Delivery Partner.

Considerations

The Manual provides tables of the RACI Matrices for Delivery Partners in v1.0, an example of said table is provided in this section. The Manual emphasizes the importance of clearly defining the roles of each Delivery Partner, which is a recurring theme across Reference Documents. This has been confirmed by technical expert review, as it improves communication, accountability, and efficiency within an Organization and Project Team.

Content

5.5.1 RACI Matrix Defined

Refer to Section 5.2.

5.5.2 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 5.6.

5.5.3 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 5.6.

Figure(s)

Yes☐ No☒

References

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

5.6 Building Information Modeling Requirements for Data Ingestion and Data Exploration in Projects

Outcome(s)

Instruct on practical applications and requirements for Data Ingestion and Data Exploration considering BIM practices.

Considerations

Competing terminology in Reference Documents is consolidated into specific and appropriate language for the purpose of the Manual.

Understand there is extensive breadth and depth in Leading Practices for BIM both nationally and internationally, but the focus of this Section is to provide instructions for the minimum requirements to meet the Manual's intended purpose and mission. Additional Information can be included in the Manual, if desired.

Content

5.6.1 Practical Applications for Reality Capture

Establish requirements for Reality Capture during Data Ingestion and intended impact for Data Exploration.

A. Perform "As-Built" Modelling (Scan to CAD/BIM)

Capture real-world conditions to create accurate 3D models of existing structures or sites.

Use these models as a reference point for design, renovation, or maintenance Projects.

B. Perform Clash Detection

Identify interferences between different Elements of a Project, such as pipes, ducts, and structural components.

Use this Information to adjust the design or construction plan to avoid clashes.

C. Write Deviation Reporting

Track progress against plans and identify any deviations from the original design or construction plan.

Use this Information to make necessary adjustments to the Project plan.

D. Routine Construction Verification

Use Reality Capture to verify that construction is proceeding according to plan and that quality standards are being met.

Use this Information to make necessary adjustments to the construction plan for Quality Assurance.

5.6.2 Requirements for Data Ingestion and Exploration in Projects for BIM

E. Perform Data Gathering with Reality Capture

Use Reality Capture to gather accurate Data about existing Infrastructure, such as pipes, cables, and other utilities.

Use this Information to inform design and construction decisions.

F. Reality Capture of Data Before, During, and After Projects

Ensure Reality Capture is used to capture Data at various stages of a Project, from pre-construction to post-construction.

Use this Information to track progress and identify any deviations from the original plan.

G. Perform Data Analysis, Extraction, and Conversion

Use Point Cloud and skilled personnel to analyze, extract, and convert Data into usable formats.

Use this Information to inform decision-making and improve Project outcomes.

5.6.3 Requirements for Common Data Environment and Automation of Data Collection and Classification

1. Confirm Data Integration from various sources:
    a. Integrate Data from various sources, such as Reality Capture, GIS, and BIM, into a CDE.
    b. Use this Information to create a comprehensive view of the Project.
2. Address classification challenges:
    a. Address classification challenges, such as inconsistent Data formats or missing Information.
    b. Use this Information to ensure Data accuracy and completeness.

3. Enable better decisions with systems:

    a. Use systems and tools to enable better decision-making based on accurate and complete Data.

    b. Use this Information to improve Project outcomes.

4. Interconnect Data Sources through Refinement Process:

    a. Interconnect Data Sources through a Refinement Process to ensure Data accuracy and completeness.

    b. Use this Information to improve Project outcomes.

5. Optimize through an Iterative Process and relevant Data selection:

    a. Optimize Data selection and refinement through an Iterative Process.

    b. Use this Information to improve Project outcomes.

5.6.4 Information Requirements for BIM

Collect only necessary Information for each Asset Object:

- Collect only the necessary Information for each Asset Object to ensure Data accuracy and completeness.

- Use this Information to improve Project outcomes.

Ensure consistency in structure of Asset Objects and Information for easy importation:

- Ensure consistency in the structure of Asset Objects and Information to facilitate easy importation into a CDE.

- Use this Information to improve Project outcomes.

Provide required Information for each Asset Object:

- Provide the required Information for each Asset Object to ensure Data accuracy and completeness.

- Use this Information to improve Project outcomes.

5.6.5 Requirements for Data Capture

Use automatic scanning solutions for efficiency:

- Use automatic scanning solutions to improve efficiency and accuracy of Data capture.
- Use this Information to improve Project outcomes.

Ensure required accuracy is met:

- Ensure the required accuracy of Data capture from the Manual is met to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Capture entire Project Area:

- Capture the entire Project Area to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Choose appropriate Data format:

- Choose the appropriate Data format to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Consider Non-Graphical Information requirements:

- Consider Non-Graphical Information requirements, such as Asset Information and Metadata, to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

5.6.6 Immediate Improvements for Data Ingestion and Data Exploration

Define BIM uses in Project Brief:

- Define BIM uses in the Project Brief to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Provide clear scope of deliverable requirements:

- Provide a clear scope of deliverable requirements to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Understand time and financial impacts of incorporating BIM uses:

- Understand the time and financial impacts of incorporating BIM uses to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Identify Design Models that can and cannot be used:

- Identify Design Models that can and cannot be used to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Confirm contractors understand benefits of more detail:

- Confirm contractors understand the benefits of more detail to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Align Procurement Methodologies with BIM Process:

- Align Procurement Methodologies with the BIM Process to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Conduct regular Information audits:

- Conduct regular Information audits to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

Assign appropriate value to "As-Built"/Handover BIM[30]:

- Assign appropriate value to "As-Built"/Handover BIM to ensure Data accuracy and completeness.
- Use this Information to improve Project outcomes.

30 The "As-Built"/Handover BIM refers to a three-dimensional Digital Model that represents the final state of a construction Project, including all modifications and changes made during the construction process. It is used as a reference for maintenance and future modifications.

Figure(s)

Yes☒ No☐

- Figure 5.5.1: Referenced ➔ CSIC – Line of Sight: An Asset Management Methodology to Support Organizational Objectives, Optimizing Asset Management Methodology to Realize Business Success
    - Flow for Data Ingestion and Data Exploration processes.
- Figure 5.5.2: Referenced ➔ CSIC – Line of Sight: An Asset Management Methodology to Support Organizational Objectives, Optimizing Asset Management Methodology to Realize Business Success
    - The Development of Organizational Information Requirements that Align to an Organizational Objective.
- Figure 5.5.3: Referenced ➔ CSIC – Line of Sight: An Asset Management Methodology to Support Organizational Objectives, Optimizing Asset Management Methodology to Realize Business Success
    - The Use of Functional Information Requirements to Support the Development of Asset Information Requirements.
- Figure 5.5.4: Referenced ➔ CSIC – Line of Sight: An Asset Management Methodology to Support Organizational Objectives, Optimizing Asset Management Methodology to Realize Business Success
    - The development of an Asset Information Model derived from a classified BIM model and the structure.

References

- Office of Projects Victoria Digital Asset Policy: Improving Infrastructure Productivity Through Data
- NUAR - Data Distribution Agreement
- Construction Innovation Hub – Smart Standards – A– Approach to Implementing ISO 19650-2 Using Tasks in a Digital Process
- OGCA - Guide to Construction and Design Technology
- CSIC – Line of Sight: An Asset Management Methodology to Support Organizational

Objectives, Optimizing Asset Management Methodology to Realize Business Success

- West Cambridge - Data Ingestion + IM5.2.3: Infographic Support Document

5.7 Utilities Infrastructure Engineering and Building Information Modeling KPIs for Data Ingestion and Data Exploration

Outcome(s)

Identify Key Performance Indicators (KPIs) to measure quality of Data Ingestion and Data Exploration for Delivery Partners in UIE and BIM.

Help to ensure that Data Ingestion and Data Exploration is efficient, accurate, and effective in supporting Projects using DTO Framework in the Utilities Industry.

Considerations

This section on KPIs for Data Ingestion and Data Exploration will allow Ontario and DTO to gauge the value of requirements set out in the Manual and orient themselves to areas of the Utilities Industry that require additional support.

Creates a reference point to attribute future value-creation and cost savings of Manual and DTO Framework.

Clarify that while some suggested values for KPIs have been provided, they have not yet been set in place requiring further consultation and advisory from Industry experts.

Content

5.7.1 Purpose of Key Performance Indicators

Key Performance Indicators (KPIs) help assess the overall progress of the Project and identify areas for improvement.

KPIs will serve Ontario and the DTO to iterate on requirements set out in the Manual for the value of the Utilities Industry.

5.7.2 Steps in Key Performance Indicators Assessment

KPIs are performed by Organizational Teams at a quarterly, bi-annually, or annually rate depending on the scale and number of Projects.

Assessments are reported to the DTO Core Team. Submission of assessments is the last step to confirm compliance with Manual Project terms.

5.7.3 Key Performance Indicators for Data Ingestion and Data Exploration towards Digital Twins in Projects

It is essential to track and measure certain KPIs to achieve the purpose of the Manual. KPIs can help assess the overall progress of the Project and identify areas for improvement.

There are five key KPIs to consider for Data Ingestion and the actions to take to improve it:

1. Data integration rate: Successfully integrate all Data Sources into the CDE for a given Project. Invest in additional tools and technologies that can help to streamline the integration process to improve this KPI.

2. Accuracy of Data capture: Capture Data accurately during the Data Ingestion process to avoid errors and inconsistencies in the final Digital Twin model.

3. Efficiency of Data capture: Capture Data efficiently during the Data Ingestion process to save time and resources.

4. Timeliness of Data capture: Capture Data in a timely manner during the Data Ingestion process to avoid delays in the Project.

5. Data completeness: Collect and ingest all Data required for the Digital Twin into the CDE. Invest in additional Data collection and ingestion tools or explore alternative Data Sources to improve this KPI.

There are seven key KPIs to consider for Data Exploration and the actions to take to improve it:

1. Data Analysis Quality: Achieve a 95% accuracy rate in Data analysis during the Data Exploration process to generate useful insights.

2. Exploration Efficiency: Increase the speed and accuracy of Data Exploration and analysis by 25% using automation techniques within the Digital Twin framework.

3. Data Exploration Effectiveness: Ensure that 90% of insights and problems are identified during the Data Exploration process to avoid rework and delays in the Project.

4. Compliance with Information Requirements: Achieve 100% compliance with Information requirements for each Asset Object to enable accurate modeling and analysis during the Data Ingestion and exploration processes.

5. Collaboration with Project Teams: Foster effective collaboration with Data Custodian, Digital Twin Developers, and other Project Teams to enable better decision-making and optimize the Project during the Data Ingestion and exploration processes.

6. Time to Data Availability: Reduce the time to Data availability by 50% by collecting, ingesting, and making Data available for exploration and analysis in the shortest time possible.

7. Classification Accuracy: Achieve a 95% accuracy rate in correctly classifying and categorizing all Data into the appropriate domain vocabulary and taxonomy. Use automation techniques

to reduce errors and inconsistencies in the classification process to improve this KPI.

Figure(s)

Yes☐ No☒

References

- CDBB – Information Management According to BS EN ISO 19650 - Guidance
- Part D: Developing Informa–ion Requirements
- CDBB – Information Management According to BS EN ISO 19650 - Guidance Part 2: Processes for Project Delivery
- Digital Twin Ontario Program Strategy: Report-Back to the Ministry of Infrastructure
- Office of Projects Victoria – Digital Asset Strategy

6. Data Sharing and Data Collaboration

6.0 Section Objective

Set out requirements for Data Sharing and Data Collaboration in the context of Digital Twins and Utility Coordination.

Instruct on how to implement DTO standard practices for Data Sharing and Data Collaboration in Projects, for UIE and BIM.

Distinguish Section 6 as the detailed minimum requirements for Data Sharing and Data Collaboration in relevant required processes for Projects found in Section 8.

Navigate content provided in Section 5 by providing an overview of the content to come.

6.1 Introduction to Data Sharing and Collaboration

Outcome(s)

Navigate content provided in Section 6 by providing an overview of the content to come.

Considerations

During the initial stages of implementing requirements, Delivery Partners may need more context to orient them to the purpose and intended outcomes of the requirement(s). This note was identified during a technical expert review.

Relevant Legislation and Regulations

Precedent for Data Sharing and Collaboration

To accelerate the deployment of Infrastructure through Open Data Collaboration across Delivery Partners and enabling Digital Twins, it is essential to consider the acts in Ontario that establish precedent for sharing and collaboration, including the Infrastructure for Jobs and Prosperity Act, 2015, ,the Simpler, Faster, Better Services Act, 2019, The Building Transit Faster Act, 2020 and the Building Broadband Faster Act, 2021

The Infrastructure for Jobs and Prosperity Act mandates municipalities to formulate Asset Management plans that include Data on Infrastructure Assets, which can be shared with other Delivery Partners to promote collaboration. The Building Broadband Faster Act requires the sharing of Information in proximity to designated broadband Projects to support the development of high-speed internet access across Ontario. The Simpler, Faster, Better Services Act, 2019 enables

the sharing of Data between government Agencies to enhance service delivery and minimize duplication.

Measures for Facilitating Data Sharing and Collaboration

The DTO Act establishes legislative provisions to facilitate Data Sharing and collaboration for the enablement of Digital Twins in Ontario. Appointing Parties are obligated to provide Digital Assets and records of Infrastructure upon receiving a Locate Request and maintain these Digital Assets and records in a local repository. At the same time, DTO's AssetFlow Hub facilitates the flow of Digital Assets and records from and to Appointing Parties.

To enhance visibility into Projects, Appointing Parties must submit permits related to Projects through a centralized E-Permitting Platform administered by DTO. These measures enable efficient and effective Data Sharing and collaboration among Appointing Parties, contractors, and excavators for all municipal and provincial permits required for or in proximity to Projects.

Content

6.1.1 Purpose and Definition of Data Sharing and Data Collaboration

Data Sharing is defined as the process of sharing Data with others within or outside an Organization. Data Collaboration, on the other hand, is defined as the process of working together to create and maintain a comprehensive and accurate Digital Model of the Infrastructure.

In the context of UIE and BIM, Data Sharing serves the purpose of validating Information for decisions based on the Digital Model. The Manual requires the Project Teams to:

Make relevant Data and Information available to Delivery Partners and Project Team Parties during a Project. This ensures that collaboration is facilitated and decision- making related to the Project is improved.

Work together with other Delivery Partners and Project Team Parties to input Data, as well as review and validate Information. This ensures that the Digital Model is accurate and up-to-date, and that decisions made based on it are reliable and effective.

6.1.2 Required Roles for Data Sharing and Data Collaboration

The Manual identifies the Organizational role of the Assets Manager as necessary for implementing Manual standards compliance across their Organizational Teams.

Assets Managers are key to Data Sharing and Data Collaboration requirements.

The Manual also identifies Project Team Roles of Data Custodian and Project Manager as responsible for meeting the requirements for Data Sharing and Data Collaboration.

It is important to note that while the Assets Manager, Data Custodian, and Project Manager have primary roles in Data Sharing and Data Collaboration, both the Organizational and Project Team roles have attributed roles in the Data processes.

6.1.3 Cost Attribution

Cost Attribution involves breaking down the various costs of storing Data, transmitting Data, as well as the costs of developing and maintaining the necessary Infrastructure and tools for Data Sharing and Data Collaboration.

Cost Attribution a critical aspect of the Data Sharing and Data Collaboration process and two considerations must be noted. First, Data Sharing and Data Collaboration involves multiple Delivery Partners; each Delivery Partner may have different Data needs and requirements and may contribute several types of Data to the Projects.

Second, Cost Attribution requires to ensure each Delivery Partner is aware of their share of the costs associated with Data Sharing and Data Collaboration, and that these costs are allocated fairly and accurately.

DTO has the Administrative Authority to attribute costs and determine appropriateness. Costs will be based on a Cost Recovery[31] model and will need to be competitive with private sector options.

Requirements for enabling Cost Attribution are as follows:

1. Delivery Partners must understand specific activities and resources required for effective Data Sharing and Data Collaboration. These activities include Data storage, Data processing, and Data analysis.

2. Relevant parties must determine the costs associated with each activity, including labor costs, equipment costs, and any other expenses using Activity-Based Costing (ABC) which assigns costs to specific activities based on their use of resources.

3. During a Project, multiple Delivery Partners will contribute to this process. Note the Appointing Party will provide the initial estimate, this task can involve the Lead Appointed Party as well.

6.1.4 Distinguishing UIE and BIM Requirements

The Manual covers both UIE and BIM requirements depending on key Elements identified in Projects.

UIE and BIM have different requirements. While UIE requirements primarily address Horizontal Structures in Projects (e.g., water and gas pipelines, electrical and communication cables, and sewer

31 Based on existing Municipal model(s) in Ontario where possible.

lines), BIM requirements primarily address Vertical Structures in Projects (e.g., power lines and transmission towers, cell phone towers, and water towers).

Regardless of the distinction, UIE and BIM practices follow an Asset classification standard based on Uniclass 2015 and IFC for software interactions. Additionally, the same policy for agreements, Intellection Property and Ownership applies. Finally, the same standard for exchange of Information about a facility is administered through the requirement of the Construction Operations Building Information Exchange (COBie) international standard.

6.1.5 Considerations for Intellectual Property and Ownership

The Projects' CDE creates an opportunity for Data Sharing and Data Collaboration during a Project but requires Intellectual Property Policy (IP Policy) to protect Intellectual Property (IP) of Delivery Partners.

While the detailed terms for IP Policy are found in Section 3, general terms considered in IP Policy are as follows:

1. Ontario determines IP rights applicable to the Project.
2. IP licenses are generally broad enough to have similar rights as ownership.
3. Ontario will not be assigned IP rights for the purpose of preventing commercial parties from further leveraging intellectual property rights.
4. Joint ownership of IP to be avoided.
5. Legal matters are considered by the appropriate Delivery Partner experiencing IP issues.

A template is provided in **Appendix O** for a Data distribution agreement referenced from the NUAR Data Distribution Agreement V1.2 [Ontario].

Figure(s)

Yes☐ No☒

References

- NUAR – Data Ingestion Specification
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

Utilities Infrastructure Engineering

6.2 Utilities Infrastructure Engineering RACI Matrix for Delivery Partners in Data Sharing and Data Collaboration

Outcome(s)

Outlines the guidelines for effective management of UIE in Projects. One key aspect of UIE management is identifying who is responsible, accountable, consulted, and informed (RACI) for each Delivery Partner.

Considerations

The Manual provides tables of the RACI Matrices for Delivery Partners in v1.0, an example of said table is provided in this section. The Manual emphasizes the importance of clearly defining the roles of each Delivery Partner, which is a recurring theme across Reference Documents. This has been confirmed by technical expert review, as it improves communication, accountability, and efficiency within an Organization and Project Team.

Content

6.2.1 RACI Matrix Defined

Refer to Section 5.2.

6.2.2 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 6.3.

6.2.3 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 6.3.

Figure(s)

Yes☐ No☒

References

- CDBB - Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

6.3 Utilities Infrastructure Engineering Requirements for Data Sharing and Data Collaboration in Projects

Outcome(s)

Outline the steps and processes involved in sharing Data from various sources into a CDE using Manual standards. The goal is to improve synchronicity and accuracy in decision making leveraging digital Data.

Considerations

United Kingdom Reference Documents informed this Section as they have the greatest similarity when considering Data Sharing and Data Collaboration agreements as well as the CDE. The team also combined ASCE 38-22, ASCE 75-22, and CSA S25050 compliance with international standards in the context of Data Sharing and Data Collaboration and the intended Deliverables.

Content

This Section clearly outlines guidelines and protocols for Data Sharing, Collaboration, Stewardship to ensure understanding among Organizational Team and Project Teams.

Specifically, the Section illustrates requirements for encouraging open communication amongst Project Teams by establishing the following initiatives during a Project within Teams:

1. Regular team meetings and communication channels to facilitate collaboration and knowledge sharing.

2. Regular touchpoints to encourage team members to share their expertise and ideas with one another.

3. A culture of openness and respect to encourage effective communication and collaboration.

4. Regular reviews and updates to guidelines and protocols to reflect changes in Technology and Leading Practice.

6.3.1 Implement Appropriate Data Security Measures

The Manual requires Delivery Partners to:

1. Establish clear Data Security policies and procedures to protect sensitive Information.

2. Train team members on Data Security Leading Practices.

3. Regularly review and update Data Security measures to ensure they are up-to-date and effective.

6.3.2 Utilize Digital Tools and Platforms to Improve Efficiency

The Manual requires Delivery Partners to:

1. Implement digital tools and platforms that support Data stewardship and collaboration.
2. Train the Organizational Team and Project Team(s) on how to effectively use these tools and platforms.
3. Regularly review and update digital tools and platforms to ensure they meet Organization Team and Project Team needs and improve efficiency.

6.3.3 Foster a Culture of Collaboration and Trust

The Manual requires Delivery Partners to:

1. Encourage team members to work together and share knowledge and expertise.
2. Foster a culture of trust and respect to promote effective collaboration.
3. Celebrate team successes and recognize individual contributions to promote a positive team culture.

6.3.4 Follow ASCE and CSA standards for Recording and Exchanging Utility Infrastructure Data

The Manual requires Delivery Partners to:

1. Familiarize the Project Team with the ASCE 75-22 standard guideline and CSA S25020.
2. Follow the guidelines outlined in these standards when recording and exchanging Utility Infrastructure Data.
3. Familiarize the Project Team with the ASCE 75-22 standard guideline and CSA S25020.
4. Follow the guidelines outlined in these standards when recording and exchanging Utility Infrastructure Data. Regularly review and update practices to ensure they align with standards.

Figure(s)

Yes☐ No☒

References

- Office of Projects Victoria - Digital Asset Policy: Improving Infrastructure Productivity Through Data

- NAUR - Data Distribution Agreement
- CDBB - UK BIM Framework + Guidance
- ASCE - ASCE 75-22: Standard Guidelines for Recording and Exchanging Utility Infrastructure Data
- CSA Group – CSA S25020: Mapping of Underground Utility Infrastructure
- TAC - Using “The TAC Guideline for the Coordination of Utility Relocations” of Capital Infrastructure Projects
- OGCA - Guide to Construction and Design Technology

Building Information Modeling

6.4 Building Information Modeling RACI Matrix for Delivery Partners in Data Sharing and Data Collaboration

Outcome(s)

Outlines the guidelines for effective management of BIM in Projects. One key aspect of BIM management is identifying who is responsible, accountable, consulted, and informed (RACI) for each Delivery Partner.

Considerations

The Manual provides tables of the RACI Matrices for Delivery Partners in v1.0, an example of said table is provided in this section. The Manual emphasizes the importance of clearly defining the roles of each Delivery Partner, which is a recurring theme across Reference Documents. This has been confirmed by technical expert review, as it improves communication, accountability, and efficiency within an Organization and Project Team.

Content

6.4.1 RACI Matrix Defined

Refer to Section 5.2.

6.4.2 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 6.5.

6.4.3 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 6.5.

Figure(s)

Yes☐ No☒

References

N/A

6.5 Building Information Modeling Requirements for Data Sharing and Data Collaboration in Projects

Outcome(s)

Instruct on practical applications and requirements for Data Sharing and Data Collaboration considering BIM practices.

Considerations

There is extensive breadth and depth in Leading Practices for BIM both national and internationally. However, the focus of this Section is to provide instructions for the minimum requirements to meet the Manual's intended purpose and mission. More specification will be provided by Bulletins as is required (at the sole discretion of DTO or as Ordered by the Minister) for the orderly implementation and operation of DTO.

Note also that the Manual has harmonize competing terminology in Reference Documents by creating establishing language appropriate for the purpose of the Manual.

Content

6.5.1 Requirements for Data Sharing and Collaboration in Construction Projects Using DTs Framework

To ensure effective Data Sharing and Collaboration in construction Projects using DTs framework, the following requirements must be met:

1. Develop Asset Information Requirements: To facilitate effective Asset Management, it is important to develop Asset Information Requirements that comply with regulatory requirements and address various aspects of Asset Management, including maintenance, repair, and replacement requirements. The Asset Information Requirements should also include Information on capacity and utilization management, normal operations Information, predicted and actual impacts (including energy, waste, and carbon), and future renovation or eventual disposal requirements.

2. Ensure Compliance with ISO 19650-1: ISO 19650-1 provides a framework for managing Information over the whole life cycle of a built Asset using

3. BIM. Compliance with this standard ensures that all parties involved in the Project are using a standardized approach to BIM and Information Management.

4. Implement an Information Structure and Asset Classification System: To ensure effective Data Sharing and collaboration, it is important to implement an Information Structure and Asset Classification System. Examples of such systems include OmniClass, Uniclass, and CBI. These systems help to ensure that all parties involved in the Project are using a standardized approach to Asset classification and Information Management.

5. Utilize Construction Operations Building Information Exchange (COBie): COBie is an international standard for the exchange of Information about a facility or campus, including Asset Data, Space Data, and maintenance Data. Utilizing COBie as an overall Asset structure helps to facilitate effective Data Sharing and collaboration in construction Projects.

6. Utilize a Model Element Authoring Schedule: To ensure effective modeling and documentation practices, it is important to utilize a Model Element Authoring Schedule to assign responsibilities to model Elements. This is part of the BIM briefing and BIM Execution Planning process.

6.5.2 Standardized Modeling and Documentation Practices

To ensure effective modeling and documentation practices, the following practices must be implemented:

1. Plan the Modeling Process: Planning the Modeling Process includes defining the scope of the Project, establishing the Project timeline, and identifying the resources required to complete the Project.

2. Determine the Model Location and Model Orientation: Determining the Model Location and Model Orientation involves identifying the geographic location of the Project and establishing the orientation of the model.

3. Establish naming conventions and structures: Establishing naming conventions and structures involves defining a standardized approach to naming and organizing files, folders, and other Project-related materials.

4. Defining the Level of Development (Level of Development): Defining the Level of Development (Level of Development) involves establishing a standardized approach to defining the level of detail required for each Element of the model. This helps to ensure that all parties involved in the Project are working towards the same Objectives and can effectively share Data and collaborate throughout–the Project lifecycle.

Figure(s)

Yes☐ No☒

References

- NUAR - Data Ingestion Specification

- Office of Projects Victoria - Digital Asset Policy: Improving Infrastructure Productivity Through Data

- CDBB - UK–BIM Framework + Guidance
- Construction Innovation Hub - Smart Standards - Data Sharing An Approach To Implementing Iso 19650-2 Using Tasks In A Digital Process
- Ontario General Contractors Association (OGCA) - Guide To Construction and Design Technology
- Geographic Information System (GIS) for Ontario

6.6 Utilities Infrastructure Engineering and Building Information Modeling KPIs for Data Sharing and Data Collaboration

Outcome(s)

Identify Key Performance Indicators (KPIs) to measure quality of Data Sharing and Data Collaboration for Delivery Partners in UIE and BIM.

Help to ensure that Data Sharing and Data Collaboration is efficient, accurate, and effective in supporting Projects using DTO Framework in the Utilities Industry.

Considerations

This section on KPIs for Data Sharing and Data Collaboration will allow Ontario and DTO to gauge the value of requirements set out in the Manual and orient themselves to areas of the Utilities Industry that require additional support.

The following content aims to provide a reference point to attribute future value- creation and cost savings of Manual and DTO Framework. Note that while some suggested values for KPIs have been provided, they have not yet been set in place requiring further consultation and advisory from Industry experts.

Content

6.6.1 Purpose of Key Performance Indicators

Key Performance Indicators (KPIs) help assess the overall progress of the Project and identify areas for improvement. KPIs will serve Ontario and the DTO to iterate on requirements set out in the Manual for the value of the Utilities Industry.

6.6.2 Steps in Key Performance Indicators Assessment

Review and assessment of KPIs must be performed by Organizational Teams at a quarterly, bi-annually, or annually rate depending on the scale and number of Projects. The results of this review and assessment are reported to the DTO Core Team. Submission is a last step to confirm compliance with Manual terms.

6.6.3 Key Performance Indicators for Data Sharing and Data Collaboration towards Digital Twins in Projects

It is essential and required for Delivery Partners to track and measure certain KPIs to achieve the purpose of the Manual. Activities to enable KPIs must be performed by Project Teams at a quarterly, bi-annually, or annually rate depending on the scale of the Project.

Seven key KPIs are required for Data Sharing and Data Collaboration on Projects:

1. Data quality and Data accuracy:
    a. Percentage of Data shared that meets established guidelines and protocols for quality and accuracy.
    b. Number of errors or discrepancies found in shared Data.
    c. Time taken to correct errors or discrepancies in shared Data.
2. Open communication and collaboration:
    a. Number of Project Teams involved in Data Sharing and collaboration efforts.
    b. Frequency and quality of communication among Project Teams.
    c. Number of knowledge-sharing sessions or workshops held.
3. Data Security:
    a. Number of security breaches or incidents related to shared Data.
    b. Percentage of sensitive Information protected from unauthorized access or use.
    c. Time taken to detect and respond to security incidents.
4. Digital tools and platforms:
    a. Time taken to share Data using digital tools and platforms.
    b. Percentage of Project Teams using digital tools and platforms for Data Sharing and collaboration.
    c. Number of process improvements achieved through the use of digital tools and platforms.
5. Culture of collaboration and trust:
    a. Percentage of Project Teams who feel that a culture of collaboration and trust has been fostered.
    b. Number of successful collaborations achieved through the implementation of a collaborative approach to Utility Infrastructure engineering.
    c. Time taken to resolve conflicts or disagreements among Project Teams.

6. Compliance with Manual prescribed standards and guidelines:

    a. Percentage of shared Data that complies with ASCE 75-22 and CSA S25020 standards and guidelines.

    b. Number of deviations from established standards and guidelines.

    c. Time taken to correct deviations from established standards and guidelines.

7. SUE Data collection and Data mapping, additionally update utility baseline documents and the conflict tracker:

    a. Percentage of utility relocations on Project that use SUE Data collection and mapping.

    b. Time taken to complete SUE Data collection and mapping.

    c. Number of process improvements achieved through the implementation of SUE Data collection and mapping.

Seven key KPIs are required for BIM Compliance regarding Data Sharing and Data Collaboration on Projects:

1. Compliance with Level of BIM: KPI measures the extent to which the Organization has achieved Level 2 BIM compliance in construction Projects. It can be measured by assessing the percentage of Projects that have achieved Level 2 BIM compliance.

2. Compliance with Asset Information Requirements: KPI measures the extent to which the Organization has complied with the Asset Information Requirements (Asset Information Requirements) that address various aspects of Asset Management. It can be measured by assessing the percentage of Projects that have met the Asset Information Requirements compliance requirements.

3. Utilization of Asset Classification System: KPI measures the extent to which the Organization has implemented an Information Structure and Asset Classification System to facilitate effective Data Sharing and collaboration. It can be measured by assessing the percentage of Projects that have utilized the Asset Classification System.

4. Compliance with Model Element Authoring Schedule: KPI measures the extent to which the Organization has assigned responsibilities to model Elements using the Model Element Authoring Schedule as part of the BIM briefing and BIM Execution Planning process. It can be measured by assessing the percentage of Projects that have met the Model Element Authoring compliance requirements.

5. Compliance with standardized modeling and documentation practices: KPI measures the extent to which the Organization has implemented standardized modeling and documentation practices, including planning the Modeling Process, establishing naming conventions and structures, and defining the Level of Development (Level of Development). It can be measured by assessing the percentage of Projects that have met the standardized modeling and documentation practices compliance requirements.

6. Compliance with COBie: KPI measures the extent to which the Organization has utilized the Construction Operations Building Information Exchange (COBie) as an overall Asset structure for a facility or campus. It can be measured by assessing the percentage of Projects that have met the COBie compliance requirements.

7. Compliance with ISO 19650-1: KPI measures the extent to which the Organization has applied ISO 19650-1 for managing Information during the life cycle of construction Projects. It can be measured by assessing the percentage of Projects that have met the ISO 19650-1 compliance requirements.

Figure(s)

Yes☐ No☒

References

- CDBB – Information Management According to BS EN ISO 19650 - Guidance
- Part D: Developing Information Requirements
- CDBB – Information Management According to BS EN ISO 19650 - Guidance Part 2: Processes for Project Delivery
- Digital Twin Ontario Program Strategy: Report-Back to government
- Office of Projects Victoria – Digital Asset Strategy

6.7 Digital Twin Ontario Data Sharing Process for Utilities Infrastructure Engineering and Building Information Modeling

Outcome(s)

Align Delivery Partners on the mechanisms, flow, and expectations for shared Utility Infrastructure Data in Ontario under DTO. Provide templates to guide Deliverables and diagrams to visualize Data flow.

Considerations

Delivery Partners need to know concretely who to send their Data to, where it goes, and how to receive Data back. This Manual establishes a single process for Delivery Partners interactions through DTO in alignment with NUAR Data Ingestion Specification and the accompanying NUAR Data Distribution agreement template.

Content

6.7.1 Asset Owner and Their Responsibilities

The Manual defines the role and responsibilities of the Asset Owner, which includes:

1. Establishing an Asset Information strategy, including Information life cycle management, Data planning, acquisition, operations, and disposal/archive.

2. Categorizing Data into two broad categories: Data about the Asset Owner's Organization and its coverage, and Data about the Asset Owner's Assets.

3. Defining rules of engagement and access to Data:

    a. Instruct DTO Operations Team to establish rules of engagement and access to Data, including Data Security protocols.

    b. Specify who has access to specific Data, such as location or Asset type.

    c. Control the CDE to ensure secure engagement with complex Asset Information.

    d. Establish security requirements, including legacy systems, user access rights, hardware and software, Data quality, and Information Management requirements.

    e. Determine user and Organizational outcomes and how the Project CDE will adapt throughout the lifecycle and translate through contracts.

6.7.2 Requirements for Data Sharing Process

Required steps for the DTO Data Sharing Process:

1. Mandate Data submission and Soft Landings[32]:

    a. Instruct Organizational and Project Teams to submit digital Information directly to DTO AssetFlow Hub and other relevant repositories through their assigned Data Liaison from the DTO Operations Teams.

    b. Instruct the use of a "Soft Landings" approach for all Projects to support end-users throughout the Data handover process.

    c. Mandate DTO Operations Team to ensure Data Security protocols for cloud storage of Digital Asset Data stored in the DTO AssetFlow Hub.

2. Enforce Data Sharing and reconciliation:

    a. Identify that Ontario must require DTO to avoid Data silos through reconciliation support as per a set of standards.

    b. Define the level of Delivery Partners' responsibilities in the event of an accident from inaccurate Data or non-compliance to Data Sharing.

    c. Provincial and municipal governments are responsible for implementing and enforcing policies at the local level.

    d. Liability extends to individual government officials or employees who were responsible for ensuring accurate Data Sharing practices were followed.

3. Establish Data Ingestion Specification:

    a. Establish a Data Ingestion Specification that includes versioning and Change Control logs, agreement date, version, and Asset Owner approval, and Organization Data such as lead contact details, senior responsible officer contact details, emergency contact details, Organization email domains, website URL, copyright text, disclaimer text, Organization type, parent Organization, operation coverage, supply coverage (area/s), supply coverage (content), and guidance documentation.

4. Update and review Data:

    a. Establish Data update/review frequency for Asset Owner's details, Asset Data, and coverage.

32 Soft Landings describes the planned, structured, and graduated handover of an Asset from the design and construction team to the operation and maintenance team. The aim of Soft Landings is to improve operational performance; as a process it aligns the interests between those who design and construct an Asset and those who subsequently use it.

5. Sign-off/transmittal process:

    a. The minimum Information needed to document the transmittal of Data includes:

        i. When the Data was created and posted

        ii. If the Data was received

        iii. How long the Data is valid for

        iv. The frequency of the Data updates

        v. Common platforms that the Data is hosted on

6.7.3 Asset Dataset Catalogue (Vector)[33]

The Manual provides a brief overview of the Asset Owner's source Vector Datasets[34] and illustrates the following requirements:

A. Deliver Transformation Artefacts

Provide two types of Transformation Artefacts to support Asset Owners, which are DTO_DataCatalogue.xlsx and DTO_Transformation.xlsx. The former documents the source Data schema(s) delivered by the Asset Owner, and the latter documents the full details of the source-to-model mappings, derived Data, code list mappings, and validation reports, including expected Data delivery formats and file structures for future deliveries.

B. Enforce Consistent Format

Ensure that Asset Owner source files are delivered in a consistent format when resupplied, as described in the Manual, and related Data Ingestion Specification documentation.

C. Perform Change Control

Capture any changes in format or structure required in future iterations of this document under Change Control.

D. Provide Stamped Plans

Mandate the requirement of stamped plans from construction proponents to depict Horizontal and Vertical Structures at their achieved Quality Levels while meeting or exceeding the Quality

33 CAD and BIM software typically use Vector graphic because they allow for precise and accurate representation of geometric shapes, lines, and curves. Vector images are also scalable, which means that they can be re-sized without losing quality, making them ideal for creating 2D drawings and diagrams that need to be printed or shared electronically.

34 Source Vector Datasets are digital images composed of mathematical equations that define paths and shapes, used as a foundation for creating other graphics or designs.

Level B standard, in alignment with ASCE 38-22/ASCE 75-22/ CSA 25020 / ISO 19650 with some exceptions.

6.7.4 Asset Dataset Catalogue (Raster)[35]

The Manual provides a brief overview of the Asset Owner's source Raster Datasets catalogue. Project Proponents must deliver the Asset Dataset Catalogue (Raster) in Zip Compressed Format to facilitate Data transfer and storage. Project Proponents must deliver must also provide summary Information about the Asset Owner's source Raster Datasets in a table.

6.7.5 Data Quality Feedback

Data Custodian and Data Liaison are each required to perform the following Data Quality Feedback checks for Manual compliance:

A. Perform Data Quality Assessment

Assess completeness, representativeness, timeliness/currency, Fit for Purpose, consistency, collection, and accuracy.

B. Ensure Compliance and Conformance

Differentiate between Compliance and Conformance in DTO. Compliance indicates whether an item of Data can be accepted into the platform based on whether Assets have been provided with 'plottable' geometries and include the mandatory Attributes. Conformance indicates to what degree an item of Data, or a broader Dataset, conforms to the standard embodied by the DTO Data Model, including how many of the optional Attributes are provided. This resolves to a position on a spectrum of conformance which may provide a measure of Data quality.

C. Complete Reporting

Report directly to Asset Owners on conformance of their Data against an Objective standard to provide useful, actionable Information to Asset Owners that will help to support Data quality improvement discussions and initiatives within their Organization. Do not report externally on individual conformance levels or enforce changes to source Data, simply provide Information to support Asset Owners in managing and improving their Data.

D. Perform Refresh

Ensure that each refresh of Data provides a report on the automatically measurable aspects of compliance and conformance for those Data items and Datasets being refreshed, and this will be

35 Raster images are not as commonly used in CAD and BIM because they are not as accurate or precise as Vector graphics. Raster images can be used for textures or images that need to be incorporated into a design, but they are not usually used for the primary design Elements.

part of the automated ingestion process.

E. Identify Non-Conformance

Report non-conformance of Data relative to the DTO Data Model to the DTO team.

F. Fill out Feedback Table

Denote the Data Quality Levels achieved in the Feedback Table as a binary YES/NO or on a scale from 1 to 4.

G. Update SUE Data and BIM Records

Require locators, surveyors, and design engineers to upload Subsurface Utility Engineering (SUE) Data and BIM records to a local repository from new Locate Requests and construction Projects for Horizontal and Vertical Structures.

H. Mandate Data Sharing

Mandate the sharing of utility Data back to the DTO AssetFlow Hub from the local repository within a specified timeline and cadence (quarterly or bi- annual updates). Require DTO and Asset Owners with existing Data to sign agreements to link DTO AssetFlow Hub to the Asset Owner's local digital repository. Administer a single Data capture and storage system.

I. Address Complaints Submission

Mandate that Delivery Partners submit complaints to a specified–arm of DTO in the event of inaccurate Data from Asset Owners.

Figure(s)

Yes☒ No☐

- Figure 6.7.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy - Feedback Table
    - 3.2. Recommendations - Table summarizing the potential future Asset Data quality improvements an Asset Owner may wish to action in future Data supplies
    - 3.3. Comments from Asset Owners - Table for capturing comments from Asset Owners in relation to the recommendations for future improvement. This can reflect any issues or constraints that make the recommendations unachievable or inappropriate

References

- NUAR - Data Ingestion Specification
- NUAR – Data Distribution Agreement
- Office of Projects Victoria - Digital Asset Strategy
- CDBB - Government Soft Landings Revised Guidance for the Public Sector on Applying B58536 Parts 1 and 2
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 1: Concepts

6.8 Data Security and Confidentiality Compliance for Utilities Infrastructure Engineering and Building Information Modeling in Projects

Outcome(s)

Provide instruction on how to effectively manage and protect Data Assets, as well as report Data Security Compliance to Digital Twin Ontario (DTO), the program providing a system and standard for Information and Data Management to enable Digital Twins of Ontario's Infrastructure.

Considerations

This Section emphasizes the authority of DTO and the essential role of the Manual in ensuring compliance with National and Provincial Data Security standards to enable effective Data Sharing across Ontario's Infrastructure and Utilities Industry.

The Manual aims to balance the requirement for Data Sharing with protecting Data that requires protection. DTO has Administrative Authority to determine what Data is modified and/or embargoed to protect IP rights and provide necessary Confidentiality protections.

Content

6.8.1 Introduction to Data Security and Confidentiality Compliance

This Section outlines the mandatory steps for Data Security, protection, and Confidentiality Compliance. Delivery Partners must comply with all regulations and standards to ensure Data Security, protection, and Confidentiality.

6.8.2 Implementing Data Security Processes and Standards

This Section will explain in detail the Data Security process and standard set by DTO that Delivery Partners must comply with. This will be followed by guidance and examples on how to implement the Data Security process and standard in practice.

DTO has Administrative Authority to decide what Data is modified and/or embargoed to protect IP rights and provide necessary Confidentiality protections.

6.8.3 Managing and Protecting Data Assets

DTO is the mandatory interchange hub for Data flow between different Utility Service Types. Infrastructure Ontario and DTO therefore has a key role in ensuring compliance and maintaining Data Security, requiring Delivery Partners to comply with mandatory steps (to be outlined) for managing and protecting Data Assets.

This Section will highlight the importance of:

- Proper Data Asset Management and protection and provide examples of Leading Practices.

- Compliance Reporting for maintaining Data Security and Confidentiality and provide examples of how to report compliance effectively.
- Mandatory Data Security and Confidentiality Compliance.

This is followed by instructions for Delivery Partners on how to:

- Follow the mandatory steps to report Data Security Compliance to DTO.
- Contact the relevant authorities for any questions or–concerns regarding Data Security, protection, and Confidentiality.

The Section will conclude with Key Takeaways for Data Security and Confidentiality Compliance.

Figure(s)

Yes☐ No☒

References

- NUAR - Data Ingestion Specification
- Office of Projects Victoria - Digital Asset Strategy
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data

7. Integration of Building Information Modeling Standards and Processes in Projects and Digital Twin Ontario

7.0 Section Objective

This section aims to clarify BIM standards for the Manual, specific to Data Types, Data quality, processes, and requirements in Projects and DTO. Providing instructions on how BIM is integrated into Projects.

7.1 Overview for Integrating Building Information Modeling with Digital Twin Ontario

Outcome(s)

Provides an overview of content outlined in Section 7 to help reader navigate the content. Another goal of Section 7.1 is to understand the purpose of BIM standards in the Manual.

Considerations

To clarify that Section 7 compliments the BIM standards set in Section 5 of the Manual for Data Ingestion, Data Exploration, Data Sharing, and Data Collaboration, as it expands on details for BIM Processes and requirements in the Manual in one section for c by Delivery Partners.

Section 7 highlights the key role that BIM plays in the development of Digital Twins in Ontario. Demonstrating clear standards in the Manual for BIM Processes ensures Ontario Projects are prepared with the BIM knowledge needed to move towards Digital Twins in Ontario.

To develop this section, the following key referenced were consulted: BIM standards in the Manual that are based on the ISO 19650 series, which both the Centre for Digital Built Britain UK BIM Framework and Guidance, and the Office of Projects Victoria Digital Assets Strategy reference as Leading Practice.

Relevant Legislation and Regulations

This Manual provides guidance on the importance of complying with various Acts and directives during the construction lifecycle of a Project in Ontario. These Acts regulations, and directives include, but are not limited to, the following:

- Ontario Underground Infrastructure Notification System Act, 2012.
- Ontario Infrastructure and Lands Corporation Act, 2011.

- Municipal Act, 2001.
- Technical Standards and Safety Act, 2000.
- Ontario Construction Act, 1990.
- Environmental Assessment Act, 1990.
- Planning Act, 1990.
- Ontario Building Code (O. Reg. 332/12).
- Broader Public Sector Procurement Directive.
- Ontario Provincial Standards.

Full compliance with the relevant legislation, regulations, and directives is required for the successful completion of public Infrastructure Projects.

In addition, the Manual outlines updates to the legislative and regulatory regime that enable Digital Twins throughout the Project lifecycle. These updates require the following:

- Creation of Digital Assets and records for Infrastructure.
- Incorporation of radio frequency identification Technology, or reasonable alternatives, such as Global Positioning System (GPS) capabilities in latitude (X), longitude (Y), and altitude (Z).
- Providing Digital Assets and records upon request,
- Further clarity on exemptions of municipalities from charging for Locate Requests.
    - Includes an exemption to charge for physical locates when a Digital Locate is made available.

Content

7.1.1 Understanding Data versus Information in the Context of BIM

To understand this section in the context of BIM, Data and Information are related but distinct concepts.

Data refers to all raw, unprocessed, facts, and figures, which are collected and stored within a BIM model. Data includes details about the physical properties of building materials, dimensions of building Elements, and other technical specifications.

- Data is typically organized in a structured way, often using standardized formats or codes to ensure consistency, as was demonstrated in Section 5 and Section 6.

Information, on the other hand, is the processed and analyzed Data that has been transformed into a meaningful context. Information is the result of interpreting and analyzing Data to create insights, knowledge, and actionable intelligence.

- In the context of BIM, this could include things like cost estimates, energy performance analysis, or Clash Detection reports.

In summary, Data is the raw material that is inputted into a BIM model, while Information is the processed and analyzed output that provides insight and knowledge to support decision-making.

7.1.2 Basis for BIM Standards from ISO 19650 Series

The Manual is based on the ISO 19650 series, which first developed out of the UK's former BIM Level 2 but incorporates and anticipates global and future digital perspectives.

1. BIM Level 2 is a level of maturity in BIM, which is distinguished by collaborative ways of working. It involves developing Asset Information in a collaborative, Data-rich, 3D environment, but created in separate discipline models[36]. The collaboration is in the form of Information exchange processed specific to a Project and coordinated between different systems and Project participants.

2. The ISO 19650 series is an international standard that provides guidelines for managing Information using BIM. ISO 19650 covers the entire lifecycle of a built Asset, from inception to demolition, and provides a framework for managing digital Information and Data exchange. Specifically, ISO 19650 covers the following topics in relation to BIM:

    a. Information Management

    b. Collaborative working

    c. Data exchange

    d. Model management

    e. Quality Assurance

BIM focuses on 2 Objectives: (1) product and (2) process. These Objectives are described as follows:

36 A discipline model for BIM is a framework that outlines how BIM can be used to organize, manage, and share Information across different disciplines involved in the construction process. (Typically includes Objectives, roles and responsibilities, communication protocols, standards and guidelines, Data management, Quality Control, and training and support.)

1. Product: This Objective of BIM is to create a digital representation of a physical Built Environment, whether it already exists or is yet to be built. This representation is used to coordinate services and structures, support Project management and enable scenario analysis. The goal is to improve Project performance by reducing cost and schedule overruns caused by clashes[37] and changes, and to speed up the design and construction process by using digital tools rather than Manual methods.

2. Process: The Objective of BIM is to promote standardized sharing of Information and collaboration among Project Proponents in a Project. To achieve this, a BIM Execution Plan should be developed to cover aspects such as quality and format of Project Data, methods of correlation, frequency of distribution, Ownership of workstreams, Quality Control, and level of detail. This plan will ensure that all parties involved in the Project are working together effectively and efficiently to achieve the desired outcomes.

There is no one definition of "BIM according to the ISO 19650 series", as BIM is comprehensive of a series of Elements, processes, and characteristics.

- The requirements for BIM standards in the Manual set the precedent in Ontario Projects for the expectations and requirements from the Information Management process provided for in the ISO 19650 series from the perspective of duties, rights, and Deliverables.

The principles of the Information delivery cycle are found in ISO 19650-1. The Project delivery cycle is specified in ISO 19650-2, and the operational phase of the Assets is specified in ISO 19650-3.

- "ISO 19650" in the Manual refers to ISO 19650-1, -2, and -3 as a series.

7.1.3 Summary of BIM Processes Required

Understanding Information Management is critical for BIM in ISO 19650 because it provides a structured approach to managing digital Information throughout the entire lifecycle of a built Asset.

1. BIM requires planned Information requirements, document controls, Data exchange, and collaboration.

2. These processes provide a consistent, collaborative, efficient, and quality- assured standard for managing Information throughout the Asset lifecycle.

The Appointing Party of a Project is required to follow pre-appointment processes in ISO 19650 series.

- Clear statements of the duties, rights, and Deliverables are set out in the Manual in connection with the ISO 19650 processes to be included in tender documents and appointments.

37 In the context of BIM, clashes refer to conflicts or collisions between different building Elements, systems, or components that are identified during the Project Stages.

Understanding Information Management processes from the ISO 19650 series is required in the Manual that has been integrated into the Manual's Project Stages. Information Management processes pertain to Information requirements, model production and management, Data exchange, Asset Information Management, and Quality Assurance.

The 6 ISO 19650-2 Phases for Processes that are incorporated during the Briefing Concept Stage are as follows:

1. Assessment and Need
2. Invitation to Tender
3. Tender Response
4. Appointment
5. Mobilization
6. Collaborative Production of Information (specific to gathering and synthesizing Information from various Project Proponents and Subject Matter Experts to define the Project's goals, Objectives, and requirements)

ISO 19650-2 Phases for Processes that are incorporated during the Defined Design Stage are as follows:

1. Collaborative Production of Information (specific to the detailed design and development of Project Deliverables)
2. Information Model Delivery

ISO 19650-2 Phases for Processes that are incorporated during the Build and Handover Stage are as follows:

1. Project Close-Out

Suppliers are required to demonstrate preparedness for a Project using BSI PAS 91. BSI PAS 91 sets out the content, format, and use of pre-qualification questions for construction related tendering.

- Suppliers must demonstrate that they possess or have access to the governance, qualifications and references, expertise, competence, and other essential capabilities to undertake work and deliver services for potential clients.
- Use BSI PAS 91 optional question set for developments where Building Information Modeling (BIM) is required.

- Use the following note on BIM questions for Suppliers involved in Projects: "The appended Table 8 – Optional Questions Module 4: Building Information Modeling is not optional and must be completed by Supplier".

Figure(s)

Yes☐ No☒

References

- CDBB – Information Management According to BS EN ISO 19650 – Guidance
- Part 1: Concepts
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part B: Open Data, BuildSMART and coBIE
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part C: Facilitating the CDE, Workflow and Technical Solutions
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part F: Information Delivery Planning

7.2 Information Management Processes for Integrating Building Information Modeling Towards Digital Twins in Ontario

Outcome(s)

This section details the requirements for Information Management processes required to achieve BIM ISO 19650 standards in the Manual.

Considerations

Based on Reference Documents and technical expert advice, it is recommended that ISO 19650 series is used as Leading Practice to define BIM standards in the Manual.

Content

7.2.1 Navigation

Section 7.2 outlines the BIM Information Management processes in each Project Stage: Briefing Concept, Defined Design, Build and Handover, Operate and Maintain.

7.2.2 Briefing Concept

This section identifies the ISO 19650 process requirements integrated into the Briefing Concept Stage.

7.2.2.1 Requirements for Assessment and Need (ISO 19650 Process)

The "Assessment and Need" is established as one of the 8 ISO 19650 Processes followed in the Manual.

Appointing Party is tasked with the effective management of Information throughout the Project and reflect the long-term Asset Information Management strategy and Asset Information Requirements.

Appointing Party is required to establish the Exchange Information Requirements.

1. Understand if Appointing Party does not do so it will be difficult for the rest of the Information Management process to be followed.

2. Ensure the Exchange Information Requirements, as a minimum, cover the matters listed at Sections 5.1.2-5.1.7 of ISO 19650-2. In particular, the key decision points should be considered for the preparation of the Exchange Information Requirements and other contract documents.

The Appointing a Party is tasked with contract documents for Projects to clarify which Party bears responsibility for management of Information. As well as written long- term Asset Information Management Strategy and Asset Information Requirements.

7.2.2.2 Requirements for Invitation to Tender (ISO 19650 Process)

The following section establishes "Invitation to Tender" as one of the 8 ISO 19650 Processes followed in the Manual.

The Appointing Party is required to establish Exchange Information Requirements to be met by the prospective Lead Appointed Party during the Project.

1. Ensure the Exchange Information Requirements consider, as a minimum, the matters listed at Section 5.2.1 of ISO 19650-2.

2. Consider which parties need to have early involvement, to ensure accurate requirements, for example Facility Manager.

3. Require Appointing Party to consider Organizational Information Requirements and Asset Information Requirements to establish the level of Information need required to meet each Information Requirement.

4. Require Appointing Party to establish the dates, relative to the Project's Information delivery milestones and Appointing Party's key decision points. Ensure all dates/milestones work in harmony with other milestones within the rest of the tender and Project documentation and consider if they will/may impact subsequent award or payment milestones.

5. Consider any copyright, confidentiality, and security issues in assembling and providing access to this Information, and how such issues need to be dealt with in the tender documentation.

The Appointing Party is required to establish CDE(s), reference Information, and shared resources (such as templates found in Appendices of the Manual) that they intend to provide to the prospective Lead Appointed Party during the tender process for the Project. The Appointing Party shall establish the requirements that tendering Organizations shall meet within their tender response.

1. Ensure tender documentation cover, at a minimum, the matters listed in Section 5.2.2-5.2.4 of the ISO 19650-2 (including consideration of the Project's Information protocol).

2. The Information and shared resources may be securely shared, bearing in mind different Information/resources may be shared with different Parties during the tender process and on the Project, in accordance with Section 3 of the Manual.

7.2.2.3 Requirements for Tender Response (ISO 19650 Process)

The following section establishes "Tender Response" as one of the 8 ISO 19650 Processes followed in the Manual.

The role of the prospective Lead Appointed Party shall have regard to the effective management of

Information throughout the appointment by nominating individuals from within its own Organization to undertake the Information Management function on behalf of the Lead Appointed Party (or appoint a prospective Appointed Party or Third Party to do so).

Each Task Team is required to undertake an assessment of their capability and capacity; the prospective Lead Appointed Party shall assess the delivery team's capability and capacity and proposed mobilization plan; the prospective Lead Appointed Party shall establish the delivery team's risk register.

- Additionally assess the system/digital preparedness of a Party for BIM production, process, and management, using the BSI PAS 91 BIM (Table 8 – Module 4) extension and the BIM Preparedness Assessment for Tenders in **Appendix P**.

Suppliers are required to demonstrate preparedness for a Project using BSI PAS 91. BSI PAS 91 sets out the content, format, and use of pre-qualification questions for construction related tendering.

Action:

1. Consider how the Information Management function and scope will be recorded within the contract documentation (if relevant) in the event of a successful tender; is this clear within the tender documentation?

2. Consider how capability and capacity will be assessed and measured in the tender process.

3. Adopt a scoring system and/or establish a flexible grid to standardize how bids are assessed.

7.2.2.4 Requirements for Appointment (ISO 19650 Process)

The following section establishes "Appointment" as one of the 8 ISO 19650 Processes followed in the Manual.

The Lead Appointed Party shall confirm the delivery team's BIM Execution Plan in agreement with each Appointed Party.

The Lead Appointed Party shall further refine the high-level responsibility matrix to establish the detailed responsibility matrix.

A Task Information Delivery Plan and Master Information Delivery Plan, covering the matters detailed in Sections 5.4.4 and 5.4.5 is to be established by the Task Teams and Lead Appointed Party, respectively.

The completed appointment documents should contain the matters listed in Sections 5.4.6 and 5.4.7 and managed via Change Control throughout the duration of the appointments. Ensure the Change Control process within the appointment will cover the matters listed. Consider how these matters

should impact a party's rights to claim additional time and costs during the appointment.

Action:

1. Ensure that the matters set out in Section 5.4.1 of ISO 19650-2 are detailed clearly within the contract documentation.

2. Ensure the responsibility matrix is reflected in the contract documents and does not conflict with any other contractual responsibility matrix or program. Ensure the responsibility matrix included in the contract (including if the CIC Protocol is used) reflects the requirements of Section 5.4.2 of ISO 19650-2.

3. Ensure the Task Information Delivery Plan and Master Information Delivery Plan are included or referred to in binding contractual documents and cover, at a minimum, the matters detailed in Sections 5.4.4 and 5.4.5 of ISO 19650-2. Consider how these plans may impact the Deliverables and milestones in the rest of the appointment documentation and ensure there is no discrepancy or contradiction; consider how they may or should impact any relevant payment milestones.

4. Ensure the Change Control process within the appointment will cover the matters listed in Sections 5.4.6 and 5.4.7 of ISO 19650-2. Consider how these matters impact a party's rights to claim additional time and costs during the appointment.

5. Have the requirements of PAS1192-5 (which relates to a security-minded approach) been incorporated into the appointment documentation, for example within the Protocol?

7.2.2.5 Requirements for Mobilization (ISO 19650 Process)

This section establishes "Mobilization" as one of the 8 ISO 19650 Processes followed in the Manual.

The Lead Appointed Party shall mobilize the resources and Information Technology,

as defined within the delivery team's mobilization plan.

The Lead Appointed Party shall test the Project's Information production methods

and procedures, as defined within the delivery team's mobilization plan.

Action:

1. Ensure the appointment documentation sets out the parties' respective responsibilities for the execution of the mobilization plan, and what entitlement there is to mobilization costs. Ensure it is clear who is responsible for the accuracy and viability/feasibility of the mobilization plan.

2. Ensure the appointment documentation clarifies who is responsible for the outcome of tests

of the Information production methods and procedures, including any resulting additional time and costs.

7.2.2.6 Requirements for Collaborative Production of Information (ISO 19650 Process)

This section establishes "Collaborative Production of Information" as one of the 8 ISO 19650 Processes followed in the Manual.

Each Task Team shall generate Information in accordance with their respective Task Information Delivery Plan.

Each Task Team shall undertake a Quality Assurance check of each Information container, in accordance with the Project's Information production methods and procedures, prior to undertaking a review of the Information within it.

Action:

1. Ensure the obligations within the appointment documentation include, at a minimum, the matters detailed in Section 5.6.2 of ISO 19650-2. Ensure any entitlement to claim additional time and costs resulting directly or indirectly from these obligations is made clear within the contract documentation.

2. Ensure the Appointed Party/Lead Appointed Party's standard of care in producing such Information and carrying out any reviews is expressly stated, where relevant.

3. Ensure that the appointment documentation clarifies the level of Quality Assurance checks that need to be carried out, and the timetable/programme for doing so. Ensure it is also clear what level of responsibility a party has for issues or errors within the Information reviewed. These same comments apply to the requirement for each Task Team to undertake a review of the Information within the Information container prior to sharing within the Project's CDE, and the delivery team undertaking a review of the Information Model.

This process may involve brainstorming sessions, workshops, or interviews with Project Proponents to gather their input and feedback. The Information collected during this stage is used to develop the Project scope, initial Project plan, and high- level Project Deliverables.

7.2.3 Defined Design

This section identifies the ISO 19650 process requirements integrated into the Defined Design Stage.

7.2.3.1 Requirements for Collaborative Production of Information (ISO 19650 Process)

This section establishes "Collaborative Production of Information" as one of the 8 ISO 19650 Processes followed in the Manual.

Each Task Team shall generate Information in accordance with their respective Task Information Delivery Plan.

Each Task Team shall undertake a Quality Assurance check of each Information container, in accordance with the Project's Information production methods and procedures, prior to undertaking a review of the Information within it.

Action:

1. Ensure the obligations within the appointment documentation include, at a minimum, the matters detailed in Section 5.6.2 of ISO 19650-2. Ensure any entitlement to claim additional time and costs resulting directly or indirectly from these obligations is made clear within the contract documentation.

2. Ensure the Appointed Party/Lead Appointed Party's standard of care in producing such Information and carrying out any reviews is expressly stated, where relevant.

3. Ensure that the appointment documentation clarifies the level of Quality Assurance checks that need to be carried out, and the timetable/programme for doing so. Ensure it is also clear what level of responsibility a party has for issues or errors within the Information reviewed. These same comments apply to the requirement for each Task Team to undertake a review of the Information within the Information container prior to sharing within the Project's CDE, and the delivery team undertaking a review of the Information Model.

This process may involve a more focused collaboration with Subject Matter Experts, designers, and other Project Team members to develop detailed designs, technical specifications, and other Project Deliverables.

7.2.3.2 Requirements for Information Model Delivery (ISO 19650 Process)

This section establishes "Information Model Delivery" as one of the 8 ISO 19650 Processes followed in the Manual.

Each Task Team shall submit their Information to the lead Appointed Part' for authorization within the Project's CDE prior to the delivery of the Information Model to the Appointing Party. The Lead Appointed Party shall review the Information Model in accordance with the Project's Information production methods and procedures, taking account of the matters listed in Section 5.7.2 of ISO 19650-2 and either accepts or rejects the Information.

If the Information is rejected the Task Teams are instructed to amend the Information and resubmit.

If the review is successful, the Lead Appointed Party authorizes the model and instructs each Task Team to submit their Information for approval by the Appointing Party within the Project's CDE. The Appointing Party then reviews the Information, taking account of the matters listed in Section 5.7.4 of

ISO 19650-2 and either accepts or rejects the Information.

If the Information is rejected the Lead Appointed Party is instructed to amend the Information and resubmit.

If the review is successful, the Appointing Party accepts the Information Model as a deliverable in the Project's CDE.

Action:

1. Ensure that the process for submission, authorization, rejection, and acceptance is clearly set out in the Master Information Delivery Plan and each Task Information Delivery Plan.

7.2.4 Build and Handover

This section identifies the key Technology and ISO 19650 process requirements integrated into the Build and Handover Stage.

7.2.4.1 Requirements for Reality Capture

Reality Capture is the process of using various technologies to capture the physical characteristics of a building or Project site, and then creating a Digital Model of that Information.

1. Establish in the context of BIM, Reality Capture is also used to create accurate 3D models of existing buildings or sites on the Project.

2. Involves the use of technologies such as laser scanning, photogrammetry, and drone surveys to capture Data about the existing building or site.

3. Resulting model can be used by architects, engineers, and construction professionals as designers and builders to work with accurate Data and models to reduce errors, improve efficiency, and save time and money.

Data sets of the site are to be captured before, during, and on completion of Projects to improve visibility and control at all construction stages.

Any discrepancies are to be identified between existing or created drawings and the reality of actual conditions.

Complications are to be communicated before they become costly by using the model at all stages of the Project.

The model can be leveraged to assist in making key decisions and mitigate implications to the construction budget and schedule.

7.2.4.2 Requirements for "As-Built" Modeling (Scan To CAD/BIM)

Define "As-Built" Modeling as the process of creating a 3D model of a Built Environment or structure based on its actual physical measurements and dimensions. Used to document and visualize the current state of a building or structure, including any modifications or additions that have been made since its original construction.

The Data obtained in Reality Capture goes directly into the BIM model to ensure that what has been built conforms to design plans.

The accuracy and validity of the on-going construction process using this method must be verified.

7.2.4.3 Requirements for Site Awareness And Visualization

Define Point Cloud as a collection of Data points that represent the surface of an Object or Space.

1. Understand these Points are generated by laser scanning or photogrammetry, which captures the geometry and spatial relationships of the Object or Space.

Share the Point Cloud with all Delivery Partners throughout the Project life cycle. Document progress per the design and digitally sign-off on it.

Check progress off-site from a remote or different location on site.

Complete digital site reviews and walkthroughs to reduce the time and cost of mobilizing on site.

7.2.4.4 Requirements for Clash Detection (Interferences)

Use Point Cloud Data inside construction software to compare against digital Design Models.

Automatically indicate potential conflicts and resolve issues well before any costly impacts. This will prevent delays caused by components not fitting into their intended locations due to errors in the process or oversights in design.

7.2.4.5 Requirements for Deviation Reporting

Validate and check the positional accuracy of work as it happens to make meeting specifications and constructing to design more efficient.

Make corrections or inform others that changes may be required to address any unwanted deviations.

Use Point Cloud Data to generate a Tolerance Report.

1. Use Point Cloud Data for additional purposes as well, such as validating a concrete slab's flatness.

7.2.4.6 Requirements for Construction Verification

Utilize Reality Capture technologies to record actual site conditions during the construction lifecycle.

Compare and contrast these snapshots in time against the Design Model to spot any irregularities.

Assess and correct any irregularities before rework is needed.

Understand that Reality Capture Data is a means to effectively demonstrate due diligence post-construction and prevent and defend against any litigation that may arise out of a legal dispute.

7.2.4.7 Requirements for Project Close-Out (ISO 19650 Process)

Upon acceptance of the completed Project Information Model, the Appointing Party shall archive the Information containers within the Project's CDE(s) in accordance with the Project's Information production methods and procedures.

Action:

1. Ensure both the duration and manner of storage of Information (including format) is clear within the appointment documentation.

2. Does the appointment documentation make it clear who shall have continuing access to the Information containers and/or the CDE(s), and the duration/limitations of such access?

3. Does the appointment documentation make it clear who is responsible for the continuing integrity of the archived Data, and responsible for hacking, degradation and/or corruption?

7.2.5 Operate and Maintain

This section identifies the key Technology requirements integrated into the Operate and Maintain Stage.

7.2.5.1 Building Information Modeling to Facility Management

Establish Leading Practice for updated BIM models of a Project in the Operate and Maintain stage in a process called BIM to Facility Management (BIM-to-FM).

1. Process involves updating the BIM model with "As-Built" Information and maintenance Data to create an accurate representation of the Project in its current state.

2. After the Project is complete, a BIM Digital Asset should be handed over to building operators as a perfect digital representation of the facility.

    a. This is used for better Quality Assurance and can be used to manage operational and maintenance process thereby reducing dependency on Third Parties for additional cost savings.

A. Required Steps for the BIM-to-FM Process

1. Collect "As-Built" Information: This involves gathering Data on any changes or modifications that have been made to the facility or Project since it was constructed. This can include Information on new equipment, changes to the building layout, and updates to the HVAC or electrical systems.

2. Update the BIM model: Once the "As-Built" Information has been collected, it is used to update the BIM model. This involves adding new components, modifying existing components, and updating the overall layout of the facility.

3. Add maintenance Data: In addition to "As-Built" Information, maintenance Data is also added to the BIM model. This includes Information on when equipment was last serviced, what maintenance was performed, and any outstanding maintenance issues.

4. Integrate with facility management software: Once the BIM model has been updated with "As-Built" and maintenance Data, it is integrated with facility management software. This allows Facility Managers to access the BIM model and use it to manage the facility more effectively.

Figure(s)

Yes☒ No☐

- Figure 7.2.5: Referenced ➔ CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
    - The Information Management function and resources

References

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 1: Concepts

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part B: Open Data, BuildSMART and coBIE

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part C: Facilitating the CDE, Workflow and Technical Solutions

- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part F:

Information Delivery Planning

- Ontario General Contractors Association (OGCA) – Guide to Construction and Design Technology

7.3 Geospatial Mapping Systems for Building Information Modeling Integration

Outcome(s)

Identifies Geospatial mapping and analysis as a key digital Data Asset, clarifying the requirements that will help to map Infrastructure and Utilities Data.

Considerations

Geographical Information System (GIS) is a common geospatial mapping system widely used in Ontario. This Manual allows for GIS Technology use while establishing parameters to move towards open-source geospatial Data formats as Leading Practice.

Content

7.3.1 Geospatial Mapping Systems Required

Define Geospatial Mapping Systems (GIS) as tools that allow users to visualize and analyze geographic Data. These systems use a combination of satellite imagery, Global Positioning System (GPS) Data, and other geographic Information to create maps and models of the Earth's surface.

1. Understand Geospatial Mapping Systems can be used to display maps and spatial Information, use standard protocols to communicate and share Data over the internet, support Interoperability between different software systems, platforms, and devices, and require spatial Data to be in a standard format.

2. Understand there is a range of Geospatial Mapping Systems readily available.

The required Geospatial Mapping Systems for the Manual, namely GIS; Open Geospatial Consortium Web Map Service (OGC WMS); and Open Geospatial Consortium Web Feature Service (OGC WFS), allow for the integration of Open Data Leading Practice with Ontario's current widely accepted geospatial mapping system practice of GIS.

There are key similarities between GIS, OGC WMS, and OGC WFS, which are all related to geospatial Data.

- Differentiate GIS as a software system for geospatial analysis, WMS as a standard protocol for serving georeferenced map images over the internet, and WFS as a standard protocol for serving geospatial Data over the internet.

- Explain that WMS is used for sharing static maps, while WFS is used for sharing dynamic and interactive maps.

Understand a General Contractor is needed for GIS.

- Hire a general contractor for GIS Projects to ensure effective and efficient use of Technology.

Require BIM-GIS integration through the following practices:

1. Use IFC formats.
2. Create Asset classification and hierarchy tables.
3. Align the coordinate reference frame for the Project with the one adopted by the Ontario Government.
4. Align Data transfer points for a GIS[38].
5. Align complexes/entities with base classes (buildings, bridges, vegetation, etc.).
6. Link sub-BIM Elements to GIS Elements such as rooms, Spaces, systems, etc.
7. Define complex 2D and 3D geometry such as planes, vertices, loops, etc.

7.3.2 Geospatial Mapping Systems Requirements for BIM

Access pre-made GIS Data using free and powerful tools like QGIS, a free and open- source GIS system.

1. 1. Utilize training to efficiently interpret multiple sources of Data and expose more benefits of GIS specific to your Project and needs.
2. 1. Use QGIS plugins and tools to integrate Data from various sources, including sensors and other IoT devices. Note that QGIS is primarily a desktop application and may not be the best choice for real-time Data access or collaboration.

Require use of WMS/WFS for real-time Data access and collaboration, which can be beneficial for Projects that require constant monitoring and updates. Note that WMS/WFS may not provide the same level of detail and analysis capabilities as QGIS and may require additional software or tools to create Digital Twins.

Choose between QGIS and WMS/WFS based on specific Project requirements and constraints. Use QGIS if detailed 3D modeling and analysis capabilities are required and use WMS/WFS if real-time Data access and collaboration are more important.

38 Transfer points, also known as Data transfer points, are locations where Data is exchanged between different components of a geospatial mapping system. These transfer points may consider: Data acquisition, Data processing, Require use of QGIS for creating detailed 3D models of Infrastructure Assets and generating Digital Twins.

Figure(s)

Yes☐ No☒

References

- Geographic Information System (GIS) for Ontario
- Ontario General Contractors Association (OGCA) – Guide to Construction and Design Technology
- Office of Projects Victoria – Digital Asset Strategy
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 1: Concepts
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part B: Open Data, BuildSMART and coBIE
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part C: Facilitating the CDE, Workflow and Technical Solutions
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part F: Information Delivery Planning

7.4 Required Tools and Technologies for Building Information Modeling Integration in Projects and Digital Twin Ontario

Outcome(s)

Reference for Delivery Partners to understand, gather, and operate tools necessary to reach Data quality requirements for BIM of the Manual.

Considerations

Consolidate Information on tools and technologies required to meet the Manual's Data quality and sharing standards.

Sets requirements for current Leading Practice tools and technologies for BIM in Projects, while introducing requirements for future technologies to be required as standard for Project's in the Manual.

Content

7.4.1 Hardware Requirements for Building Information Modeling on a Project

Require Project Team and any issued General Contractor(s) to have the following Hardware:

1. Data Storage (Vector graphics and CAD files are typically huge).
2. Computers/Technology to operate cloud-based BIM software platforms.
3. Computers/Technology processing power to operate cloud-based BIM software platforms.

7.4.2 Software Solutions for BIM Integration

Recommend and describe software platforms for Project BIM creation and operations as follows:

1. Revit
2. Revitzo
3. Navisworks
4. ArchiCAD
5. AutodeskBIM360

Recommend and describe BIM Viewers for Project BIM analysis as follows:

1. Procore BIM Viewer

2. BIM Vision

3. Solibri Anywhere (Solibri Model Viewer)

4. Areddo

5. Autodesk Viewer

7.4.3 BIM Specialist Decision-Making for Photogrammetry versus Laser Scanner

The BIM Specialist on a Project is Responsible for determining the use of photogrammetry versus laser scanner based on the level of detailed required for an area, Element, or Object.

1. Decision-making should consider the standards for Data quality established in the Manual.

7.4.4 Requirements for Use of Photogrammetry

Understand photogrammetry is a technique used to create 3D models and maps from 2D images that involves taking multiple photographs of an Object or a scene from different angles and using specialized software to analyze the photographs and create a 3D model.

Establish low barrier to entry for photogrammetry as it can be done using standard cameras and equipment making it accessible to a wide range of users. However, it does require specialized software and expertise to create accurate and detailed 3D models.

Understand requirement for photogrammetry from Briefing Concept to Operate and Maintain Stage must capture all of the Project's above- and below-ground features and Infrastructure, as well as Utility Services within the defined Project area.

Understand photogrammetry process requirements are as follows:

1. Plan photogrammetry missions carefully by identifying areas to be captured, best time of day for capture, and selecting the right equipment and approaches from standards set in Manual.

2. Use high-quality cameras for high-resolution images that have a high dynamic range to capture both visible and infrared light.

3. Use a high-quality camera or a drone-mounted scanner operated by a certified drone pilot to capture the Information.

4. Utilize unmanned aerial vehicles (UAV) to cover large areas or places that would be otherwise hazardous to visit.

5. Use ground control points markers placed on the ground to help accurately georeference the Data captured and ensure it algins with other Data Sources.

6. Use a combination of aerial and ground-based photogrammetry to capture Data from both aerial and ground-based perspectives for completer and more accurate model of the Project.

7. Used specialized software tools available for photogrammetry that include both open-source and commercial options considering the needs of the Project. Leading Practice examples of commercial and open-source software include:

    a. Agisoft Metashape (commercial)

    b. Pix4D (commercial)

    c. OpenDroneMap (open source)

    d. Meshroom (open source)

    e. RealityCapture (commercial)

There are different approaches to photogrammetry allowed for Delivery Partners to meet Manual BIM standards for Projects are as follows:

1. Aerial photogrammetry: Approach involves photograph taken from an aircraft or drone to create 3D models of large areas, such as terrain or buildings.

2. Terrestrial photogrammetry: Approach involves using photographs taken from the ground to create 3D models of smaller Objects or environments, such as buildings or utility sites (includes underground when exposed).

3. Close-range photogrammetry: Approach involves using photographs taken from a short distance to create highly detailed 3D models of small Objects, such as pipe features or connections.

4. Structure-from-Motion (SfM): Approach involves using multiple overlapping photographs to create a 3D model of an Object or environment. SfM uses algorithms to calculate position and orientation of each photograph and combine to create a 3D model.

5. Multi-View Stereo (MVS): Approach involves using multiple photographs taken from different angle to create a 3D model of an Object or environment. MVS uses algorithms to match and combine the different views to create a detailed 3D model.

Encourage use of solutions to provide still and video imagery or live video for situation analysis.

Note, photogrammetry should also be applied to civil/topography related tasks such as cut/fill calculations or site logistic planning.

7.4.5 Requirements for Use of Laser Scanners

Understand laser scanners are high-resolution, non-invasive, Data capture for the use of creating 3D models in BIM software.

Encourage use of laser scanners to provide highly accurate Data with very tight tolerances (i.e., exceedingly small margins of error).

Use laser scanners for confined Spaces or for jobs that require higher accuracy. Gear laser scanners towards building component-related tasks.

7.4.6 Addressing the Future of Building Information Modeling Technologies

Identify future Artificial Intelligence (AI)/Machine Learning requirements as BIM technologies improve are as follows:

1. Incorporate AI and machine learning technologies into BIM models to improve accuracy and efficiency.
2. Train algorithms to analyze Data and identify potential issues or conflicts in Projects.
3. Develop machine learning models to optimize Project schedules and resource allocation.
4. Regularly evaluate and update AI and machine learning models to ensure they align with Project goals and Objectives.
5. Use natural language processing to facilitate communication and collaboration between Project Proponents.

Identify future drones, robots, and sensors requirements as BIM technologies improve are as follows:

1. Integrate drones, robots, and sensors into BIM models to improve Data collection and analysis.
2. Use drones for aerial surveys and inspections of Projects.
3. Deploy robots for tasks such as excavation, demolition, and construction.
4. Utilize sensors for real-time monitoring of environmental conditions and equipment performance.
5. Regularly maintain and test drones, robots, and sensors to ensure optimal performance and safety

Identify future 3D printing concrete, steel, and polymer requirements as BIM technologies improve are as follows:

1. Implement 3D printing technologies to produce Infrastructure components such as concrete, steel, and polymer materials.

2. Develop and optimize printing processes to ensure quality and consistency of printed Objects.

3. Use 3D printing for the rapid prototyping and production of customized parts.

4. Explore the potential for 3D printing to reduce waste and improve sustainability in Projects.

5. Regularly evaluate and update printing processes to incorporate new materials and technologies that align with Project requirements.

Figure(s)

Yes☐ No☒

References

- Geographic Information System (GIS) for Ontario
- Ontario General Contractors Association (OGCA) – Guide to Construction and Design Technology
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 1: Concepts
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part A: The Information Management Function and Resources
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part B: Open Data, BuildSMART and COBie
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part C: Facilitating the CDE, Workflow and Technical Solutions
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part F: Information Delivery Planning

8. Data Sharing and Utility Coordination Requirements for Project Stages

8.0 Section Objective

Provide instructions on activities required for Data Sharing and Utility Coordination Requirements for Key Stages of a Project.

The Key Stages are the Briefing Concept Stage, the Defined Design Stage, the Build and Handover Stage, and the Operate and Maintain Stage.

8.1 Key Understandings for Project Stages

Outcome(s)

This section familiarizes Delivery Partners with context for Project Data regarding Utility Coordination, SUE as it relates to UIE, Information Management, and Asset Management.

Considerations

The intent is to create adaptable Project Stages for Projects, using IO Project Stages and ISO 19650 Project Stages as condition precedent. This is because Projects may use various procurement routes and adaptable stages will better accommodate these differences.

Understand that Reference Documents from Canadian jurisdictions, such as the York Region Utility Coordination Manual, and British Columbia Utility Policy Manual, are prioritized for Utility Coordination in the Manual.

The purpose of incorporating the York Region Utility Coordination Manual is to ensure compliance with the Ontario Provincial Standards for Roads and Public Works (OPS) and other Leading Practices in Ontario. The York Region Manual serves as a comprehensive guide for utility companies, contractors, and consultants engaged in Projects within York Region. It outlines the requirements and specifications for the installation, maintenance, and relocation of utilities within the Region's Right-of- Ways, all of which are based on the OPS. The OPS is a collection of technical standards and specifications for the design, construction, and maintenance of municipal Infrastructure in Ontario.

The Deliverables required for each stage of the Project are informed by the standards and Leading Practices outlined in the Reference Documents from the UK and Australia. These documents provide valuable insights and recommendations for the successful completion of the Project. It is imperative

that all Deliverables follow these standards and Leading Practices to ensure the Project is completed efficiently and effectively.

Content

8.1.1 Summary of Project Stages

The Manual Project Stages are in alignment with pre-existing IO Project Stages and Stage Gates. The Project Stages are the Briefing Concept Stage, the Defined Design Stage, the Build and Handover Stage, and the Operate and Maintain Stage.

An end-to-end overview of the Project Stages, key functions throughout the Stages, and a summary of required Deliverables, is provided as a Level One Process Map in **Appendix Q**.

8.1.1.1 Briefing Concept Stage

Understand Briefing Concept Stage:

The purpose of this stage is to help the Appointing Party understand and articulate the problem statement into a Project opportunity statement. The stage also involves gathering relevant contextual Information to inform various concepts. The following are the key Elements of the Briefing Concept Stage Gate:

The Briefing Concept Stage involves assessing a wide range of options that meet the Business Case and Project Objectives to select a preferred Procurement Methodology. The procurement options include:

1. Traditional Design-Bid-Build (DBB): This is the most common procurement method in Ontario. It involves the owner hiring an architect or engineer to design the Project, then putting the Project out to bid for construction contractors to compete for the Project.

2. Public-Private Partnerships (P3): P3s involve a private consortium taking on the responsibility of designing, building, financing, and operating a public Infrastructure Project. This is typically done through a long-term contract with the government.

3. Design-Build (DB): A P3 model where the private consortium is responsible for both designing and building the Project.

4. Design-Build-Finance-Operate-Maintain (DBFOM): A P3 model where the private consortium is responsible for designing, building, financing, operating, and maintaining the Project over a long-term contract.

5. Integrated Project Delivery (IPD): IPD is a collaborative procurement method where all parties involved in the Project (owner, architect, engineer, contractor, and subcontractors) work together from the beginning to complete the Project.

6. Collaborative Contracting: This procurement method involves the owner and contractor working together to complete the Project. The contractor is involved in the design process and shares in the risks and rewards of the Project.

The Briefing Concept Stage includes complying with Data and Information requirements. This involves gathering relevant contextual Information to inform various concepts. It also involves considering critical legal and security Elements.

The Briefing Concept Stage requires Delivery Partners to follow and complete the Due Diligence Process for utilities on a Project. For this, reference the requirements outlined in Section 3.2 and 3.3.

The Briefing Concept Project Stage Gate is marked by selecting the preferred procurement route. The selected procurement route will inform the next stage of the Project.

8.1.1.2 Defined Design Stage

Understand Defined Design Stage:

The purpose of the Defined Design Stage is to expand on the selected procurement option from the Briefing Concept and provide a more detailed Business Case. This stage involves gathering a significant amount of Information and initiating the procurement of the Lead Appointed Party and/or Appointed Parties. Depending on the procurement route, the detailed design and engineering activities can commence once the necessary Parties have been confirmed.

During this stage, Information gathering, and detailed design occur simultaneously with community engagement, commercial reviews, pre-construction activities, permitting, technical studies, and the development of a Digital Engineering Execution Plan, which includes a RACI Matrix to guide construction and site activities.

The Defined Design Project Stage Gate is marked by agreement among all Parties on the strategies, documents, and execution plan(s) assigned to the Project Stage.

8.1.1.3 Build and Handover Stage

Understand Build and Handover Stage:

The Build and Handover Stage aims to transform the drawings, designs, and intentions from the Defined Design stage into a physical structure and commission the Project. This stage is crucial to the success of the Project, and it requires the utmost attention to detail and precision.

The Appointed Party and its supply chain are responsible for executing the Project. Upon completion of the Project in accordance with the Project Objectives and plan, the Appointed Party must create Handover Material to be presented to the Asset Owner. This handover must include all designs in the "As-Constructed" or "As-Built" format, as well as all necessary Information from the Briefing Concept

stage to the Build and Handover stage of the Project. The Asset Information Model should be utilized during this process.

It is essential to use BIM during the handover process to ensure that all necessary Information is accurately transferred to the Asset Information Model. This will enable the Asset Owner to effectively manage and maintain the Project throughout its lifecycle.

8.1.1.4 Operate and Maintain Stage

Understand Operate and Maintain Stage:

The Operate and Maintain stage serves the purpose of operating the facility or Asset in accordance with the expectations set by the Organization and business case.

The Asset Information Model is maintained in accordance with the Digital Asset Objectives set by the DTO. This ensures that the Asset is able to deliver benefits to Ontario in a timely and effective manner.

8.1.2 Purpose and Importance of Utility Coordination

The purpose of Utility Coordination is to Identify the various utility systems present within a construction site or Project area.

Failure to coordinate utilities can cause significant delays, cost overruns, and safety hazards.

Locate and manage utilities such as water, gas, electricity, and telecommunications. Improper coordination can result in damage to existing Utility Infrastructure.

Ensure proper functioning of utilities necessary for the Project. Damage to Utility Infrastructure can be costly and time-consuming to repair.

Emphasize Utility Coordination is required for any work that will affect or be affected by existing and planned utilities.

Negligence of Utility Coordination will mean the Project is non-compliant to Manual requirements.

A. Key Reference Documents for Utility Coordination

1. British Columbia – Utility Policy Manual
2. York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
3. Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

8.1.3 Implementation of Subsurface Utility Engineering (SUE) Data Collection and Mapping

Require performing Subsurface Utility Engineering (SUE) investigations in accordance with ASCE 38-02 to ensure consistency and transparency in the collection and depiction of utilities at various stages of Projects.

Understand key aspects of ASCE 38-02 as follows:

1. Use ASCE 38-02 to classify the quality of the Subsurface Utilities mapped on engineering drawings.

2. Understand the Quality Level of the utilities depicted on engineering drawings to achieve excellent Utility Coordination.

Use the Quality Level Descriptions from ASCE Standard 38-02 to classify the quality of Subsurface Utilities.

1. Understand Quality Levels increase from Quality Level D (QL-D) to Quality Level A (QL-A), separated by increasing requirements on the method for collecting and confirming Subsurface Utilities Information.

2. Understand QL-D is Information derived from existing records or oral recollections.

Understand Quality Level C (QL-C) is Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this Information to QL-D Information.

Understand Quality Level B (QL-B) is Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of Subsurface Utilities.

Understand QL-A is precise horizontal and vertical locations of utilities obtained by the actual exposure (or verification of previously exposed surveyed utilities) and subsequent measurement of surface utilities, usually at a specific point.

1. Minimize the potential for utility damage by using minimally intrusive excavation equipment.

2. Show a precise horizontal and vertical location, as well as other utility Attributes, on plan documents.

3. Set accuracy to 15-mm vertical and to applicable horizontal survey and mapping accuracy as defined or expected by the Project Owner.

8.1.4 Required Documents for Information Management and Asset Management in a Project

Identify key deliverable documents required and utilized in various Project Stages. This is not an exhaustive list of all deliverable documents but identifies definitions for key deliverable documents in the Manual.

8.1.4.1 Asset Information Requirements

Data and Information requirements by the Appointing Party in relation to the operation of an Asset.

- From ISO 19650-1:2018

8.1.4.2 Organization Information Requirements

Specification for what, when, how, and for whom Information is to be produced in relation to Organizational Objectives.

- From ISO 19650-1:2018

8.1.4.3 Exchange Information Requirements

Specification for Data and Information by the Appointing Party that the Appointed Party is expected to meet during the appointment. Note in Reference Documents Exchange Information Requirements and Exchange Information Requirements have been used interchangeably, for the Manual Exchange Information Requirements is used.

- From ISO 19650-1:2018, 3.19.

An Exchange Information Requirements provides guidance and pre-qualification documentation for Appointed Parties and forms the basis of appointment and tender documents on a Project using Digital Engineering.

An Exchange Information Requirements defines which Information is produced at each Asset stage together with the required level of detail and definition.

8.1.4.4 Digital Engineering Execution Plan

A plan that delivers and explains how the Digital Information Management aspects of the appointment will be carried out by the Appointed Parties prior to and during contract award. Outlines the overall strategy and approach for using Digital Engineering technologies and processes across a Project or Organization.

8.1.4.5 Digital Engineering Execution Response

A template that is standardized enables the Appointing Party to evaluate the Digital Engineering Execution Plan of bidders in a way that is consistent and transparent.

The Digital Engineering Execution Response is a checklist of Information Management criteria that are crucial throughout the Project or Asset lifecycle. These criteria include shared vision/

Objectives, people, training, approach, visual bidding, standards, alignment with Asset Information Requirements and Organizational

Information Requirements, and more. By using this template, the Appointing Party can determine whether the tenderers have documented and considered their approach to Digital Engineering, as well as whether it aligns with the Asset Information Requirements and Exchange Information Requirements and their scope of services.

8.1.4.6 Building Information Modeling Execution Plan

Detailed document that outlines how BIM will be used specifically for a particular Project. Includes Information on BIM standards, protocols, workflows, and responsibilities for each Project Proponent. The BIM Execution Plan is aimed at Project Teams and provides a detailed plan for how BIM will be implemented and managed throughout the Project lifecycle.

8.1.4.7 Master Information Delivery Plan

Used to manage the overall delivery of Information during the Project lifecycle. It is typically developed by the BIM Specialist and Data Custodian in collaboration with other Project Team roles.

In the Defined Design Stage:

1. The Master Information Delivery Plan provides a Project-wide view of how Information will be created and managed across the lifecycle.

2. The Lead Appointed Party use the Master Information Delivery Plan to ensure Project Information is developed by the respective Project Team members in line with Project Stages and key decisions.

3. A process flow diagram, showing the Information containers, should support the Master Information Delivery Plan.

4. This enables clear accountabilities and transparency on Information creation, management, and delivery timeframes.

In the Build and Handover Stage:

5. The BIM Specialist and Data Custodian will create a construction Master Information Delivery Plan combining the construction Task Information Delivery Plans from all awarded Appointed Parties.

Figures

Yes☒ No☐

- Figure 8.1.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy – Page B.23
    - Alignment of the [Manual] with the Asset Management Accountability Framework (AMAF)
- Figure 8.1.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy – Page B.27
    - Alignment of the–[Manual] with the ISO19650 Process and example of Procurement strategy overlayed

References

- York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

Briefing Concept Stage

8.2 Overview of Data Sharing and Utility Coordination during the Briefing Concept Stage

Outcome(s)

Establish overview of instructions for Data Sharing and Utility Coordination during the Briefing Concept Stage.

Considerations

Focus of British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices.

Utilize Centre for Digital Built Britain BIM and Digital Twin Reference Documents, as well as the Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Relevant Legislation and Regulations

The Manual emphasizes the importance of considering various Acts and directives throughout the construction lifecycle of a Project, which apply to Utility Infrastructure procurement and construction in Ontario. These include:

- Ontario Underground Infrastructure Notification System Act, 2012, which mandates that anyone planning to excavate must contact Ontario One Call to ensure that underground utilities are marked and protected before any digging takes place in public Infrastructure Projects.
- The Ontario Infrastructure and Lands Corporation Act, 2011, which establishes Infrastructure Ontario as the responsible entity for procurement of public Infrastructure Projects.
- The Municipal Act, 2001 which allows municipalities to enter into agreements with other public sector Organizations for procurement of public Infrastructure Projects.
- The Technical Standards and Safety Act, 2000, which regulates the technical standards and safety requirements for operating and maintaining facilities or Assets in Ontario.
- The Construction Act, 1990 which mandates a written contract with a detailed scope of work, prompt payment provisions, dispute resolution mechanisms, and the provision of necessary Information to contractors.
- The Environmental Assessment Act, 1990 which requires environmental assessments for all

public Infrastructure Projects.

- The Planning Act, 1990 which sets out rules for land use planning and development of official plans and zoning by-laws.
- Ontario Building Code (O. Reg. 332/12), which outlines requirements related to building classification, height and area, structural design, fire protection, accessibility, HVAC and mechanical systems, and energy efficiency.
- The Broader Public Sector Procurement Directive, which sets out procurement policies and procedures that must be followed by all public sector Organizations in Ontario.
- The Ontario Provincial Standards developed by the Ministry of Transportation, which provide guidelines and specifications for the construction and maintenance of public Infrastructure Projects in Ontario.

It is important to note that the Manual does not exempt Appointing Parties from complying with all legislative and regulatory requirements that are relevant to the Project in Ontario.

In accordance with the updated legislative and regulatory regime, the following provisions have been enacted to enable Digital Twins throughout the Project lifecycle:

- The Lead Appointing Party is required by legislation to inform the Infrastructure Owner when subsurface Infrastructure has been located during an excavation and the Infrastructure Owner is required to create a Digital Asset and record according to the standards referenced in the Manual, should an accurate Digital Asset and record not exist.
- The Lead Appointing Party must ensure that underground Infrastructure installed after a certain date include radio frequency identification Technology or a reasonable alternative as defined in regulation.
- The Lead Appointing Party must provide a Digital Asset and record upon a Locate Request and maintain Digital Assets and records of Infrastructure for a specified period of time.
- External Parties will not be permitted to charge for a Locate Request required under the Ontario Underground Infrastructure Notification System Act, 2012 by a Lead Appointing Party, while allowing exemptions for municipalities.

Content

8.2.1 Approach to the Briefing Concept Stage

Delivery Partners are required to follow the approach to the Briefing Concept Stage as described:

1. Focus on creating a Preferred Alignment Base Plan early in the Project design process.
2. Finalize and lock the Project site location/coordinates.
3. Develop preliminary plot plans and/or routes.
4. Understand existing conditions.
5. Begin the Due Diligence Process.
    a. For this, Delivery Partners must reference Section 3.2 and 3.3, following the process through to completion through the various Project Stages.
6. Develop and analyze basic massing diagrams (volumes).
7. Finalize preliminary schedules.
8. Conduct basic material take-offs.
9. Engage with key internal and external Project Teams.

8.2.2 Organizational Information Requirements

Understand the Organizational Information Requirements aids the Implementation Lead in ensuring effective and efficient day-to-day business activities related to the Projects.

Use the Organizational Information Requirements template provided in **Appendix D** and review the format, completeness, and quality of the Organizational Information Requirements.

Collect up-to-date and complete documents before commencing a Project.

During the Briefing Concept, led by the Appointing Party and Implementation Lead, review the Organizational Information Requirements in the context of the Project.

Repeat this process with the Project Team. Seek inputs from business case authors, executive sponsors, engineering, operations, strategic Assets Managers, Project Managers, commercial, procurement, and legal to discuss key Project items with reference to the Organizational Information Requirements. These key items include:

1. Asset identifiers and classification
2. Data standards/policies and procedures
3. Handover of Information during Project implementation

4. Handover of Information post Project delivery
5. Reporting and regulatory requirements
6. Capital investment financial Data
7. Asset Information Requirements
8. Quality Control
9. Data validation

8.2.3 Asset Information Requirements

Articulate and document Information, decisions, Data, reporting, and Project Proponents required for Assets to support their function and the wider Organization effectively and efficiently on a day-to-day basis in an Asset Information Requirements.

Follow these general guiding principles regarding the Asset Information Requirements:

1. Make it much more granular than the Organizational Information Requirements.
2. Ensure it feeds into the Organizational Information Requirements.
3. Create more than one Asset Information Requirements if managing different Assets.

For the Project, the Asset Information Requirements is a key input that sets out the expectations for how Information is gathered, used, processed, and acted on.

Establish the Asset Information Requirements prior to the commencement of the Project. The Appointing Party is the key accountable person to:

1. Engage the appropriate Project Proponents for the Asset Information Requirements.
2. Assess the quality of the Asset Information Requirements and seek clarification and update (where applicable).
3. Lead conversations with the Project Team around the Asset Information Requirements in the context of the key decision points on the Project.

Asset Information Requirements will lead the Project Team on key topics, including:

1. Level of Information need
2. Level of Development (Level of Development)

3. Key decision points when Information is required
4. The status of the existing Asset Information Model and its ability to support the Project development process
5. Asset classification
6. Asset location referencing
7. Asset attributes and Data schemas
8. Performance Data
9. Maintenance Data
10. Relevant commercial Information
11. Asset register
12. Data Collaboration strategy (CDE)
13. Quality Control/validation

Remember that the Implementation Lead and the Assets Manager share co- responsibility for the Asset Information Requirements.

Keep the document up-to-date and relevant to the current context or situation.

Articulate the processes for how Information should be handed over during Project Stages (e.g., Soft Landings approach).

8.2.4 Exchange Information Requirements

Establish the Exchange Information Requirements to produce and consume Information and Data throughout the Project and Asset lifecycle.

Clearly define the Owner's Data and Information requirements throughout the life of the Project.

Use the responsible, accountable, consulted, and informed (RACI) scope checklist and the level of Information need to articulate the Information you want and its purpose.

Specify the detailed Data and Information needed to achieve high-level strategic Objectives, including Information security requirements. Issue the Exchange Information Requirements to bidders as part of the tender process.

Require bidders to respond to the Exchange Information Requirements in the form of a Digital Engineering Execution Plan. Ask bidders to demonstrate how they will work with their supply chain to deliver and manage Data and Information in line with the Appointing Party's requirements.

Figure(s)

Yes☒ No☐

- Figure 8.2.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Summary of the actions associated with Phase 1 to 2 (Brief and Concept)
- Figure 8.2.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Phase 1 to 2 Deliverables Checklist (Brief and Concept)

References

- York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

8.3 RACI for Delivery Partners in the Briefing Concept Stage

Outcome(s)

Identify who is Responsible, Accountable, Consulted, and Informed (RACI) for each Delivery Partner as it relates to the Briefing Concept Stage.

Considerations

Based on Reference Documents and technical expert advice, it is recommended that the Manual explicitly defines the role of Delivery Partners to improve communication, accountability, and efficiency within an Organization and Project Team.

In this Manual, the definition and purpose of a RACI Matrix is repeated in every section where a RACI is mentioned assuming that Delivery Partners may only engage with sections that is relevant to them and not the entire content of the Manual.

Content

8.3.1 RACI Matrix Defined

Refer to Section 5.2.

8.3.2 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.4.

8.3.3 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.4.

Figure(s)

Yes☐ No☒

References

N/A

8.4 Application of Existing Standards in the Briefing Concept Stage

Outcome(s)

Identify and address the key standards for Data Sharing and Utility Coordination in the Briefing Concept stage.

Considerations

Focus on British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices.

Utilize Centre for Digital Built Britain BIM and Digital Twin Reference Documents, as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Content

8.4.1 Requirements for Effective Information Management and Maintenance

Require specific formats and means for sharing Data for newly built Infrastructure.

Ingest Data into the Project CDE, to be ingested to DTO AssetFlow Hub by Data Custodian. Utilize expert guidance to know the best place to start.

8.4.2 Requirements for Utility Coordination

8.4.2.1 Integrated Requirements from TAC Guidelines for Utility Relocations

Use "The TAC Guideline for the Coordination of Utility Relocations on Projects" during the Briefing Concept Stage of Projects to identify and manage potential utility conflicts early in the Project lifecycle.

Identify and communicate with Utility Providers in the Briefing Concept Stage:

1. Commence communication with Utility Providers early in the Briefing Concept Stage.
2. Highlight the benefits of early consultation for the Project and Utility Providers.
3. Ensure Utility Providers can budget for relocation work in the appropriate year.

Assign a Utility Coordinator to manage Utility Coordination process:

1. Assign a Utility Coordinator to manage utility risk in the Briefing Concept Stage.
2. Emphasize the importance of the Utility Coordinator's role in the process.

Conduct a Subsurface Utility Engineering (SUE) investigation:

1. Begin the process of identifying utilities within Project limits in the Briefing Concept Stage.
2. Follow ASCE 38-02 standard guideline for SUE investigation.
3. Determine the Quality Level of SUE investigation through a high-level Utility Impact Study.
4. Map Information gathered through SUE investigation to form a foundational pillar of Project's Base Plan.

Equip Design Planner with utility Information:

1. Provide Design Planner with utility Information on the Base Plan.
2. Use utility Information to aid in the selection of preferred design option Obtain Key Information from Utility Agency in Briefing

Concept Stage:

1. Obtain critical or vital Infrastructure Information.
2. Obtain high-level relocation schedule and cost estimate.
3. Ensure preferred design option is approved.

Select Project Utility Coordinator in Defined Design Stage:

- Ensure all utility tasks are completed correctly and at the appropriate time.

Divide Defined Design Stage into Two Sub-Phases:

1. Preliminary Defined Design Stage
2. Detailed Defined Design Stage

Complete Key Design Elements in Preliminary Defined Design Stage:

1. Complete Base Plan survey
2. Complete composite utility drawing
3. Identify required Right-of-Way widths and constraints
4. Complete plan and profile views of existing and new construction
5. Add Road Geometrics and identify excessive changes

6. Consult with potential new developments
7. Identify retaining walls and initial Utility Conflict Matrix
8. Identify SUE QL-A (test pit) locations
9. Complete existing structures condition survey
10. Identify railway crossings and permitting process
11. Commence land attainment process
12. Identify required Permission to Enter agreements
13. Identify environmental conditions and permit requirements
14. Identify Partnerships and cost-sharing agreement
15. Review initial constructability
16. Complete Street Tree Inventory and Preservation Plan
17. Complete initial streetscape plan Notify and Identify Design Consultant:
18. Notify Utility Providers of the Commencement of the Defined Design Stage.
19. Identify the Design Consultant, contact Information, Project scope and timelines.

Conduct SUE Investigations:

1. Conduct additional SUE investigations to identify existing utility corridor.
2. Update Base Plans with additional SUE investigation findings.

Prepare Utility Conflict Analysis:

1. Prepare utility conflict analysis.
2. Create Utility Conflict Matrix to track potential utility conflicts.

Conduct Utility Coordination Meeting:

1. Create a schedule for the Project.
2. Conduct a Utility Coordination face-to-face meeting with Project Owner, design team, and

impacted Utility Providers.

Complete Key Design Elements:

1. Finalize Base Plan survey, composite utility drawing, required Right-of-Way widths and constraints.
2. Finalize plan and profile views of existing and proposed storm sewers, watermains, sanitary sewers, and new construction.
3. Finalize Road Geometrics, horizontal alignment, vertical grade, new developments access locations, and servicing.
4. Finalize road cross-sections, retaining walls, and updated Utility Conflict Matrix.
5. Identify further SUE QL-A locations, existing and proposed structures, railway crossings, and required permitting process.
6. Complete Street Tree Inventory, Street Tree Preservation Plan, and Streetscape design.

Prepare Utility Relocation Cost Estimate:

1. Prepare utility relocation cost estimate upon acceptance of relocation design by design team.
2. Commence Purchase Order Process, which is a dependency for utility relocation construction.

Complete Detailed Defined Design Stage:

1. Complete utility relocation designs and submit for Road Authority and other regulating agency permits.
2. Obtain and register land and issue Purchase Orders to Utility Providers.
3. End Detailed Defined Design Stage when all utility relocation construction dependencies are in place.

Digitize locate and/or survey Data on existing Infrastructure upon excavation by construction proponents. Ensures accurate Data is available for future Projects and reduces the risk of conflicts and delays.

Require survey equipment used by construction proponent surveyors and locators to be a total station, GNS Real Time Kinematic (RTK), or 3D Laser Scanning for underground Subsurface Utilities.

Record Metadata related to Projection/coordinate Information along feature types, geometry types,

and attributes, as specified in ASCE 38-22 and ISO 19650.

Apply existing Leading Practice standards on the environmental assessment stage of utilities Projects to enhance Data Sharing and Utility Coordination.

8.4.2.2 Integrated Requirements from York Region Utility Coordination Manual

Consult the York Utility Coordination Manual for guidance on consultation with Utility Providers, identifying existing utilities, and conducting a utility risk assessment workshop.

Initially consult with Utility Providers as follows:

1. Notify Utility Providers of planned Project and request Mark-Up Drawings using Letter #1 from **Appendix R**.
2. Schedule a meeting between Ontario Municipality and Utility Provider if critical/vital Infrastructure is located within Project limits using Mark-Up Drawings received from Utility Provider and Letter #2.
3. Preferably notify Utility Providers of scheduled public consultation using Letter #3.
4. Notify Utility Providers that the Environmental Assessment has been completed using Letter #4.

Identify Existing Utilities in the Project Limits:

1. Develop an up-to-date topographic survey and plan of the construction Project area.
2. Ensure the Base Plan is adequate for Utility Coordination requirements.
3. Forward the Base Plan and Letter #1 of the Utilities Relocation Process to all Utility Providers with a request for Mark-Up Drawings.
4. Forward Letter #2 (Utility Mark-Up Drawings) to the Project Utility Coordinator by each Utility Provider.
5. The Mark-Up Drawings display where the Utility Provider's records indicate the Infrastructure is located within the study area.
6. Many factors may influence the level of accuracy to which utilities are mapped during the Briefing Concept Stage.
7. Utility Providers should flag any existing or planned critical/vital Infrastructure and known abandoned Infrastructure within the Project's study area on the Mark-Up Drawings.

The ASCE Standard 38-02 establishes Quality Levels for the underground utility Information so that all parties can evaluate the accuracy and reliability of the Data.

The SUE investigation of QL-B will meet most Environmental Assessment requirements, but for congested corridors, increased accuracy of QL-A must be utilized.

Plan a Utility Risk Assessment Workshop:

1. Coordinate a workshop between the Project design team and the Utility Providers.
2. Inform Utility Providers of the scope of the Project.
3. Identify high-risk Utility Infrastructure within Project limits, including details of the Infrastructure.
4. Identify high-level long duration utility relocations.
5. Obtain high-level cost estimates on the high-risk potential utility relocations.
6. Identify land needs for utility relocations, if possible.
7. Produce a Utility Risk Assessment Matrix as a deliverable from the workshop (See **Appendix S**: Sample Utility Risk Assessment Matrix).

Initiate Utility Conflict Analysis:

1. Utilize Base Plan with current SUE Information and Briefing Concept design.
2. Create preliminary Utility Conflict Matrix.
3. Note: **Appendix T** provides a sample of Utility Conflict Matrix.
4. List potential utility conflicts and pertinent Information about utilities.
5. Provide recommended mitigation.

Preferably schedule a public consultation meeting once the Environmental Assessment design has progressed to an acceptable level:

1. Prepare and send Letter #3 to Utility Providers, notifying them of the date and location of the public consultation meeting. This notification gives the Utility Providers the opportunity to attend the public consultation.

Create a Base Plan for Preferred Alignment:

1. Instruct the Environmental Assessment consultant to create a Base Plan for the Preferred Alignment at the end of the Briefing Concept Stage.

2. Forward Letter #4 to Utility Providers, prepared by the Project Utility Coordinator.

8.4.2.3 Integrated Requirements from the BC Utility Policy Manual

Instruct to refer to the BC Utility Policy Manual for detailed requirements on permits, consultation, management, and locates.

1. Instruct to follow the permit requirements outlined in the BC Utility Policy Manual, including authorization for all utility installations, issuing permits to one utility Organization only, and responsibility for Third Parties.

Manage Risk and Ensure Proper Consultation:

1. Instruct to conduct a site inspection/quality audit and monitoring to manage risk when applying for permits.

2. Instruct to ensure proper First Nation consultation is performed, either by the district, the applicant, or the utility Organization.

3. Instruct to obtain necessary approvals and develop construction environmental management plans to manage environmental impact.

Follow Guidelines:

1. Instruct to follow municipal guidelines for vegetation management, highway Right-of-Way preservation, and contaminated environmental media.

2. Instruct to initiate a Data Sharing process and mark the location of all underground Utility Infrastructure according to the American Public Works Association color code, endorsed by the Canadian Standards Association.

8.4.2.4 Integrated Requirements from CSA S25020 Mapping of Underground Utility Infrastructure

Ensure Reliability and Accuracy of Cadastral Parcel Data[39]:

1. Derive cadastral parcel Data from authoritative provincial sources, preferably land registry systems.

2. Relate parcel mapping to topographical and geographical features to achieve required reliability and accuracy of the record.

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39 Cadastral parcel Data refers to Information about land parcels, including their boundaries, dimensions, location, and ownership. This Data is typically maintained by government Agencies responsible for land management, such as land surveying departments or land registry offices.

Correct Mapping Records:

1. Notify Owner/operator of errors and omissions in mapping records.

    a. Owners must update Data records within 30 days (or as agreed upon by all involved Parties) and provide updated Data as a record for subsequent Locate Requests.

2. Develop and educate key Project Proponent groups on discrepancies between records and physical location of underground Utility Infrastructure.

3. Categorize discrepancies based on risk and significance to drive urgency of record adjustment.

4. Submit observations to appropriate person or department with relevant Information.

Obtain Information about Utility Infrastructure in Construction Area:

1. Use reasonable and available means to increase confidence in accuracy and completeness of existing underground Utility Infrastructure.

Design and Locate Underground Utility Infrastructure for easy Locating:

1. Consider the use of tracer wire, electromagnetic markers, or similar methods of locating for non-conductive underground Utility Infrastructure.

2. Establish and follow a standard installation location to assist with mapping and locating of underground Utility Infrastructure.

Note: Failure to note errors or omissions in mapping records could result in future damage to the Utility Infrastructure and impact public safety.

8.4.3 Asset Management Deliverables Checklist

Establish the Asset Management Deliverables as a Briefing Concept Stage Gate to the Defined Design Stage by completing task as follows:

1. Review the Description of Roles

2. Onboard the Appointing Party and Lead Appointed Party to the Project

3. Identify key decision points for Information transfer (Lead Appointed Party)

4. Identify and align preferred procurement routes with key decisions (Lead Appointed Party)

5. Check and update Organizational Information Requirements currency (Data Custodian)

6. Check and update Asset Information Requirements currency (Assets Manager/Facility Manager)
7. Agree upon Asset Classification System (Assets Manager/Facility Manager
8. Engage operations and maintenance representative (Assets Manager/Facility Manager)
9. Complete Project statement of intent (Appointing Party)
10. Consult Data dictionary for naming conventions and validate (Project Manager)
11. Validate existing Asset Information Model and collate required Data (Assets Manager/Facility Manager)
12. Compile and organize existing site Information to a clear format (Assets Manager/Facility Manager)
13. Understand and document site constraints (Project Manager)
14. Hand over existing model/drawings to parties in Defined Design Stage (Lead Appointed Party)
15. Relay lessons learnt back to the Appointing Party Organization for inclusion in future Projects/ approaches (Appointing Party)
16. Clarify and check user access rights (Lead Appointed Party)
17. Review Briefing Concept key decision points (Appointing Party)
18. Answer Briefing Concept key decision points in collaboration with key Project Proponents (Appointing Party)

Figure(s)

Yes☒ No☐

- Figure 8.4.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Summary of the actions associated with Phase 1 to 2 (Brief and Concept)
- Figure 8.4.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Phase 1 to 2 Deliverables Checklist (Brief and Concept)

References

- York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

Defined Design Stage

8.5 Overview of Data Sharing and Utility Coordination during the Defined Design Stage

Outcome(s)

Establish overview of instructions for Data Sharing and Utility Coordination during the Defined Design Stage.

Considerations

Focus of British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices.

Utilize Centre for Digital Built Britain BIM and Digital Twin Reference Documents, as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Relevant Legislation and Regulations

Allocate the attribution of specific costs at the Project Owners' expense.

1. Construction Act, 1990

Content

8.5.1 Approach to the Defined Design Stage

Delivery Partners are required to follow the approach to the Defined Design Stage as described:

1. Develop a detailed Information Management plan that outlines the collection, storage, and sharing of Project Data and Information.

2. Develop an Asset Management plan that outlines the ongoing maintenance and management of Project Assets.

3. Coordinate with Utility Providers and develop a plan to manage any potential conflicts or constraints.

4. Establish protocols for sharing Data and Information with Project Proponents and Partners throughout the Defined Design Stage.

5. Develop a Digital Engineering Execution Plan that outlines the roles and responsibilities for managing Project Data and Information.

6. Develop a RACI Matrix to inform construction and site activities.
7. Review and update the plans as necessary throughout the Defined Design Stage.
8. Ensure that the plans are aligned with the procurement route selected at the Defined Design Project Stage Gate.

Figure(s)

Yes☒ No☐

- Figure 8.5.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Summary of the actions associated with Phase 3 to 4 (Definition and Design)
- Figure 8.5.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Phase 3 to 4 Deliverables Checklist (Definition and Design)

References

- York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Deliver
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

8.6 RACI for Delivery Partners in the Defined Design Stage

Outcome(s)

Identify who is Responsible, Accountable, Consulted, and Informed (RACI) for each Delivery Partner as it relates to the Defined Design Stage.

Considerations

Based on Reference Documents and technical expert advice, it is recommended that the Manual explicitly defines the role of Delivery Partners to improve communication, accountability, and efficiency within an Organization and Project Team.

In this Manual, the definition and purpose of a RACI Matrix is repeated in every section where a RACI is mentioned assuming that Delivery Partners may only engage with sections that is relevant to them and not the entire content of the Manual.

Finally, note that RACI Matrices currently in bullet-list form will be visually represented as an actual matrix for v1.0 of the Manual.

Content

8.6.1 RACI Matrix Defined

Refer to Section 5.2.

8.6.2 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.7.

8.6.3 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.7.

Figure(s)

Yes☐ No☒

References

N/A

8.7 Application of Existing Standards in the Defined Design Stage

Outcome(s)

Identify and address the key standards for Data Sharing and Utility Coordination in the Briefing Concept stage.

Considerations

This Section was informed by the British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices. This Section also utilized Centre for Digital Built Britain BIM and Digital Twin Reference Documents as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Content

8.7.1 Requirements for Effective Data Management and Maintenance

1. Establish Soft Landings and Data drops as essential components of the Defined Design stage.

2. Conduct a 'trial' exchange of Exchange Information Requirements Data to inform key decision points and facilitate improved and staged handover processes.

3. Use specific formats and means by which Data must be shared for newly built Infrastructure to ensure the Data can be ingested into the DTO AssetFlow Hub.

Seek expert guidance to determine the best place to start.

1. Establish existing standards are incorporated into the design process using software and collaboration between Project Teams.

2. Utilize the Line-of-Sight Methodology[40] for Asset Management to support Organizational Objectives by optimizing Asset Management Methodology to realize business success.

3. Introduce Organization Information Requirements, establish Asset Information Requirements through functional Information requirements; finally, design and develop an Asset Information Model.

8.7.2 Requirements for Utility Coordination

40 The Line-of-Sight Methodology aids the establishment of Asset Information Requirements from Organizational Information Requirements: Organizational Objectives, lead to Organizational Information Requirements, lead to Functional Information Requirements, lead to Asset Information Requirements, results in Asset Information Model.

8.7.2.1 Integrated Requirements from TAC Guidelines for Utility Relocations

Delivery Partners must follow the TAC guideline for the coordination of utility relocations on Projects during what the TAC calls the Defined Design Stage, including the preliminary and detailed stages (Defined Design Stage in Manual):

1. Define Project scope: Identify the Project limits and the scope of the Project.
2. Identify existing utilities: Conduct a survey to identify all the existing utilities within the Project limits.
3. Conduct utility risk assessment: Conduct a workshop to assess the potential risks associated with the Project and develop strategies to mitigate those risks.
4. Analyze potential utility conflicts: Analyze potential conflicts that may arise between the new Project and existing utilities.
5. Hold a 30% detailed design[41] Utility Coordination meeting: Review the detailed design and coordinate with utility companies to ensure there are no conflicts.
6. Prepare Composite Utility Plan: Prepare a Composite Utility Plan that includes all the existing utilities and the proposed Project.
7. Estimate costs and relocation durations: Estimate the costs and duration of relocating the existing utilities.
8. Develop initial Utility Coordination schedule: Develop a schedule that outlines the coordination between the Project Team and the utility companies.
9. Identify existing works: Identify any existing works that may impact the Project and develop strategies to mitigate those impacts.
10. Hold a 60% detailed design[42] Utility Coordination meeting: Review the detailed design and coordinate with utility companies to ensure there are no conflicts.
11. Update Composite Utility Plan: Update the Composite Utility Plan based on the 60% detailed design.
12. Expedite utility relocation process: Use the accelerated utility relocation process to expedite the relocation of the existing utilities.

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41 The 30% design stage is the preliminary design phase, where the Project's general scope and concept are defined. At this stage, the Project's basic layout and overall functionality are determined, and initial cost estimates are made.

42 The 60% design stage is the intermediate design phase, where the Project's design is further developed and refined. At this stage, more detailed design drawings and specifications are produced, and the Project's cost estimate is updated.

13. Design new utilities: Design the new utilities and ensure they are electronically locatable (RFID or an equivalent alternative such as GPS sub- hectometer with X, Y, and Z).

14. Update Utility Coordination schedule: Update the schedule that outlines the coordination between the Project Team and the utility companies.

15. Develop Utility Coordination Plan: Develop a plan that requires at least 40- 50% of decision-making comes from new collected Data at QL-B or higher. It also requires locators, surveyors, and design engineers to upload subsurface Infrastructure Data and BIM records to a local repository from new Locate Requests and construction Projects for Horizontal and Vertical Structures.

8.7.2.2 Integrated Requirements from CSA S25020 Mapping of Underground Utility Infrastructure

Integrated requirements include:

1. Require Appointing Party to share received utilities mapping Information with relevant Utilities Industry Delivery Partners for the Project.

2. Coordinate and share mapping Information with other Appointing Parties when executing current plans or planning future Projects.

3. Be Aware of Regulatory Compliance:

4. Be aware of federal and provincial statutes, regulations, codes, standards, and guidelines when planning or designing the installation of new or replacement Utility Infrastructure.

5. Be aware of municipal by-laws.

6. Be aware of Owner and operator standards.

8.7.2.3 Integrated Requirements from the York Region Utility Coordination Manual

This Section will outline all tasks essential for utility relocation design and their timing for the Project's detail design process during the Detailed Design Stage. This phase follows the Briefing Concept Stage and continues until all required utility relocation designs are completed. Delivery Partners must ensure the completion of these tasks at the right time in the Defined Design Stage process.

Requirements when consulting with Utility Providers:

Develop a Utility Communication Plan:

During the Defined Design Stage, it is important to develop a Utility Communication Plan to ensure effective coordination with Utility Providers. This plan should include a series of letters to be used for Utility Coordination. The following is a summary of each of the letters to be used in the plan.

Request Utility Mark-Up Drawings:

Letter #5 in the Utility Communication Plan requests utility Mark-Up Drawings from the Utility Providers. The Environmental Assessment Base Plan should be forwarded with the letter. This letter should be prepared and sent to Utility Providers by the Project Utility Coordinator.

Obtain Utility Providers' Mark-Up Drawings:

Letter #6 in the Utility Communication Plan is used to obtain the Utility Providers' Mark-Up Drawings. This letter should be prepared and sent to the Project Utility Coordinator by the Utility Provider.

Schedule a 30% Detailed Design Utility Coordination Meeting:

Letter #7 in the Utility Communication Plan is used to schedule a 30% Detailed Design Utility Coordination Meeting. The'30% Detailed Design drawings and Utility

Conflict Matrix should be forwarded with this letter. This letter should be prepared and sent to Utility Providers by the Project Utility Coordinator.

Provide High-level Relocation Estimate and Construction Duration:

Letter #8 in the Utility Communication Plan is used to provide a high-level relocation estimate and construction duration.

Schedule a 60% Detailed Design Utility Coordination Meeting:

Letter #9 in the Utility Communication Plan is used to schedule a 60% Detailed Design Utility Coordination Meeting. The 60% Detailed Design drawings and Utility Conflict Matrix should be forwarded with this letter. This letter should be prepared and sent to Utility Providers by the Project Utility Coordinator.

Submit Utility Municipal Consent Application:

Letter #10 in the Utility Communication Plan is used to submit a Utility Municipal Consent Application. This letter should be prepared and sent to the Project Utility Coordinator by the Utility Provider.

Provide Utility Agency's Final Estimate:

Letter #11 in the Utility Communication Plan is used to provide the Utility Provider's final estimate. This letter should be prepared and sent to the Project Utility Coordinator by the Utility Provider.

Provide Municipal Consent Approval:

Letter #12 in the Utility Communication Plan is used to provide Municipal Consent Approval from the Ontario Municipality's Corridor Control Section. This letter should be prepared and sent to Utility Providers by the Ontario Municipality.

Issue Purchase Order:

Letter #13 in the Utility Communication Plan is used to issue a Purchase Order to the Utility Providers. This letter should be prepared and sent to Utility Providers by the Project Utility Coordinator.'

Initiate Defined Design Stage:

1. Procure a Detailed Design consultant to develop the Project's design.

2. Ensure the Detailed Design Request for Proposal (RFP) outlines the Utility Coordination duties of the Detailed Design consultant.

3. Assign a Project Utility Coordinator to oversee Utility Coordination tasks, who may be a Utility Coordination specialist on complex Projects.

Manage Utility Coordination:

1. Ensure the Detailed Design consultant and Utility Providers complete their respective Utility Coordination tasks at the correct time during the Detailed Design process.

2. Complete any Utility Coordination tasks that are beyond the scope of the Detailed Design consultant's RFP.

Requirements for identifying Existing Utilities in the Project Limits:

- Implement a QL-B SUE investigation to gain greater certainty of the location of existing utilities within the Project limits.

- Complete test holes (QL-A) in key areas to aid in the development of the detailed design.

- Prepare and send Letter #5 to Utility Providers, requesting Mark-Up Drawings and detailed design commencement notification.

- Receive Mark-Up Drawings and update utility Information on the Project's Base Plan using additional SUE investigation Information.

Requirements for implementing a SUE Investigation:

1. Perform an ASCE 38-02 QL-B SUE investigation prior to selecting QL-A (test pits) locations.

2. Select QL-A locations only at critical areas that would help identify utility conflicts with the Project design and are necessary for the Project's detailed design.

3. Having greater certainty of the horizontal location of existing underground Infrastructure is fundamental in determining critical QL-A locations for the Project.

Requirements for New Installation / Betterments:

1. Identify new third-party utility installation/Betterments requirements during the Defined Design Stage.

2. Obtain Municipal Consent Approval of proposed installation(s) in accordance with Section 5.14.

Coordinate a Utility Risk Assessment Workshop between the Ontario Municipality design team and the Utility Providers after updating and mapping the existing underground and above ground Utility Infrastructure.

- Note that the deliverable from the Utility Risk Assessment workshop is a Utility Risk Assessment Matrix (See **Appendix S**: Sample Utility Risk Assessment Matrix).

If an Environmental Assessment Utility Risk Assessment Matrix has not been completed, follow the outline below:

1. Inform the Utility Providers of the scope of the Detailed Design Project.

2. Identify high-risk Utility Infrastructure within the Project limits, including details of the Infrastructure (e.g., twenty duct concrete structure, vital gas mains, electrical towers, fibre cables, etc.).

3. Identify high-level long duration utility relocations.

4. Obtain high-level cost estimates on the high-risk potential utility relocations.

5. Identify land needs for utility relocations, if possible.

The following are required actions to update the Environmental Assessment Utility Risk Assessment Matrix if completed in the Briefing Concept Stage.

Identify Utility Conflicts:

Identifying utility conflicts in Ontario Municipality is not always a simple task as there could be several design and construction Elements that can result in a conflict.

Typically, there are two types of utility conflicts: a physical conflict and a constructability conflict.

Identify Physical Conflicts:

When identifying physical conflicts, the Utility Coordinator must look at existing conditions, proposed temporary designs and proposed ultimate design for both underground and aboveground Infrastructure. A physical conflict is when an existing utility location is vertically or horizontally in conflict with the Project design or another utility relocation or the existing utility location encroaches into the minimum clearance zones.

Examples of Physical Conflicts:

An example of a horizontal utility conflict is when an existing underground telecommunications cable resides in the boulevard but will be located under the pavement in the Project road widening design. A vertical conflict is when a Project design Element impacts an existing utility vertically.

Determine Mitigation Strategy:

All potential utility conflicts are then given a mitigation strategy. The following are types of mitigation strategies: further investigation (i.e., SUE QL-A) required to verify the conflict, Project redesign to eliminate the conflict, implement utility protection, accept substandard condition, or relocate utility.

Track Utility Information:

The utility Information (i.e., utility Owner, utility size, material type), location (sta. to sta.), and utility conflict mitigation strategy is tracked in the Project's Utility Conflict Matrix. It is the responsibility of the Project Utility Coordinator in consultation with the Ontario Municipality design team, Detailed Design consultant and Utility Provider to identify all potential conflicts and their mitigations strategies. The Project Utility Coordinator is also responsible for the preparation and updating of the Utility Conflict Matrix.

Identify Constructability Conflicts:

A constructability utility conflict is when an existing utility is not physically in conflict, but its location prevents an aspect of the road construction to occur. Expertise and experience in road construction is needed to identify these potential utility conflicts.

- An example of a typical constructability utility conflict occurs when aerial electrical components are not physically in conflict with the proposed bridge, but the equipment required to deliver the proposed work encroaches within the regulated clear zone.

Required steps to create a Utility Conflict Matrix:

1. Identify all potential utility conflicts and their mitigation strategies
2. Track utility Information, location, and mitigation strategy in the Utility Conflict Matrix
3. Identify all potential utility conflicts and their mitigation strategies.
4. Track utility Information, location, and mitigation strategy in the Utility Conflict Matrix.
5. Prepare and update the Utility Conflict Matrix as needed.

Required steps to hold a 30% Detailed Design Utility Coordination Meeting:

1. Update the Utility Conflict Matrix based on the 30% Detailed Design Stage design.
2. Prepare and send Letter #7, 30% Detailed Design drawings, and Utility Conflict Matrix to impacted Utility Providers.
3. Co-ordinate additional SUE QL-A investigation based on decisions made at the meeting.
4. Update the 30% Detailed Design with new SUE Information.

Required steps to prepare a Composite Utility Plan:

1. Prepare a living document plan containing existing and proposed utilities and the most recent detailed design.
2. Update the Composite Utility Plan with new SUE Information, approved proposed utility design, and “As-Built” utility installation Information.
3. Share the Composite Utility Plan with Utility Providers to ensure they have the most recent Project Information.

Required steps to estimate Utility Relocation Costs and Durations:

1. Request high level relocation cost estimate and construction duration from Utility Providers.
2. Update the Project utility relocation budget based on the cost estimate.
3. Complete the Ontario Standard Utility Relocation Estimate Form based on the Utility Provider’s estimate.
4. Understand utility relocation design and construction dependencies, including predecessors and duration for each task in the schedule

5. Include utility relocation phasing if any

6. Complete Enabling Works, such as tree removals or fence removals, to enable utility relocation construction to commence

7. Update the Composite Utility Plan and Utility Conflict Matrix based on the 60% Detailed Design milestone

8. Prepare and send Letter #9, 60% Detailed Design drawings, and Utility Conflict Matrix to impacted Utility Providers at least 2 to 3 weeks prior to the 60% Detailed Design Utility Coordination meeting

9. Co-ordinate additional SUE QL-A investigation based on decisions made at the meeting

10. Prepare utility agency requested cross sections/profiles to determine electrical relocation scope and design proposed electricity and/or utility poles

11. Finalize utility relocation scope for each agency using SUE Information and cut/fill Information

12. Update the Utility Conflict Matrix to reflect finalized relocation scope and prepare a Utility Relocation Matrix to track identified utility relocations

Prepare a high-level Utility Coordination Schedule using the Utility Conflict Matrix and relocation durations received from Utility Providers.

Understand utility relocation design and construction dependencies, including predecessors and duration for each task in the schedule.

- Include utility relocation phasing, if any.

Complete Enabling Works, such as tree removals or fence removals, to enable utility relocation construction to commence.

Update the Composite Utility Plan and Utility Conflict Matrix based on the 60% Detailed Design milestone.

Prepare and send Letter #9, 60% Detailed Design drawings, and Utility Conflict Matrix to impacted Utility Providers at least 2 to 3 weeks prior to the 60% Detailed Design Utility Coordination meeting.

Co-ordinate additional SUE QL-A investigation based on decisions made at the meeting.

Prepare Utility Provider requested cross sections/profiles to determine electrical relocation scope and design proposed electrical and/or utility poles.

Finalize utility relocation scope for each agency using SUE Information and cut/fill Information.

Update the Utility Conflict Matrix to reflect finalized relocation scope and prepare a Utility Relocation Matrix to track identified utility relocations.

Forward SUE report, cross sections/profiles, cut/fill, and Utility Relocation Matrix to Utility Providers.

Requirements for updating the Composite Utility Plan (Composite Utility Plan):

1. In consultation with the Project Utility Coordinator and Corridor Control Section, show proposed relocation alignments for each utility on the Composite Utility Plan.

2. Apply Ontario Municipality's standard utility corridors whenever possible.

3. Update the Composite Utility Plan whenever an approved utility design is received within the Project limits.

4. Share the updated Composite Utility Plan with Utility Providers to ensure they have the most recent Project Information.

Requirements for designing Utility Relocation/New Installation:

1. Each Utility Provider prepares an initial relocation design utilizing Project Information received.

2. Submit the initial relocation design to the Project Utility Coordinator within the negotiated timeframe.

3. The Project Utility Coordinator reviews the initial design and forwards comments to the Utility Provider.

4. The revise, resubmit, review, and comment process continues until a design is acceptable to the Utility Provider and Project design team.

5. It is highly recommended that Ontario Municipality's Corridor Control section also review each relocation design to obtain their comments.

6. Using the acceptable relocation design, the Utility Provider prepares and submits a Municipal Consent application to Ontario Municipality's Corridor Control section.

7. The revise, resubmit, review, and comment process continues until the Municipal Consent design is acceptable.

8. The Utility Provider prepares a final relocation cost estimate that reflects the cost-sharing

formula determined among Project Proponents for each respective Utility Provider.

9. The estimate should contain scope of relocation work, betterment works, and total cost breakdown.

10. It is important that the scope of relocation work be prescriptive enough for the Project Utility Coordinator to justify the estimate.

Requirements for accelerating Utility Relocation Process:

1. Inform Utility Provider of Ontario Municipality's intent to accelerate utility relocation design early in Detailed Design process.

2. Complete specific Project design Elements to proceed with early start utility relocation design (aka Enhanced Design).

3. Consult with Utility Providers to identify key Project design Elements required for Enhanced Design to limit risks such as repetitive relocations and compromised streetscaping Elements.

Requirements for noting Utility Relocation Construction Dependencies:

1. Ensure dependencies are in place prior to Utility Provider commencing relocation construction.

2. Examples of dependencies include Ontario Municipality Municipal Consent, Purchase Order, Road Occupancy Permit, Early Works, and various permits and contractual obligations.

Requirements for updating Utility Coordination Schedule:

1. Project Utility Coordinator updates high-level Utility Coordination Schedule prepared at 30% Detailed Design.

2. Schedule tracks each Utility Coordination construction dependency for the Project and is critical to identifying critical path tasks and impacts on Project's tendering process.

Requirements for preparing Utility Coordination Plan:

1. Project Utility Coordinator prepares Utility Coordination Plan utilizing Utility Relocation Schedule.

2. Utility Coordination Plan displays location, sequence, and timing of utility relocation to manage Project's constructor issues.

8.7.3 Asset Management Deliverables Checklist

The Asset Management Deliverables is a Defined Design Stage Gate to the Build and Handover Stage. Delivery Partners must complete requirements below:

1. Complete audit review checklists
2. Complete Responsive Digital Engineering (30%, 60%, 90%) review notes and feedback
3. Report Digital Engineering progress
4. Confirm Task Information Delivery Plans and Master Information Delivery Plan
5. Handover of Planning Stage Exchange Information Requirements
6. Receipt, and assurance of Planning Stage Exchange Information Requirements
7. Development and handover of Design Stage Exchange Information Requirements, engineering drawings, cost estimate, Project schedule, CAD and GIS Deliverables, Data, and schedules

Figure(s)

Yes☒ No☐

- Figure 8.7.1: Not referenced ➔ Visually present Surface Geophysical Methods for Utility Imaging
- Figure 8.7.2: Not referenced ➔ Visually represent Three-Dimensional Utility Methods
- Figure 8.7.3: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy

References

- The development of Organization Information Requirements that align to an Organizational Objective
    - York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
    - British Columbia – Utility Policy Manual
    - CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery

- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

Build and Handover Stage

8.2 Overview of Data Sharing and Utility Coordination during the Build and Handover Stage

Outcome(s)

Establish overview of instructions for Data Sharing and Utility Coordination during the Build and Handover Stage.

Considerations

This Section was informed by the British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices. This Section also utilized Centre for Digital Built Britain BIM and Digital Twin Reference Documents as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Content

8.8.1 Approach to the Build and Handover Stage

Delivery Partners must follow the approach to the Build and Handover Stage as described:

1. Ensure that the Information Management plan is implemented throughout t–e Build and Handover Stage.

2. Ensure that the Asset Management plan is implemented throughout the Build and Handover Stage.

3. Coordinate with Utility Providers and manage any potential conflicts or constraints.

4. Ensure that Data and Information are shared with Project Proponents as necessary throughout the Build and Handover Stage.

5. Develop Handover Material that includes all designs to "As-Constructed" or "As-Built" and transfer required Information from the Briefing Concept stage to the Build and Handover stage of the Project to the Asset Information Model.

Figure(s)

Yes☒ No☐

- Figure 8.8.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy

- Summary of the actions associated with Phase 5 to 6 (Build and Commission and Handover and Closeout)

- Figure 8.8.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
  - Phase 3 to 4 Deliverables Checklist (Build and Commission and Handover and Closeout)

References

- York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

8.9 RACI for Delivery Partners in the Build and Handover Stage

Outcome(s)

Identify who is Responsible, Accountable, Consulted, and Informed (RACI) for each Delivery Partner as it relates to the Build and Handover Stage.

Considerations

Based on Reference Documents and technical expert advice, it is recommended that the Manual explicitly defines the role of Delivery Partners to improve communication, accountability, and efficiency within an Organization and Project Team.

In this Manual, the definition and purpose of a RACI Matrix is repeated in every section where a RACI is mentioned assuming that Delivery Partners may only engage with sections that is relevant to them and not the entire content of the Manual.

Finally, note that RACI Matrices currently in bullet-list form will be visually represented as an actual matrix for v1.0 of the Manual.

Content

8.9.1 RACI Matrix Defined

Refer to Section 5.2.

8.9.2 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.10.

8.9.3 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.10.

Figure(s)

Yes☐ No☒

References

N/A

8.10 Application of Existing Standards in the Build and Handover Stage

Outcome(s)

Identify and address the key standards for Data Sharing and Utility Coordination in the Briefing Concept stage.

Considerations

This Section was informed by the British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices. This Section also utilized Centre for Digital Built Britain BIM and Digital Twin Reference Documents as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Content

8.10.1 Requirements for Effective Data Management and Maintenance

This section of the Manual illustrates the requirements for Effective Data Management and Maintenance. Delivery Partners must adhere to key standards (e.g., ISO 19650 and BS EN ISO 1192-4) during the Build and Handover Stage of Projects.

For requirements on effective Data Management and Maintenance, Delivery Partners must:

Perform key tasks during the Build and Handover Stage, including the following:

1. Model and Information federation and review
2. Seeking alignment with designers and engineers
3. Supply chain engagement
4. Daily site briefings coordinated through 3D model usage
5. Quality Control
6. Construction sequencing and scheduling
7. Cost management
8. Health and safety planning
9. Progressive Asset Information commissioning

10. Create specific formats and means for Data Sharing to ensure newly built Infrastructure Data can be ingested into the DTO AssetFlow Hub.

11. Prioritize expert guidance to determine the best place to start and share incomplete or progressing Data as an interim for the final Data product in specific circumstances and types of Data.

12. Identify safety-critical testing and commissioning workflows during Handover and Closeout stages and ensure that the Asset cannot go live and be accepted into use before workflows are certified as completed.

13. Log and review all commission Data against performance targets, complete end-user orientation and training, and familiarize Asset and Facilities Management with primary operating systems.

14. Update all construction Information and relevant design Information to "As-Constructed" or "As-Built" status.

15. Finalize all laser scanning surveys and Reality Capture surveys and associated Point Cloud Datasets linked with BIM, GIS, and CAD systems.

16. Align the "As-Built" model with the "As-Constructed" Asset, transfer relevant Exchange Information Requirements Information into the Asset Information Model, and store and/or archive the Exchange Information Requirements as required.

17. Review the Exchange Information Requirements and finalize delivery and handover of Data and Information in line with the Asset Information Requirements and complete the Project in line with Exchange Information Requirements and Digital Engineering Execution Plan.

Finally, note that training and education materials will be provided for Delivery Partners to ensure effective implementation of Manual standards.

8.10.2 Requirements for Utility Coordination

This section of the Manual identifies the Utility Coordination requirements and steps in the Build and Handover Stage.

8.10.2.1 Integrated Requirements from the TAC Guidelines for Utility Relocations

The following section outlines requirements for Utility Coordination, specifically on TAC Guidelines for Utility Relocations.

Requirements for Utility Relocations during the Build and Handover Stage:

1. Ensure a Utility Coordinator is assigned or maintains assignment from previous Project Stages, at the start of the Build and Handover Stage.
2. Track the schedule of utility relocations in the field during the "Prior to Construction" timeline.
3. Communicate any schedule slippage to the design team, Appointing Party, and affected Utility Providers.
4. Collaborate with Utility Providers and Project contractor during the "During Construction" timeline to ensure time and Space are available for relocation work.
5. Notify Utility Coordinator upon completion of utility relocations.
6. Provide "As-Built" drawings and invoices to Utility Coordinator.

Requirements for reconciling Utility Relocation finances during the Post-Build and Handover Stage:

1. Review and recommend payment of all invoices to Project Owner.
2. Resolve invoicing discrepancies or concerns.
3. Review and accept CSA S250 quality "As-Built" utility drawings.
4. Manage any Project contractor delay claims caused by negligent Utility Agency.
5. Retain "As-Built" utility drawings in comprehensive record storage.
6. Consider GIS mapping, including GPS (sub-hectometer with X, Y, and Z), as a Leading Practice[43].

8.10.2.2 Integrated Requirements from the York Region Utility Coordination Manual

Requirements for tracking Utility Relocation Construction Tasks:

1. Ensure all dependencies are in place before commencing construction of utility relocations.
2. Monitor and control the construction of utility relocations.
3. Track all tasks, communicate delay impacts, and adhere to all processes.

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43 In GIS, the accuracy of the GPS sub-hectometer with X, Y, and Z is used to improve the quality of spatial Data and increase the prevision of spatial analysis.

GPS sub-hectometer with X, Y, and Z refers to a highly accurate GPS positioning system that can provide location Data with sub-meter accuracy in three dimensions: latitude (X), longitude (Y), and altitude (Z). This can be achieved using Real-Time Kinematic (RTK) or Post-Processed Kinematic (PPK) techniques.

Requirements for arranging Pre-Construction Meeting:

1. Arrange a pre-construction meeting with Utility Provider and Municipality representatives.
2. Review, discuss and finalize the proposed Utility Coordination Plan outlining the sequence and timing of utility relocations.
3. Discuss status of dependencies required to commence construction.
4. Communicate process to handle scope changes.
5. Keep a written record of decisions and action steps.
6. Exchange 24-hour emergency contacts.

Requirements for holding Utility Construction Progress Meetings:

1. Hold Utility Construction Progress meetings to monitor progress on complex Projects with significant utility involvement.
2. Call meetings as needed.
3. Decide best course of action based on Project needs.

Requirements for developing a Utility Coordination Plan:

1. Develop a Utility Coordination Plan with the Road Authority and Utility Providers to complete utility relocations prior to Project construction.
2. Include sequencing of relocations and duration of utility relocations.
3. Monitor and update the Project Utility Coordinator on the field status of the utility relocations.
4. Notify Project Utility Coordinator once relocation is completed.
5. Determine strategy to manage existing illumination attachments on existing electricity and/or utility poles.
6. Relocate all utilities to permanent location.

Requirements for relocating Utilities during or after Project Construction:

1. Relocate utilities during Project Build and Handover Stage if necessary.
2. Ensure Project's tender documents reflect this situation and allow for time or Space for relocation.

3. Communicate between road contractor, Project Utility Coordinator and Utility Provider.

4. Notify Utility Provider when Project construction is complete, and site is available for their relocation to commence.

Requirements for coordinating with electricity Utility Provider and Utility Pole Owner for Utility Work during Project Construction:

1. Obtain a new electrical service connection from the electricity company for the installation of new traffic signals and illumination.

2. Obtain a Joint Use Permit or approval from the Utility Pole Owner when attaching traffic signal and/or illumination components to an electricity and/or utility pole.

3. Mitigate minimum clearance deviations from energized power lines by re- designing the temporary traffic signals, installing taller poles, or obtaining a temporary deviation from the Utility Provider.

Requirements for Quality Assurance/Quality Control for Utility Relocation:

1. Develop Quality Assurance processes in conjunction with each Utility Provider to ensure the quality of the utility relocation product, including documentation control, installation tolerances, testing types and frequency, and installation/construction Methodology.

2. Document the Quality Assurance processes and ensure their implementation.

3. Perform inspection, documentation, and testing as the main Quality Control activities for utility relocation.

4. Address quality issues discovered during inspection immediately and resolve them while construction is still in progress.

5. Test materials used in the utility relocation, with the Utility Provider being primarily responsible, but with Ontario Municipality also performing testing to verify any concerns.

Requirements for unknown field conflict resolution:

1. Communicate any unknown conflicts encountered in the field to the Ontario Municipality Corridor Control Utilities Technologist immediately.

2. The Corridor Control Utilities Technologist, in consultation with the Project Utility Coordinator and impacted Utility Providers, leads the implementation of the utility field conflict resolution process.

3. Keep written records of all decisions made during the resolution process.

4. Review and communicate any delays to the relocation schedule due to the unknown field conflict to the Project Manager.

5. Work with the Utility Provider to mitigate any delay to the utility relocation schedule, such as by providing additional crews or working overtime.

Requirements for scope change process:

1. Alter scope only with written agreement from Utility Provider and keep records of signed scope changes.

2. Resubmit utility plans for approval if significant scope changes occur.

3. Follow Ontario Municipality Corridor Control Section's requirements for "As-Built" plans.

Requirements for Post Build and Handover Stage:

1. Project Manager oversees the tasks within this section.

2. Project Manager co-ordinates processing of invoices for privately owned utilities and some municipally owned utilities.

3. For reimbursement agreements, Project Manager reconciles all utility relocation invoices received from Utility Providers and verifies invoices fall within agreed scope change.

4. Utility agency must notify Project Utility Coordinator in writing and provide cost estimate for additional work before performing work beyond agreed scope.

5. Utility Providers submit itemized invoices for actual cost of relocation with justification documentation if required.

6. Utility Coordination Team reviews and recommends payment for invoices based on cost apportionment defined in agreements and/or legislation.

7. Betterments not required by the Project are cost apportioned between Project Team and Utility Provider.

8. Exceptions to general betterment rule include those required by law or regulation, equivalent replacements, and those required by current design practices with direct benefit to the Project.

9. Project Utility Coordinator determines overall scope of betterment and verifies Utility Provider's calculation.

Requirements for preparing and submitting "As-Built" plans of relocated

Infrastructure to Ontario Municipality Corridor Control Section.

1. Ensure "As-Built" plans meet minimum requirements specified in Ontario
2. Municipality/Utility Provider agreements.
3. Resolve any discrepancies with "As-Built" plans between Project Utility –
4. Coordinator and Utility Provider.
5. Provide acceptable "As-Built" plans to Project Utility Coordinator before final invoice payment.
6. Receive final utility relocation payment when Project Utility Coordinator's
7. recommendation and "As-Built" plans are received.
8. Hold utility relocation meetings to coordinate relocation efforts.
9. Implement Quality Assurance/Quality Control measures to ensure accuracy of relocated Infrastructure.
10. Resolve unknown field conflicts as they arise.
11. Manage scope changes as needed.
12. Manage invoicing and payments related to utility relocations.

8.10.2.3 Integrated Requirements from CSA S25020 Mapping of Underground Utility Infrastructure

Delivery Partners are required to use the CSA S25020 Mapping of Underground Utility Infrastructure to measure and record the location of underground Utility Infrastructure.

Provide Mapping Records in Accordance with Chapter 6 and 7 of the CSA S25020:

1. Collect field records contemporaneously during construction to support mapping of underground Utility Infrastructure
2. Define type and format of field records collected
3. Create "As-Built" drawing in a timely manner using field records and Data collected during construction

4. Collect field records contemporaneously during construction to support mapping of underground Utility Infrastructure.

5. Define type and format of field records collected.

6. Create "As-Built" drawing in a timely manner using field records and Data collected during construction.

7. Use photographs and video recordings taken during construction as supplemental records to support mapping of underground Utility Infrastructure.

Apply Clause 5 to Newly Installed and Exposed Underground Utility Infrastructure:

1. Provide reliable and accurate Information on underground Utility Infrastructure records at time of construction and when exposed during subsequent excavation for maintenance or modification purposes, daylighting, or subsurface underground Utility Infrastructure mapping investigation.

2. Provide reliable and accurate Information on underground Utility Infrastructure records at time of construction and when exposed during subsequent excavation for maintenance or modification purposes, daylighting, or subsurface underground Utility Infrastructure mapping investigation.

3. Recognize that the most reliable way to accurately identify and record location of underground Utility Infrastructure is to do so while it is exposed and available for direct visual inspection and measurement.

Note that there will be a degree of uncertainty as to identity and exact location of underground Utility Infrastructure hidden beneath the surface and not exposed.

1. Note that there will be a degree of uncertainty as to identity and exact location of underground Utility Infrastructure hidden beneath the surface and not exposed.

2. Do not apply these requirements retroactively to existing installations by requiring Owner to initiate independent locating activities to update prior records.

Measure and Record Intervals:

1. Ensure that distances between interval measurements are no more than 50 m, even in straight positions and/or locations.

2. Place intervals closer together for positions and/or locations where the underground Utility Infrastructure bends or changes direction.

3. Adjust intervals further apart for straight positions and/or locations.

Measure and Record Underground Utility Infrastructure:

1. Measure and record the horizontal and vertical location and attributes of the underground Utility Infrastructure when it is constructed or visible and capable of measurement.

2. Follow Clause 5.5 and Clause 6 of the CSA 25020 for measurement and recording standards.

3. Do not expose legacy underground Utility Infrastructure solely for the purpose of meeting the requirements of this Standard or to measure and record the horizontal and vertical location and attributes of its legacy underground Utility Infrastructure that has already been measured and recorded in accordance with this Standard, or in respect of which the Owner is satisfied that its current records accurately depict the actual location and description of that underground Utility Infrastructure.

Derive Absolute Geodetic Positions[44]:

1. Use absolute geodetic positions for Data exchange purposes, although relative positioning is useful for some purposes.

Ensure Accuracy of "As-Built" Records:

1. Measure and record precise horizontal and vertical locations of underground utilities while exposed to an accepted geodetic datum with a 95% confidence level by a competent individual.

2. Specify the spatial accuracy of the Data as per Table 1 when creating "As- Built" records.

Make Corrections to Mapping Records and provide updated/corrected mapping records within 30 days (or within the period of time agreed upon by all Parties) after being informed of the discrepancy:

1. Make all location or description changes resulting from operations and maintenance activities to the mapping record.

2. Report any significant discrepancy discovered during construction, excavation, SUE activities, daylighting, locating, or otherwise to the Owner and/or the source of the record in a timely manner.

3. When reporting a discrepancy, provide the name and contact Information of the originator of

44 Precise measurements of the Earth's surface that are referenced to a global coordinate system, such as the World Geodetic System (WGS84).

the report, location of discrepancy (either address or reference points, tracking number), and date and detailed description of the discrepancy (may include a sketch) to the Owner and/or the source of the record for the updating of the mapping records systems.

Positional Accuracy of As-Built Records[45]

See Clause 5.5 and 5.6.2, Table 2, and Figure 2 to 6 from the CSA S250:20 Mapping of Underground Utility Infrastructure.

Accuracy Level	Description	Reference
1	The measurements shall be taken and tied into an absolute reference as described in Clause 5.3, and that reference system shall be stated on the drawing. The position shall be accurate to +/- 25mm in the x, y, and z coordinates.	Absolute
2	The measurements shall be taken and tied into an absolute reference as described in Clause 5.3, and that reference system shall be stated on the drawing. The position shall be accurate to +/- 100mm in the x, y, and z coordinates.	Absolute
3	The measurements shall be taken and tied into either a relative feature as described in Clause 5.4 or geodetic datum as described in Clause 5.3, and such features referenced on the drawing. The position shall be accurate to +/- 300mm in the x, y, and z coordinates.	Relative or Absolute
4	The measurements shall be taken and tied into either a relative feature as described in Clause–5.4 or geodetic datum as described in Clause 5.3, and such features referenced on the drawing. The position shall be accurate to +/- 1000mm in the x, y, and z coordinates.	Relative or Absolute

Note: Where the accuracy levels of all the x,y, and z coordinates are not the same, the accuracy level to be ascribed to the Infrastructure shall be determined by the least accurate coordinate.

8.10.3 Asset Management Deliverables Checklist

Delivery Partners must complete the following Asset Management Deliverables checklist before moving on to the next Project Stage:

45 Table contents directly from CSA S250:20 Mapping of Underground Utility Infrastructure.

1. Complete an Asset Management Deliverables checklist before moving on to the next stage of the Project
2. Create a lesson learned report for the Assets Manager
3. Gather feedback from Appointed Parties
4. Provide updated Digital Engineering reporting and progress updates
5. Create a final Asset Information Model and final Exchange Information Requirements
6. Provide 360-degree Digital Engineering lessons learned feedback
7. Provide Digital Engineering lessons learned feedback to the supply chain

By following these instructions, Organizations can ensure that Data Sharing and Utility Coordination are managed effectively during the Build and Handover Stage of a Project.

Figure(s)

Yes☐ No☒

References

- York Region – Utility Coordination Manual: Major Capital Planning and
- Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

Operate and Maintain Stage

8.11 Overview of Data Sharing and Utility Coordination during the Operate and Maintain Stage

Outcome(s)

Establish overview of instructions for Data Sharing and Utility Coordination during the Operate and Maintain Stage.

Considerations

This Section was informed by the British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices. This Section also utilized Centre for Digital Built Britain BIM and Digital Twin Reference Documents as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Content

8.11.1 Approach to the Operate and Maintain Stage

Partners are required to follow the approach described in the Operate and Maintain Stage:

1. Maintain the Asset Information Model in line with Digital Asset Objectives set by the DTO.
2. Ensure that Data and Information are managed and shared in accordance with the Information Management plan.
3. Implement the Asset Management plan to ensure the ongoing maintenance and management of Project Assets.
4. Coordinate with Utility Providers and manage any potential conflicts or constraints.
5. Review and update the plans as necessary throughout the Operate and Maintain Stage to ensure that they remain aligned with Project Objectives and Project Proponent needs.

Figure(s)

Yes☒ No☐

- Figure 8.11.1: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Summary of the actions associated with Phase 7 (Operations and Maintenance)

- Figure 8.11.2: Referenced ➔ Office of Projects Victoria – Digital Asset Strategy
    - Phase 7 Deliverables Checklist (Operations and Maintenance)

References

- York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

8.12 RACI for Delivery Partners in the Operate and Maintain Stage

Outcome(s)

Identify who is Responsible, Accountable, Consulted, and Informed (RACI) for each Delivery Partner as it relates to the Operate and Maintain Stage.

Considerations

Based on Reference Documents and technical expert advice, it is recommended that the Manual explicitly defines the role of Delivery Partners to improve communication, accountability, and efficiency within an Organization and Project Team.

In this Manual, the definition and purpose of a RACI Matrix is repeated in every section where a RACI is mentioned assuming that Delivery Partners may only engage with sections that is relevant to them and not the entire content of the Manual.

Finally, note that RACI Matrices currently in bullet-list form will be visually represented as an actual matrix for v1.0 of the Manual.

Content

8.12.1 RACI Matrix Defined

Refer to Section 5.2.

8.12.1.1 RACI Matrix for Organizational Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.13.

8.12.1.2 RACI Matrix for Project Team Roles

Note: A subsequent version of the Manual will include a RACI Matrix informed by requirements found in Section 8.13.

Figure(s)

Yes☐ No☒

References

N/A

8.13 Application of Existing Standards in the Operate and Maintain Stage

Outcome(s)

Identify and address the key standards for Data Sharing and Utility Coordination in the Briefing Concept stage.

Considerations

This Section is informed by the British Columbia Utility Policy Manual and York Region Utility Coordination Manual to ensure Utility Coordination requirements are aligned with Canadian practices. This is also supported by the Centre for Digital Built Britain BIM and Digital Twin Reference Documents as well as Office of Projects Victoria Digital Asset Strategy to integrate Data Sharing practices into Project Stages.

Content

8.13.1 Requirements for Effective Data Management and Maintenance

Delivery Partners are required to:

1. Monitor Asset performance and condition in real-time.
2. Incorporate feedback and lessons learned to continuously improve operations.
3. Utilize Data analytics to optimize Asset performance and reduce costs.
4. Implement predictive maintenance strategies to minimize downtime.
5. Measure and record the location of underground Utility Infrastructure as-is according to CSA25020.

8.13.2 Requirements for Utility Coordination

Delivery Partners are required to establish clear communication channels for Utility Coordination and Data Sharing in operations and maintenance by enacting the following:

1. Develop a comprehensive utility management plan.
2. Identify and prioritizing critical utility Assets for maintenance and management.
3. Implement Data Sharing protocols for efficient and effective Information exchange.
4. Utilize BIM and Digital Twins to visualize and manage utility Assets and systems.
5. Conduct proper documentation and record-keeping of utility Data.

6. Monitor and update regularly utility Information to reflect changes and maintenance needs.

8.13.2.1 Integrated Requirements from CSA S25020 Mapping of Underground Utility Infrastructure

Delivery Partners are required to:

Arrange and retrieve source records:

- The Owner must arrange and be able to retrieve and use source records that support the Data contained in a records management system.

Preserve and retain source records:

- The Owner must ensure that source records are preserved and retained for as long as required for legal, business, or regulatory requirements.

Monitor and audit records management system:

- The Owner must monitor and audit the mapping records management system to ensure compliance with policies, practices, processes, and procedures.
- The Owner should review and modify program Elements to satisfy any non- conformances in a timely manner.
- External monitoring and auditing may be required by the regulatory environment.

Continual improvement:

- The Owner should follow the continual improvement framework cycle of plan, do, check, and act by identifying and evaluating opportunities for improving the effectiveness, efficiency, or quality of its processes.

Implement risk mitigation measures for disaster recovery:

1. The Owner must ensure that the mapping records management system identifies records and systems critical to the functioning of its underground Utility Infrastructure.
2. Appropriate risk mitigation measures should be implemented for the recovery of mapping records systems and Data in a timely fashion.

Plan for mapping Data collection during construction:

1. The construction process should be planned and conducted to facilitate the collection of mapping Data while the underground Utility Infrastructure remains exposed.

Follow accuracy and feature content requirements for mapping records during operation and maintenance:

1. The construction process should be planned and conducted to facilitate the collection of mapping Data while the underground Utility Infrastructure remains exposed.

2. Mapping records collected during the ongoing operation and maintenance of the underground Utility Infrastructure should follow Clause 5 for accuracy and Clause 6 for feature content.

3. Measure and record the location of underground Utility Infrastructures.

Provide mapping records upon request:

1. The Owner should provide mapping records of proposed, in-service, out- of-service, and abandoned underground Utility Infrastructure, as required.

2. The frequency of updates to shared Data shall be determined by the Owner and the user of the Data.

3. Upon receiving a request for underground Utility Infrastructure Data, the Owner shall respond in a timely fashion and provide copies of available mapping records (in any format) if "As-Built" drawings have not been prepared as permanent records.

8.13.2 Asset Management Deliverables Checklist

Delivery Partners are required to complete the following Asset Management Deliverables checklist for the Operate and Maintain Stage, due within the first quarter of the Project at this Stage, and updates performed quarterly. This checklist includes:

1. An executive Project report including challenges and opportunities.

2. Ongoing feedback and engagement with DTO Operations Team.

3. New systems, tools, integrations defined and budgeted.

4. Updated Data and Asset Information as needed.

5. Asset Information Management updates, training, upskilling, mentoring, and support.

6. Reporting to the Assets Manager on Project progress and challenges.

Figure(s)

Yes☐ No☒

References

- York Region – Utility Coordination Manual: Major Capital Planning and
- Delivery Roads Projects
- British Columbia – Utility Policy Manual
- CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery
- Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data
- Office of Projects Victoria – Digital Asset Strategy
- Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects

9. Conclusion and Next Steps

9.0 Section Objective

The Manual provides a summary of the key points discussed for each of the Delivery Partners. This Information is intended to be a helpful reference for Delivery Partners and can be used to guide decision-making throughout the Project.

As innovative technologies and Leading Practice emerge, the Manual will be updated to reflect these changes. This ensures that the Manual remains relevant and up-to-date, and that Delivery Partners have access to the most current Information available.

This section outlines where Delivery Partners can go to find more detailed Information on specific topics, as well as additional resources that may be useful throughout the Project.

9.2 Key Takeaways

9.1.1 Summary of Section 1 Introduction

Delivery Partners must review the Introduction section of the Manual for important Information about the purpose and alignment of the Manual, as well as mandatory requirements and key roles for Delivery Partners.

Delivery Partners are advised to have a foundational understanding of Digital Twins, including key definitions, perceived barriers and challenges, and benefits for utilities Infrastructure productivity and decision-making.

Delivery Partners are reminded of the potential benefits of using Digital Twin Technology in their work.

Delivery Partners are advised to navigate the Manual carefully and refer to the reference documents provided to ensure they understand their roles and responsibilities.

9.1.2 Summary of Section 2 Designated Priority Projects

To effectively participate in Projects, Delivery Partners must:

- Understand that the authority to designate a priority Project lies with a Designating Authority.
- Review the specific features and requirements that must be met for a Project to be designated as a priority Project.

- Familiarize themselves with the requirements and expectations for participating in Projects.
- Communicate with the Designating Authority and other Project Proponents to ensure that all requirements and expectations are met.

9.1.3 Summary of Section 3 Legislation and Regulations

Delivery Partners should review the Legislation and Regulations section of the Manual carefully to understand the requirements for Data management.

Delivery Partners should apply Data standards, share Data, and synchronize Data storage to comply with regulations and legislation.

Delivery Partners should cooperate with enforcement mechanisms to ensure compliance with regulations and legislation.

Delivery Partners should assign cost and liabilities to appropriate parties to ensure accountability.

Delivery Partners should comply with regulations and legislation when working on Projects.

Delivery Partners should follow the guidelines provided in this section to ensure compliance and avoid potential consequences of non-compliance.

9.1.4 Summary of Section 4 Digital Twin Ontario

To ensure successful implementation of the DTO Framework in Ontario, Delivery Partners must follow these instructions:

- Understand the basis for the Manual, including the BSE Flex 260 Digital Twins requirements for the Built Environment, and the four Data management pillars for quality Digital Twins.
- Familiarize themselves with the Digital Asset strategy for improving Infrastructure productivity through the Digital Twin Ontario AssetFlow Hub.
- Refer to the training materials and templates available for Project Teams.
- Use this section of the Manual as a reference when considering pathways to implementing Digital Twin Technology in their work.

9.1.5 Summary of Section 5 Data Ingestion and Data Exploration

Delivery Partners should identify the required roles for Data Ingestion and exploration and ensure that these roles are appropriately assigned within their Organization.

Delivery Partners should follow the Iterative Cycle of sense/ingest, classify, refine, decide, and act/optimize when working with Data.

Delivery Partners should ensure that cost attribution is properly accounted for in Data Ingestion and exploration activities.

Delivery Partners should distinguish between UIE and BIM requirements and ensure that the appropriate standards are being followed.

Delivery Partners should house Data in a CDE to ensure accessibility and consistency.

Delivery Partners should understand the differences between Uniclass 2015 and IFC and use the appropriate classification standards based on Uniclass 2015.

Delivery Partners should utilize the RACI Matrix provided to ensure that Organizational roles and Designated Priority Project Teams are clearly defined.

Delivery Partners should consider practical applications for Reality Capture in Data Ingestion and exploration activities.

Delivery Partners should follow the requirements for Data Ingestion and exploration in Projects for BIM.

Delivery Partners should monitor key performance indicators for Data Ingestion and exploration to ensure progress towards Digital Twins in Projects.

9.1.6 Summary of Section 6 Data Sharing and Data Collaboration

The purpose of this section is to provide guidelines for effective Data Sharing and collaboration in Projects. Delivery Partners must adhere to the following:

1. Understand the purpose and definition of Data Sharing and collaboration.
2. Identify required roles, cost attribution, UIE, and BIM requirements, and intellectual property and ownership considerations.
3. Enforce clear guidelines and protocols for Data Sharing and collaboration.
4. Encourage open communication amongst Project Teams.
5. Implement appropriate security measures.
6. Use digital tools and platforms to improve efficiency.
7. Foster a culture of collaboration and trust.
8. Follow ASCE and CSA standards for recording and exchanging Utility Infrastructure Data.

9. Standardize modeling and documentation practices.

10. Identify key performance indicators for Data Sharing and collaboration towards Digital Twins in Projects.

11. Follow the DTO Data Sharing process.

12. Ensure Data Security and Confidentiality Compliance.

Delivery Partners should refer to this section of the Manual when planning and executing a Project to ensure that Data Sharing and collaboration are effectively managed throughout the Project's lifecycle.

9.1.7 Summary of Section 7 Integration of Building Information Modeling Standards and Processes in Projects and Digital Twin Ontario

The purpose of this section is to provide guidelines for effective integration of building Information Modeling (BIM) standards and processes in Projects and Digital Twin Ontario. Delivery Partners must adhere to the following:

- Understand that BIM can be integrated with Digital Twin Ontario to improve Project outcomes.
- Review the several processes for integrating BIM with Digital Twins, including Reality Capture, "As-Built" Modeling, site awareness and visualization, Clash Detection, Deviation Reporting, and Construction Verification.
- Consider using geospatial mapping systems to integrate BIM with Digital Twins.
- Invest in GIS to facilitate BIM integration if they are general contractors.
- Utilize tools such as photogrammetry and laser scanners to facilitate BIM integration in Projects and Digital Twins.

Delivery Partners should refer to this section of the Manual when planning and executing a Project to ensure that BIM integration is effectively managed throughout the Project's lifecycle.

9.1.8 Summary of Section 8 Data Sharing and Utility Coordination Requirements for Project Stages

The purpose of this section is to provide guidelines for effective Data Sharing and Utility Coordination through key stages of a Project. Delivery Partners must adhere to the following:

1. Identify the RACI for each stage of the Project, including roles and responsibilities for Data Sharing and Utility Coordination.

2. Apply existing standards for Data Sharing and Utility Coordination to ensure consistency and

efficiency throughout the Project's lifecycle.

3. To effectively coordinate Data Sharing and Utility Coordination, Delivery Partners must take the following actions during each stage of the Project:

4. During the Briefing Concept Stage, establish clear communication channels between all Project Proponents and identify any potential conflicts or issues related to Data Sharing and Utility Coordination.

5. During the Defined Design Stage, develop a comprehensive plan for Data Sharing and Utility Coordination, including timelines and responsibilities for each Project Proponent.

6. During the Build and Handover stage, ensure that all Project Proponents are aware of their responsibilities and that Data Sharing and Utility Coordination are monitored closely to prevent any delays or issues.

7. During the Operate and Maintain stage, continue to monitor Data Sharing and Utility Coordination to ensure that the Project operates smoothly and efficiently.

8. Delivery Partners should refer to this section of the Manual when planning and executing a Project to ensure that Data Sharing and Utility Coordination are effectively managed throughout the Project's lifecycle.

Figure(s)

Yes☐ No☒

References

N/A

9.2 Next Steps for the Manual in Ontario

9.2.1 Digital Twin Ontario Phases for the Manual

This Manual introduces Phase 0, also known as the "DTO Utility Manual Mock-up", which serves to socialize and gather feedback from Industry experts. This focus is on creating a preliminary version, v0.1 of Manual.

DTO is leveraging a two-phased approach for the development of the Manual, informed by a review of over forty-five combined Reference Documents and standards.

Phase 1, the "DTO Utility Manual," provides high-level instruction for Data Sharing and Utility Coordination that applies to all Delivery Partners involved in Projects.

Phase 2 will include developing "Utility-Specific Instructions," which focuses on developing specific versions of the Manual to instruct on a particular Utilities Infrastructure use case, such as water or gas, through the form of Bulletins.

9.2.2 Progress of BIM Standard

It is important to note that the Manual is based on the ISO 19650 series, which builds upon BIM Level 2 and incorporates global and future digital perspectives.

As Technology capabilities develop, the Manual will progress to adopt BIM Level 3, which focuses on integrating the entire Asset lifecycle from design and construction through to operation and maintenance.

While BIM Level 3 is not yet widely adopted, it is viewed as the future of BIM and is expected to become more prevalent as Technology and processes continue to evolve.

9.2.3 Progress of UIE Standard

To comply with UIE standards, it is important to refer to ASCE 38-22 and ASCE 75-22 as outlined in the Manual. It is important to note that as these standards and guidelines are updated, the terms used in the Manual will reflect changes in the next Update Cycle following the release of updates to the standards and guidelines.

Additionally, as 3D modeling of utilities becomes more prevalent and national and international standards are developed, the Manual will adopt 3D modeling standards for utilities as deemed appropriate for the Data needs of Projects.

9.2.4 Addition of Sustainability Practices and Procedures

Future iterations of the Manual may integrate sustainability practices and procedures as Ontario is expediting construction Projects by streamlining review processes and minimizing barriers, while ensuring robust environmental oversight. Simultaneously, the Province is taking substantial measures to reduce greenhouse gas emissions to meet the 2030 target and assist communities in preparing

for the impacts of climate change. For this Manual, sustainability practices may include further consultation and coordination with Indigenous communities, beyond what is currently set in the Manual.

Achieving Canada and Ontario's sustainability targets requires significant efforts from all sectors of the economy and will involve transitioning to cleaner energy sources, improving energy efficiency, and implementing innovative technologies such as BIM and Digital Twins.

In future, Digital Twins may be leveraged for resource optimization, lifecycle analysis, predictive maintenance, product design, and energy management; energy management being the initial focus in regard to sustainable practices for Projects.

9.2.5 Manual Update Cycle

It is important to note that the Manual undergoes a bi-annual review to ensure that all instructions are complete and up-to-date. If the review confirms the need for a revision or update, the current Update Cycle for the Manual will be adjusted to a yearly basis. Any changes to terminology, processes, or established requirements will prompt a revision or update to the Manual. It should be established that the Update Cycle for this content will be reconfirmed on a yearly basis as well.

9.2.6 Progress of Digital Twins in Ontario

To effectively implement a province-wide Digital Twin, the Manual recommends identifying key national roles that will be required. These roles will include benefits managers, cyber security specialists, Data regulators, Industry leaders, core DTO team[46], DTO Architects, Data and/or Digital Twins Subject Matter Experts, policy makers, and sector regulators.

By identifying these roles and their responsibilities, the Manual aims to provide guidance on the necessary personnel needed to drive the success of a Digital Twin initiative.

9.2.7 Contact for Additional Information and Support

To obtain further Information regarding the next steps outlined in the Manual, Delivery Partners may contact the DTO Support Team at: info@digitaltwinontario.ca.

Figure(s)

Yes☐ No☒

References

N/A

46 The core DTO team, as defined in the IO Report Back to the Province, includes the Overall Lead, Delivery Lead, Use Case Lead(s), Technology/Data Lead, Data Governance Lead, and Partnership Lead.

Reference Documents

36 Reference Documents were leveraged to inform the development of the Manual.

As a reminder, acronyms used to categorize Reference Documents are as follows: BIM = Building Information Modeling; DP = Data Policy; DS = Data Sharing; DTs = Digital Twins; IM = Information Management; and UC = Utility Coordination.

1. [Canada] Digital Twin Ontario Program Strategy: Report-Back to government (DTs, IM)
2. [Canada] Government of Canada – Canada's Digital Ambition 2022 (DP, DS)
3. [Canada] Government of Canada – Digital Standards: Playbook (DP, DS_
4. [Canada] Infrastructure Ontario – Building Broadband Faster in Ontario Guideline (DP, IM)
5. [Canada] Government of Ontario – Geographic Information System (GIS) for Ontario (DS)
6. [Canada] British Columbia Ministry of Transportation and Infrastructure – Utility Policy Manual (UC)
7. [Canada] Infrastructure Ontario – Proposed Delegation Regulation Under the Building Transit Faster Act, 2020 (DP)
8. [Canada] Ontario General Contractors Association (OGCA) – Guide to Construction and Design Technology (BIM)
9. [Canada] Transportation Association of Canada (TAC) – Using "The TAC Guideline for the Coordination of Utility Relocations" on Projects (UC)
10. [Canada] York Region – Utility Coordination Manual: Major Capital Planning and Delivery Roads Projects (Utility Coordinator)
11. [United States] Florida Department of Transportation – 2017 Utility Accommodation Manual (UC)
12. [United Kingdom] National Underground Asset Register (NUAR) – Data Distribution Agreement (DP)
13. [United Kingdom] NUAR – Data Ingestion Specification (DP)
14. [United Kingdom] British Standards Institution (BSI) Flex 260 – Built Environment: Digital Twins Overview and Principles (DS, DTs)

15. [United Kingdom] Centre for Digital Built Britain (CDBB) – UK BIM Framework + Guidance (BIM, DS, IM)

16. [United Kingdom] CDBB – The Pathway Towards an Information Management Framework (DS, IM)

17. [United Kingdom] CDBB – The Gemini Principles (DTs)

18. [United Kingdom] CDBB – Government Soft Landings (DS, IM)

19. [United Kingdom] CDBB – Digital Twin Journey Infographic (DTs)

20. [United Kingdom] West Cambridge – Data Ingestion + IM5.2.3: Infographic Support Document (DS)

21. [United Kingdom] Cambridge Centre for Smart Infrastructure & Construction (CSIC) – Line-of-Sight: An Asset Management Methodology to Support Organizational Objectives, Optimizing Asset Management Methodology to Realize Business Success (DS, IM)

22. [United Kingdom] Construction Innovation Hub – Smart Standards – An Approach to Implementing ISO 19650-2 Using Tasks in a Digital Process (BIM, DS, IM)

23. [United Kingdom] CDBB – Developing a Capability Enhancement Programme (DTs)

24. [United Kingdom] CDBB – Skills and Competency Framework (DTs, IM)

25. [United Kingdom] CDBB – New Energy and Carbon Reporting Framework 26.[United Kingdom] CDBB – Information Management According to BS EN

26. ISO 19650 – Guidance Part A: The Information Management Function and Resources (DS, IM)

27. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 – Guidance Part B: Open Data, BuildSMART and coBIE (BIM, DP, DS)

28. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 – Guidance Part C: Facilitating the CDE, Workflow and Technical Solutions (BIM, DS, IM)

29. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 – Guidance Part D: Developing Information Requirements (BIM, DP, DS)

30. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 – Guidance Part E: Tendering and Appointments (BIM, Data Sharing , IM)

31. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 –

Guidance Part F: Information Delivery Planning (BIM, Data Sharing , IM)

32. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 1: Concepts (BIM, DTs)

33. [United Kingdom] CDBB – Information Management According to BS EN ISO 19650 – Guidance Part 2: Processes for Project Delivery (BIM, DS)

34. [Australia] Office of Projects Victoria – Digital Asset Policy: Improving Infrastructure Productivity Through Data (DP, DS)

35. [Australia] Office of Projects Victoria – Digital Asset Strategy (DP, DS, DTs, IM)

36. [New Zealand] New Zealand Ministry of Business, Innovation & Employment – The New Zealand BIM Handbook, A Guide to Enabling BIM on Built Assets 2019 Third Edition (BIM)

Appendices

Note: Appendices will be developed and included in a subsequent version of the Manual.

Appendix A: Template for Organizational DTO Alignment Strategy

Template for Organizational DTO Alignment Strategy facilitates the exercise of identifying Organizational strengths, gaps, and goal setting to meet or exceed the Manual requirements. Considers the Organizations current Digital Asset level of maturity as compared to the Manual's vision for the Organization.

Appendix B: Pathways for Delivery Partners Navigating the Manual

Provides detailed diagrams for Delivery Partners to use as navigation through the Manual.

Appendix C: Summary Template Job Descriptions

Template job descriptions for Organizational Team and Project Team roles.

Appendix D: Organization Information Requirements Template

Organization Information Requirements document template.

Appendix E: Asset Information Requirements Template

Asset Information Requirements document template.

Appendix F: Sample Key Decision Points

Minimum required key decision points for required documents/Deliverables set out in the Manual.

Appendix G: DTO Data Dictionary

Dictionary for aligning Organizations on Data terminology and nomenclature for the DTO AssetFlow Hub.

Appendix H: Exchange Information Requirements Template

Exchange Information Requirements document template.

Appendix I: Digital Engineering Execution Plan Template

Digital Engineering Execution Plan document template.

Appendix J: RACI/Scope Checklist Template

RACI/Scope Checklist template adaptable for overall Project Stages or Project Tasks.

Appendix K: Digital Engineering Execution Response Template

Digital Engineering Execution Response document template.

Appendix L: Designated Priority Projects Example – Use Case in Water Utilities Services

Practical example of Project privileges demonstrated on a use case for water utilities services.

Appendix M: Asset Classification Standard

Eleven tables for Asset Classification standards referenced from ISO 12006-2:2015 Building Construction – Organization of Information about Construction Works.

These tables include:

1. Co – Complexes
2. En – Entities

3. SL – Spaces/Locations
4. EF – Elements/Functions
5. Ss – Systems
6. Pr – Products
7. Ac – Activities
8. FI – Form of Information
9. PM – Project Management
10. TE – Tools and Equipment
11. Zz – CAD

Appendix N: NUAR Data Exploration Agreement V1.0 – Modified for Ontario

Adapted NUAR – Appendix B – Data Exploration Agreement template for Delivery Partners Data Exploration Agreement for Projects.

Appendix O: NUAR Data Distribution Agreement V1.0 – Modified for Ontario

Adapted NUAR Data Distribution Agreement v1.2 for Delivery Partner Data Distribution Agreement for Projects.

Appendix P: BIM Preparedness Assessment for Tenders

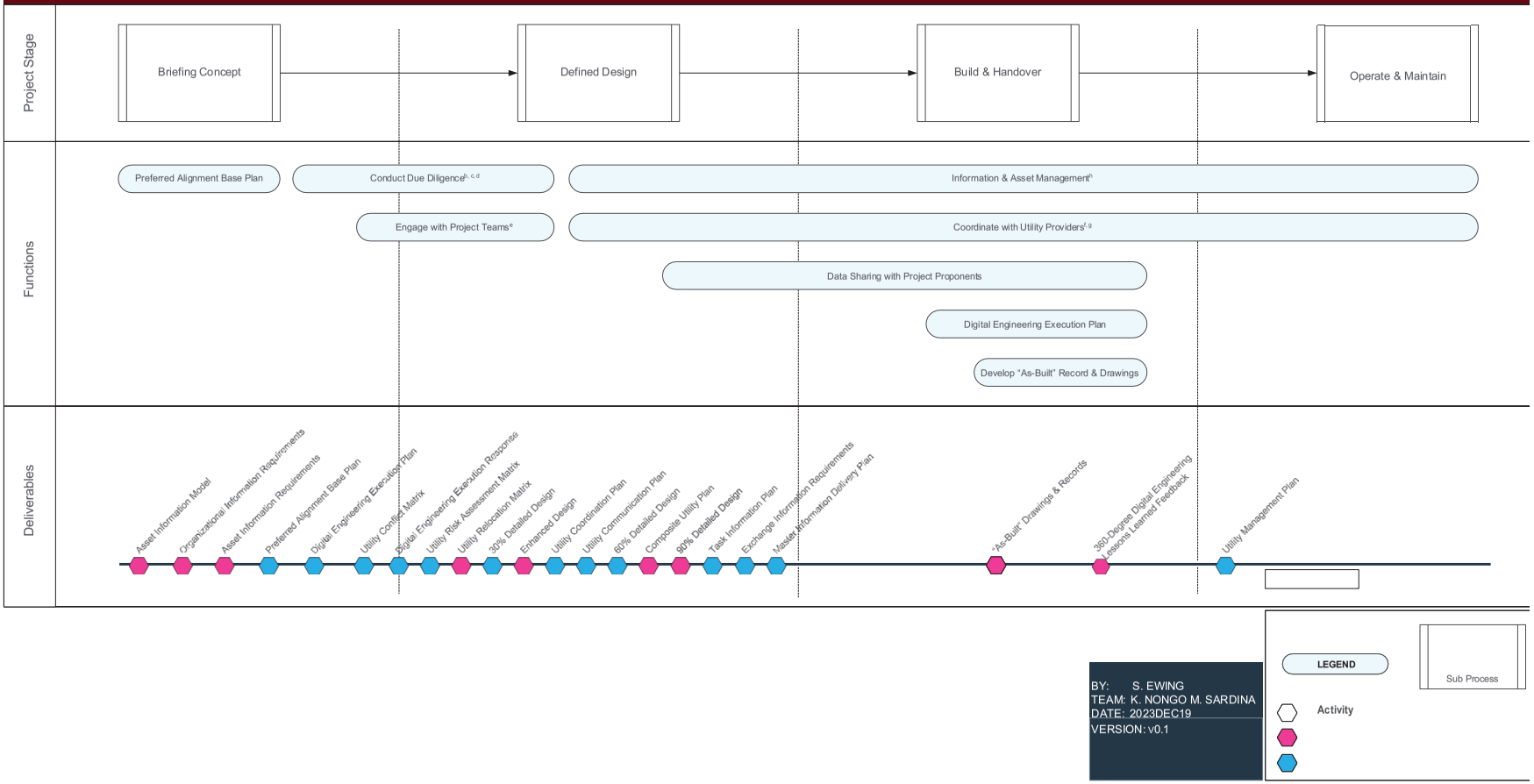
Assess the system/digital preparedness of a Party for BIM production, process, and management.

Appendix Q: Digital Twin Ontario (DTO): End-to-End Project Stages – Level One – Project Stages Overview

Level One (i.e., high-level overview) Process Map for the Project Stages providing an end-to-end overview of the Project Stages, key functions throughout the Stages, and a summary of required Deliverables.

Digital Twin Ontario (DTO): End-to-End Project Stages

Level One – Project Stages Overview[a]



Footnotes

a. The DTO Act provides DTO with Administrative Authority to update existing regulations, create new regulations, administer the AssetFlow Hub, and leverage enforcement tools to mandate adherence to the Manual.
b. Legislation to notify other Infrastructure Owners when a subsurface utility has been located during excavation.
c. Legislation requires Infrastructure Owners to create a Digital Asset as per standards in the Manual, upon notification by an Appointing Party that a Subsurface Utilities Infrastructure has been located.
d. Legislation mandates that Infrastructure Owners provide a Digital Asset to an Appointing Party acting as the Project Proponent through the DTO AssetFlow Hub within the time period mandated for a Locate Request.
e. DTO Act requires Infrastructure Owners to hold a minimum level of insurance in the event of an accident on a Project.

Appendix R: Letter #1 to Letter #13 for Utility Coordination

Letter #1 to Letter #13 for the purpose of Utility Coordination with Municipality/Municipalities and Utility Providers.

Appendix S: Sample Utility Risk Assessment Matrix

Minimum requirements for a Utility Risk Assessment Matrix of a Project.

Appendix T: Sample Utility Conflict Matrix

Minimum requirements for a Utility Conflict Matrix of a Project.

10. Glossary

Accountable Organization	An Accountable Organization is assigned to an activity and is ultimately answerable for the activity ("yes" or "no" authority and veto power). Source: ISO 19650-2 Clause 5.1.1 and 5.3.1
Administrative Authority	The Manual defines Administrative Authority as a government agency or body that possesses the authority to enforce and administer particular laws or regulations. These authorities bear the responsibility of ensuring adherence to the rules and regulations established by the government. They may also be authorized to issue fines, and penalties for non-compliance. In the context of the Digital Twin Ontario (DTO), the DTO Act would enable administrative authorities, and DTO would be granted specific powers and responsibilities to fulfill its mandate.
Agencies	Agencies are specialized bodies or Organizations established by the government to carry out specific functions or provide specialized services related to Projects. These Agencies often operate under the oversight and guidance of a specific ministry.
Appointed Party	Provider of goods or services to an Appointing Party. Source: ISO 19650-1

Appointing Party	Individual or Organization named in an appointment or Project contract as the Client/Owner. Receiver of Information concerning works, goods, or services from a Lead Appointed Party. Source: ISO 19650-1 Individual or Organization named in the Project as the employer. Receiver of Information concerning works, goods, or services from a Lead Appointed Party. Source: ISO 19650-1 Note that in this version of the Manual the Ontario Government is the Project Team or Asset Owner representing the Government Entity (Ontario Government, the Ontario Government department or agency). Also known as Employer/Client.
"As-Built" Modeling	"As-Built" Modeling in BIM for Infrastructure Projects refers to the process of creating a digital representation of a physical Asset or Infrastructure Project after it has been constructed. This Digital Model is created by capturing accurate and detailed Information about the "As-Built" conditions of the Project, including the location, dimensions, and attributes of all components and systems that were installed during construction. As-Built Modeling is an important aspect of BIM for Infrastructure Projects because it provides an accurate record of the actual construction process, which can be used for future maintenance, repairs, and renovations. It also enables Delivery Partners to visualize and analyze the Asset in a virtual environment, which can help identify potential issues and improve decision-making. "As-Built" Modeling typically involves the use of advanced surveying and scanning technologies, such as laser scanning and photogrammetry, to capture accurate and detailed Information about the physical Asset. This Information is then integrated into a BIM model, which can be used for a wide range of purposes, including Asset Management, facility management, and construction planning.

Asset	An "item, thing, or entity that has potential or actual value to an Organization." Assets can be tangible or intangible through Physical Assets and Digital Assets. Data and Information should be considered a Digital Asset. Source: ISO 55000 Ontario Project Assets are Designated Priority Project Assets owned by the Ontario Government.
Asset Classification System	Asset classification is the "common language;" the one source of agreement among all Project Proponents. An Asset Classification System (such as Uniclass 2015) allows for a common alignment of scope and nomenclature. Having a consistent Asset Classification System is paramount for enabling the requirements of the Manual.
Asset Information	Asset Information relates to the reinterpretable representation of Asset-related Data in a formalized manner suitable for communication, interpretation, or processing. Asset Information is a key requirement for the successful creation and management of any physical Asset. The value of Asset Information is enhanced when specified and considered early by the Client/Asset Owner/Operator. Digital Engineering enables and facilitates the integration and sharing of Asset Information and Data requirements across all phases of the Asset lifecycle.
Asset Information Model	An Information Model relating to the Operate and Maintain phase of a Project. Source: ISO 19650-1
Asset Information Requirements	Data and Information requirements by the Appointing Party in relation to the operation of an Asset. Source: ISO 19650-1

Asset Management	Asset Management is the coordinated activities of an Organization to realize value from Asset(s). Asset Management is a suite of activities that enable physical and non-physical Assets to deliver the value they were designed to deliver. Asset Management typically involves an Asset Management system. The system will ensure resources, competence, awareness, communication, Information requirements and documented Information are all enabled and focused on enabling the value that Asset Management delivers from the Assets. Source: ISO 55000
Asset Object	Refers to a digital representation of a physical Asset or component of an Infrastructure system created using BIM software. Can include detailed Information about the Asset, such as its dimensions, materials, and performance characteristics.
Asset Owner	The individual, entity, or Organization responsible for Asset Management policy, strategy, planning and decision-making for optimizing the cost, risk, and performance of Assets over their lifecycle. Note that ownership of physical and non-physical Assets may differ over the life cycle of the Asset.
Assets Manager	Ensures that all relevant Data related to their Organization's Assets is properly collected, stored, analyzed, and shared as needed by the Manual. More context to the role is provided in Section 1.5.
Asset Occupants	Asset Occupants are employees, non-employees, and members of the public.
Base Plan	A topographical survey plan depicting the existing conditions (surface and subsurface) within the Project limits. Source: York Regional Utility Coordination Manual

BIM Execution Plan	A formal document that defines how a Project will be executed, monitored, and controlled regarding BIM. A BIM Execution Plan is developed at Project initiation to provide a Master Information Management Plan and specifies roles and responsibilities for model creation and Information integration throughout the Project.
BIM Process	BIM Process refers to the use of BIM as a collaborative process to create, manage, and share Information throughout the lifecycle of an Infrastructure Project. In the context of the Manual, the BIM Process involves the use of BIM software to create a Digital Model of Ontario's Infrastructure Assets. The Digital Model contains Information about the physical and functional characteristics of the Assets, including location, condition, and utility connections. The BIM Process involves the collaboration of all Project Proponents involved in the management of Ontario's Infrastructure Assets to ensure that the Digital Model is accurate and up-to-date. The Digital Model is then used to create a Digital Twin of Ontario's Infrastructure, which allows for better management and maintenance of the Assets.
BIM Specialist	The BIM Specialist is the professional responsible for managing and implementing BIM Technology for the Project. They set up software and ensure compliance with BIM standards. They work with Project Team members to coordinate the BIM model, minimize errors, and update the model throughout the Project lifecycle. More context to the role is provided in Section 1.5.
BS EN ISO 19650 Series	First developed out of the UK's former BIM Level 2 but incorporates and anticipates global and future digital perspectives. The BS EN ISO 19650 Series of standards (or "ISO 19650 Series") is an international standard of Leading Practice. It defines Information Management principles and requirements within a broader context of digital transformation in the disciplines and sectors of the Built Environment (including construction and Asset Management industries).

Built Environment	A collection of manufactured or induced physical Objects located in a particular area or region. Source: BS ISO 6707-3:2017, 3.1.3, modified More context is provided in Section 1.6.
Building Management System	A computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment, such as ventilation, lighting, power systems, fire systems and security systems.
Bulletin	Bulletins are subsequent documents that will be provided following the release of v.01 of the Manual. These documents will provide instructions for Projects with greater specificity and address relevant use cases.
Change Control	The Change Control process orchestrates and records updates to Data schemas, transformations and Data refresh schedules agreed upon with the Appointing Party, the Lead Appointed Party, and Appointed Parties.
Clash Detection	An important aspect of BIM to identify and resolve potential conflicts before construction begins, saving time and money by preventing errors or rework during construction. By using BIM software to identify potential clashes or conflicts between different Infrastructure Elements, Delivery Partners can ensure that the Digital Twin(s) accurately reflect the real-world Infrastructure and can be used effectively for planning and maintenance purposes.
Confidentiality Compliance	Delivery Partners shall follow confidentiality requirements set out in pre-existing legislation and regulations to prevent identification or re-identification of individuals and the use of pattern-of-life Data that can identify individuals or groups or individuals. Confidentiality measures need to be understood and approved: At a senior management/board level in an Organization that owns or operates the Observable Element; or Where physical Assets in multiple ownership comprise the Observable Element, by a group with appropriate governance arrangements that represents the Asset Owners/Asset Users.

Construction Verification	The process of ensuring that the construction of a physical Infrastructure Project meets the design specifications and requirements. Involves the use of BIM Reality Capture and/or Laser Scanner Technology to compare the "As-Built" conditions to the original design and identify any discrepancies or areas that require correction. The goal of Construction Verification is to ensure that the Infrastructure Project is built to the required standards and will function as intended.
Contractors and Services	Contractors refer to individuals or Organizations that are hired to perform specific tasks or provide services for a Project. The Services provided by Contractors may include mechanical, electrical, and plumbing (MEP) work, security services, IT support, general contracting, and emergency response services. The Project Team typically hires contractors to provide specialized expertise or to perform tasks that are outside of the Project Team's scope of work.
Cost Recovery Model	Method used to recover the costs associated with a Project. The Cost Recovery Model is typically used to determine how much revenue should be generated from the Project in order to cover the costs of construction, operation, and maintenance.
Damages	Financial losses or costs incurred as a result of physical harm or destruction to the Project or its components. Damages can also refer to losses incurred due to delays or disruptions to the Project schedule, as well as any other costs associated with repairing or replacing Damaged Infrastructure.
Data	Data refers to raw, unprocessed, facts, and figures, which are collected and analyzed to provide insights and support decision-making. Data is the raw material that is collected and analyzed. In the context of Infrastructure Projects, Data can include measurements, statistics, and other quantitative Information that is used to assess the feasibility, costs, and risks of a Project.

Data Collaboration	The process of working together to create and maintain a comprehensive and accurate Digital Model of the Infrastructure. In the context of UIE and BIM, Data Collaboration can involve different Project Proponents working together to input Data, review and validate Information, and make decisions based on the Digital Model.
Data Custodian	The Data Custodian facilitates how Data Information is shared and represented to other custodians and users, they are Accountable for the ownership, management, and quality of the Project Data. More context is provided in Section 1.5.
Data Exploration	The process of analyzing and visualizing Data to gain insights and identify patterns or trends. In the context of UIE and BIM, Data Exploration can involve using visualization tools to analyze Data from various sources and gain a better understanding of Infrastructure performance, maintenance needs, and potential risks.
Data Governance	The development and enforcement of policies related to the management of Data. Source: BS ISO 8000-2:2020+A1:2021, 3.16.1, modified The process of managing the availability, usability, integrity, and security of Data used in the Digital Twin Development process.
Data Ingestion	The process of collecting and importing Data from various sources into a centralized system or platform. In the context of UIE and BIM, Data Ingestion can involve gathering Information from various sources such as GIS Data, Asset Management systems, and construction documents, and importing them into a BIM platform to create a comprehensive Digital Model of the Infrastructure.
Data Liaison	Data Liaisons are responsible for operating the DTO AssetFlow Hub. They are responsible for facilitating communication between departments or Project Teams within an Organization regarding Data-related issues. More context provided in Section 1.5.

Data Policy	Data Policy refers to a set of guidelines, rules, and procedures that govern the collection, storage, use, and sharing of Data in a particular context. Data Policy is the policies and procedures that govern the collection, management, sharing, and use of Data related to Ontario's Infrastructure.
Data Security	To ensure Project Proponents retain the value of their Data, Data and Information transactions should be secure and follow relevant Ontario policies set out in the enabling legislation and regulations of this Manual.
Data Sharing	The process of making Data available to others within or outside an Organization. In the context of UIE and BIM, Data Sharing can involve making BIM models, Asset inventory Data, and other relevant Information available to Project Proponents such as contractors, engineers, and maintenance personnel to facilitate collaboration and improve decision-making.
Data Source(s)	The origin or location from which Data is collected or obtained for use in the Digital Twin environment. It represents the specific systems, devices, or sources that generate or provide the Data needed to create and maintain the Digital Twin of Infrastructure Assets.
Data Specification	Set of requirements covering the characteristics of Data being fit for one or more purposes. Source: BS ISO 8000-2:2020+A1:2021, 3.6.3, modified A set of rules and guidelines that define the structure, format, and content of Data used in the Digital Twin Development process.
Data Types	Refer to the specific categories or formats in which Data is classified and organized. These Data Types define the structure and characteristics of the Information that will be utilized to create and maintain Digital Twins of Infrastructure Assets.
Deliverables	The product of engineering and design efforts, delivered to the Client as digital files and/or printed documents. A deliverable may have multiple phases.

Delivery Partners	Delivery Partners refer to the Organizations or individuals responsible for delivering and managing Projects. These Partners are typically involved in the planning, design, construction, and operation of Projects and are responsible for the collection, management, and sharing of Data related to Projects. Delivery Partners in this Manual include Government Entities, the Utilities Industry, Project Consortium, and DTO Operations Team. Delivery Partners can also include private sector companies, academic institutions, and other Organizations involved in the development and management of Infrastructure Assets. The Manual provides guidance on how Delivery Partners can work together to facilitate Data Sharing, Information Management, and Utility Coordination to support the development and operation of Digital Twins of Ontario's Infrastructure.
Design Manager	The Design Manager is responsible for managing the Defined Design phase of a Project. More context is provided in Section 1.5.
Design Model	A Design Model is a digital representation of a Project that is created during the Defined Design Stage using BIM software. A 3D Digital Model that includes all the design Information for a particular Project, such as the layout, dimensions, materials, and other details. Used as a central source of Information for all Project Proponents involved in the Project, including designers, engineers, contractors, and owners.
Designating Authority	A Designating Authority is an Organization or entity responsible for designating a Project as a Designated Priority Project (Project). The Designating Authority is responsible for reviewing Project proposals and determining which Projects meet the criteria for designation as a Project.
Designated Priority Project(s)	As prescribed under regulation, every Infrastructure Project where funding, in full or in part, has been provided through the Ministry of Infrastructure for the purposes of establishing Digital Twins of Infrastructure in Ontario is a Designated Priority Project for the purposes of the prescribing regulation. Also known as Project(s) in this Manual.

Deviation Reporting	Meeting specifications and constructing to design is made much more efficient by validating and checking the positional accuracy of work as it happens. This allows contractors to either make corrections or inform others that changes may be required to address any unwanted deviations. Calculated decisions can then be made to avoid costly changes. By way of examples, Point Cloud Data can be used to validate a concrete slab's flatness by generating a Tolerance Report.
Digital Asset	A Digital Asset refers to any digital representation of a physical Asset that is part of a Project. This can include 3D models, Point Clouds, geospatial Data, Metadata, and other types of digital Data that describe the physical Asset. Digital Assets are essential components of Digital Twins because they enable accurate, real-time monitoring and analysis of Infrastructure Assets, which can help improve maintenance, reduce downtime, and enhance safety. Examples of Digital Assets in an Infrastructure Project might include 3D models of buildings, bridges, or tunnels; geospatial Data that describes the location and characteristics of underground utilities; or Metadata that provides Information about the age, condition, and maintenance history of a particular Asset. These Digital Assets can be created and managed using BIM Software and other digital tools and shared among stakeholders using Data Sharing platforms and protocols.
Digital Engineering	A contemporary and collaborative approach to working on Assets that allows for a faster and more efficient approach to delivering Projects and managing physical Assets. It is a convergence of emerging technologies such as BIM, GIS, and other related systems form deriving better business, Project, and Asset Management outcomes. Digital Engineering can contain additional digital Information systems including drafting, electronic document management systems, Project controls (time, cost, risk, etc.),

Digital Engineering Execution Plan	A plan that delivers and explains how the digital Information Management aspects of the appointment will be carried out by the Appointed Parties prior to and during contract award. For Projects, a Digital Engineering Execution Plan may be integrated with other Execution Plans, such as Project Execution Plans, Detailed Contractor's Activity Proposal and Activity Execution Plan. The Digital Engineering Execution Plan may contain Elements of a BIM Execution Plan.
Digital Locate(s)	Digital Locates refer to the use of digital Technologies to map and locate underground utilities. Digital Locates typically involve the use of GIS software, which allows Utility Providers to create accurate maps of their underground Infrastructure.
Digital Model	A three-dimensional representation in electronic format of Infrastructure Elements representing a combination of solid Objects and specially located Data with true-to-scale spatial relationships and dimensions. A model may include additional Information or Data. Source: ConsensusDocs 301 BIM Addendum, 2008 Also known as Digital Twin, BIM Model or Data-rich 3D Model.
Digital Twin(s)	Digital Twins are "virtual representation of a real Asset or process – Assets can be considered individually, as a network or at neighborhood level – enriched with analytics, which can act as a single source of truth to effectively support more dynamic decision-making while helping manage uncertainty." Source: Infrastructure Ontario - Digital Twin Ontario Program Strategy: Report-Back to the Ministry of Infrastructure A Digital Twin is a digital representation of an Observable Element with a means to enable convergence between the Observable Element and its digital representation. Within a Project, multiple Digital Twins may be operated to translate Information into decision making for both the Project Team and their respective Organizational Teams.

Digital Twin Change Management	The process of managing changes to the Digital Twin model of an Infrastructure Asset. This process involves identifying, evaluating, and implementing changes to the Digital Twin model in a controlled and structured manner to ensure that the model accurately reflects the current state of the Asset.
Digital Twin Developer	The entity responsible for developing and managing the Digital Twin model of an Infrastructure Asset.
Digital Twin Development	The process of creating and maintaining a Digital Twin model of an Infrastructure Asset.
DTO Act	Digital Twin Ontario Act is the working title of the anticipated enabling legislation called for the Report Back to the Ministry of Infrastructure in Fall 2023.
DTO Architect	DTO Architects will build and operate the platform and IT system required to perform the function of the DTO and house the DTO AssetFlow Hub.
DTO Framework	The DTO Framework is the Information Management system for Projects, administered through the DTO; enabling the creation of Digital Twins for Ontario's Infrastructure.
DTO Operations Team	Sub-team of the DTO responsible for engaging with individual Projects. The DTO Operations Team currently consists of a Data Liaison and DTO Architect for each Project.
DTO Support Team	Team responsible for enabling DTO in the initial phases of the program (Phase 0 to 2). The DTO Support Team is currently managed by Infrastructure Ontario's Accelerated High-Speed Internet Program (ASHIP) Technical Assistance Team (TAT).
Due Diligence Process	The steps taken by Appointed Parties to ensure that all underground utilities are located and marked before any excavation or construction work begins. This process is most often undertaken during the Briefing Concept Stage.
Element	A component of an Infrastructure Asset that can be represented in the Digital Twin model.
End-User Ownership	The entity responsible for owning and maintaining the Digital Twin model of an Infrastructure Asset.
Exchange Information Requirements	Information requirements in relation to a Project. Source: ISO 19650-1

E-Permitting Platform	The E-Permitting Platform is a digital tool that streamlines the permitting process and facilitates collaboration between Delivery Partners. Its Objectives include improving Data Security and visibility, accelerating the permitting process, increasing efficiency, and enabling collaboration and coordination. An example of this platform is the common permitting platform for AHSIP, the Broadband One Window, which provides a repository for geospatial Data and mapping, enables intuitive and interactive Data visualization, and facilitates real-time tracking of permit applications and approvals
Facility Manager	The Facility Manager oversees the maintenance and operation of a building or facility. This includes managing the physical Infrastructure, equipment, and services required for the facility to function effectively. Further context is provided in Section 1.5.
Facilities Management	Integration of processes within an Organization to maintain and develop the agreed services that support and improve the effectiveness of its primary processes and activities. Source: BS 8536-1
Federated System	A Federated System is a decentralized system in which multiple entities or Organizations cooperate and share resources while maintaining their own autonomy. In a Federated System, each entity retains control over its own Data and resources, but also agrees to share some of those resources with other entities in the system. This allows for greater collaboration and efficiency while still preserving each entity's independence and security.
Fit for Purpose	Data is considered Fit for Purpose when it is appropriate for its intended use. Source: IM-GUIDE-09
gbXML	Green building extensible markup language (XML). A digital file format for exchanging sustainability Information in simulation applications.

Government Entities	Refers to the various levels of government Agencies involved in the planning, design, construction, and maintenance of Projects in Ontario. These entities include federal, provincial, and municipal government Agencies, as well as other public sector Organizations involved in Infrastructure planning and development.
Horizontal Structures (or Horizontal Infrastructure)	Network Assets, including road, rail, water, power, and communications distribution systems.
Idem	Idem is a Latin term that means "the same." For purposes of this Manual, Idem is used to refer to a document or contract that has been previously mentioned and is being referred to again.
Implementation Lead	Executive responsibility to establish and deliver the Manual in their Organization. They are Accountable for the development of key Deliverables such as the Organizational Information Requirements and Asset Information Requirements.
Industry	Industry refers to the various sectors and businesses involved in the planning, design, construction, operation, and maintenance of public Infrastructure. This includes companies and Organizations involved in engineering, architecture, construction, transportation, utilities, and other related fields. The Industry is also responsible for ensuring that Infrastructure Projects are delivered on time, on budget, and to the highest standards of quality and safety. In Ontario, the Infrastructure Industry is regulated by various government bodies, including Infrastructure Ontario, the Ministry of Transportation, and the Ministry of Infrastructure. These bodies work with Delivery Partners to ensure that Infrastructure Projects are planned and executed in a way that meets the needs of Ontario's communities and supports the province's economic growth and development.

Information	Information is Data that has been organized, analyzed, and presented in a meaningful way to support decision-making. Information is the processed output that is used to support decision-making. Information provides context and insights that help Delivery Partners understand the implications of the Data and make informed decisions. In the context of Infrastructure Projects, Information can include reports, maps, and visualizations that communicate key findings and recommendations to decision-makers. For example, Information on the environmental impacts of a proposed Project can be presented in a report that outlines the potential risks and mitigation measures.
Information Management	Information Management is the management and execution of tasks related to defining Information requirements, producing, checking, and delivering Information. Information Management is a critical function that applies to all types of Information, and it involves a structured and consistent approach to managing digital Data. The Information Management lifecycle includes Data planning, Data acquisition, Data operations, and Data disposal/archival.
Information Model	Set of structured and unstructured Information containers. This can relate to the Operate and Maintain or the Build and Handover phase of a Built Asset i.e., a Project Information Model or an Asset Information Model, respectively. Information Models may include geometrical models, schedules, Databases, etc. Unstructured Information containers may include documentation, video clips, sound recordings etc. Source: ISO 19650-1
Information Structure	The Organization and structure of Information used in the Digital Twin Development process.

Infrastructure	Infrastructure in the context of Ontario refers to the physical structures, facilities, and systems that are essential for the functioning of the province and its communities. This includes transportation systems such as roads, highways, bridges, and public transit, as well as utilities such as water and wastewater treatment facilities, electricity generation and distribution systems, and telecommunications networks. Other types of Infrastructure in Ontario may include public buildings such as schools, hospitals, and government offices, as well as recreational facilities such as parks and community centres.
Infrastructure Owners	Please note, "Infrastructure" is defined in the context of this Manual and does not directly correlate to "Infrastructure Owners." An Infrastructure Owner is any person or entity that owns, operates, or controls any underground Infrastructure, including but not limited to pipelines, cables, wires, conduits, ducts, or sewers. This includes both public and private entities, such as utility companies, municipalities, and construction companies. The Act requires Infrastructure Owners to register with Ontario One Call and provide accurate Information about the location and nature of their Infrastructure to prevent damage during excavation or construction activities. Currently, It is important for anyone planning to dig or excavate in Ontario to contact Ontario One Call at least five business days prior to starting work to ensure that all underground Infrastructure is located and marked to prevent damage and ensure public safety.
Interoperability	The ability of two or more functional units to exchange Information and use it readily. Exchange should not require users to possess knowledge of the unique characteristics of those units.
Iterative Cycle	The process used to refine and optimize Data throughout stages of a Project. This includes Sensing/Ingesting, Classifying, Refining, Deciding, and Acting/Optimizing. Further context is provided in Section 5.1.

Lead Appointed Party	The party who is accountable for coordinating Information exchange between Task Teams, the Project Team, and the Appointing Party.
Leading Practice	Leading Practice is the most effective and efficient method, process, or technique to achieve a goal or Objective that has been validated through research and practical application. It is considered the standard for excellence in a specific field or Industry and is used as a benchmark to improve Organizational processes. Leading Practices are constantly evolving and require Organizations to be adaptable and willing to adopt innovative approaches to remain competitive.
Level of Development	A scale used to describe the level of completeness to which a model Element can be relied on at various times during model development.
Level 2 BIM	BIM Level 2 is a level of maturity in BIM, which is distinguished by collaborative working. It involves developing Asset Information in a collaborative Data-rich 3D environment but created in separate discipline models. The collaboration is in the form of Information Exchange Processes specific to a Project and coordinated between different systems and Project Proponents. Specification for what, when, how, and for whom Information is to be produced in relation to Organizational Objectives. Source: ISO 19650-1
Level 3 BIM	BIM Level 3 is a level of Building Information Modeling that involves the creation of a fully integrated and collaborative Digital Twin model of a building or Infrastructure Asset.
Line-of-Sight Methodology	A "golden thread" of Information to provide a Line-of-Sight between Organizational Objectives and Asset requirements. Source: Cambridge Centre for Smart Infrastructure & Construction (CSIC) – Line-of-Sight: An Asset Management Methodology to Support Organizational Objectives, Optimizing Asset Management Methodology to Realize Business Success
Locate Request	Refers to the process of requesting a utility locate through the Ontario One Call system, which is mandated by the Ontario Underground Infrastructure Notification System Act, 2012.

Master Information Delivery Plan	Used to manage the overall delivery of Information during the Project lifecycle. It is typically developed by the BIM Specialist and Data Custodian in collaboration with other Project Team roles.
Mark-Up Drawings	A plan view drawing supplied by the Utility Owner reflecting the location of subsurface Infrastructure within the requested limits.
Means and Methods	Means and Methods refer to the specific techniques and procedures that are prescribed in the Manual for proposing and executing Projects. Adhering to the Means and Methods outlined in the Manual is essential to ensure successful Project designation and implementation. Failure to comply with the prescribed Means and Methods can lead to delays, complications, and potential Damages.
Metadata	Commonly defined as Data about Data, though differing from the Data itself. For example, in a BIM context: Object size = 300mm In this case, calling out "Object size" is Metadata, while the fact that the Object size is 300mm is Data.
Ministries	Ministries refer to the various government departments responsible for overseeing and managing specific areas of public policy and governance.
Model Element Authoring Schedule	Assigns responsibilities to model Elements via an author. Defines the LOD of model Elements aligned to Project phases.
Model Location	The geographic location of the Digital Model of an Infrastructure Asset.
Model Orientation	The way in which the Digital Model of an Infrastructure Asset is oriented in relation to the real-world Asset.
Model View Definition	Defines a subset of the IFC schema (a Data model used in Industry to describe building and construction Data in a standardized way), providing implementation guidance for all IFC concepts (classes, Attributes, relationships, property sets, quantity definitions, etc.) used within this subset. It represents the software requirement specification for the implementation of an IFC interface to satisfy the exchange requirements.
Modeling Process	The process of creating a Digital Model of an Infrastructure Asset.

MTO Controlled Area	Designated areas under the control and authority of the Ministry of Transportation are typically situated along highways or other transportation routes. These areas are subject to specific regulations and restrictions related to construction, maintenance, and use.
Municipal Access Agreement	A Municipal Access Agreement is a legal agreement that provides companies the ability to construct, maintain, relocate, and operate their equipment within Right-of-Ways that are under the authority of a Municipality. It states the roles, responsibilities, and requirements for both the signatory and the Municipality and deals primarily with issues such as Municipal Consent, hazardous substances and materials, Road Occupancy Permits, rights-of-way, costs to be carried by municipalities, third party and sub-contractor agreements, service level agreements, maintenance, and repair responsibilities as well as equipment use and invoicing.
Municipal Consent	Is provided by a Municipality for a Utility Provider to occupy a specific location within the Municipal Rights-of-Way. Utility locations and separations have been established for various road cross-sections to avoid conflicts in the planning of Projects by various utilities occupying the rights-of-way and to minimize the impact of proposed work on any adjacent Infrastructure. Municipal Consents are only issued to Utility Providers, commissions, Agencies, and private Applicants who have the authority to construct, Operate and Maintain their Infrastructure within the right-of-way as established through legislation or terms of a Municipal Access Agreement where they apply and are approved. Municipal Consent gives a company permission to install or move facilities and is required when a road needs to be excavated.

Municipality/Municipalities	A Municipality refers to a local government unit responsible for managing and providing public services within a specific geographic area. Municipalities are typically responsible for providing essential services such as water supply, waste management, transportation, and public safety. They may also be responsible for managing Projects within their district, including planning, design, construction, and maintenance of roads, bridges, public buildings, and other facilities. Municipalities work in partnership with other levels of government, private sector companies, and community Organizations to plan and implement Projects that meet the needs of their residents and promote economic growth.
Natural Environment	All living and non-living things that exist on Earth affecting ecosystems and human life. Source: BS ISO 21401:2018, 3.23
Non-Graphical Information	Information such as operating Manuals, performance limits, and supplier details, which can be attached to a graphical Object within a model.
Object	A modeled item within an Asset.
Observable Element	An Element of an Infrastructure Asset that can be observed and measured using sensors or other Data collection methods.
OmniClass	A classification system for the construction Industry, developed by the Construction Standards Institute (CSI), and used as a classification structure for electronic Databases. OmniClass is a classification system for the construction Industry that is used worldwide, including in Canada. It is a standardized system for organizing and retrieving Information about construction Projects and Assets. OmniClass is recognized and supported by many Organizations in Canada, including the National Research Council of Canada and the Canada BIM Council. It is also referenced in Canadian building codes and standards, such as the National Building Code of Canada.

Ontario One Call	Ontario One Call is an Administrative Authority responsible for coordinating requests from excavators, for the location of underground Infrastructure (e.g., buried gas pipelines).
Ordered	Means the Minister or DTO has given instructions or directives for the implementation and operation of a Project and/or the DTO.
Organization	An entity or group of entities.
Organizational Information Requirements	Specifications for what, when, how, and for whom Information is to be produced in-relation to Organizational Objectives. Information requirements in relation to Organizational Objectives. Source: ISO 19650-1 Data and Information required for an Organization to meet the needs of its Organizational functions and its Asset Management system.
Organizational Objectives	Short- and medium-term goals that an Organization seeks to achieve to reach overall strategic goals.
Organizational Team	The Organizational Team refers to a group of individuals within an Organization who are responsible for managing and coordinating the implementation of the Digital Twin strategy.
Open Data	Data is considered open when not tied to specific software solutions (ex. HTML, PDF, OOTX, MP3, IFC, BCF, IDM).
Point Cloud	A set of Data points in three-dimensional Space that can be used to create a digital representation of an Infrastructure Asset.
Point Cloud Data	The Data contained in a Point Cloud, which can be used to create a Digital Model of an Infrastructure Asset.
Preferred Alignment Base Plan	Base Plan for the preferred alignment of Utilities that will be the foundation for future detailed design.
Procurement Methodology	Procurement Methodology refers to the process used to acquire goods and services needed to implement the Project. The Procurement Methodology should also include provisions for Data Sharing, BIM, and Utility Coordination, ensuring that vendors and Parties are aware of and adhere to the Organization's standards in these areas.

Project(s)	As prescribed under regulation, every Infrastructure Project where funding, in full or in part, has been provided through the Ministry of Infrastructure for the purposes of establishing Digital Twins of Infrastructure in Ontario is a Designated Priority Project for the purposes of the prescribing regulation. Also known as Designated Priority Project(s) in this Manual.
Project Brief	A Project Brief is a document developed by a client to outline their requirements when engaging designers or design and build teams. Define BIM uses in the Project Brief to ensure Data accuracy and completeness. Information in the Project Brief is used to improve Project outcomes.
Project Information Model	Information Model relating to the Build and Handover phase. Source: ISO 19650-1 May contain the Information Model, contracts, reports, certificates, and communications Data set.
Project Manager	The Project Manager shares the role of "Project Owner" in ASCE 38-22 and oversees the entire Project. They are responsible for Appointing Party communications, maintaining progress trackers, producing stage reports, meeting agendas/minutes, and ensuring effective Project Team communications. Further context is provided in Section 1.5.
Project Objectives	Overarching outcomes that the Client aims to achieve from the Project. Examples include improved operating efficiency, Project Proponents satisfaction, and reduced journey times.
Project Owner	An individual person or entity (e.g., firm, government agency, Utility owner, design-builder, Construction Manager-at-Risk, or public-private Partnership entity) responsible for a Project.
Project Partners	Project Partners refer to the Project Proponents involved in a Project who collaborate to achieve a common goal.

Project Proponent	A Delivery Partner that entered into the Project Agreement with the Government of Ontario to carry out a Project. Primarily refers to engineering and construction firms involved in the design, construction, and management of Project's in Ontario, but can include various entities such as government Agencies, utility companies, and other Project Proponents. Work collaboratively to share Data, coordinate activities, and implement technologies to create Digital Twins of Ontario's Infrastructure.
Project Team	A Lead Appointed Party and their associated Appointed Party or Parties Task Teams.
Project Stages	Project Stages refer to the distinct phases or steps involved in the planning, design, construction, and maintenance of a Project. The Project Stages in the Manual are the Briefing Concept Stage, then the Defined Design Stage, followed by the Build and Handover Stage, and finally the Operate and Maintain Stage.
Proprietary Data	Data restricted to specific software and ownership by an entity or Organization.
Quality Assurance	A program for the systematic monitoring and evaluation of the various aspects of a Project, service, or facility to ensure standards of quality are being met.
Quality Control	The activity of checking goods as they are produced to ensure the final products are good.
Quality Level	Refers to the 4 Utility Quality Levels: Utility Quality Level D (QL- D), Utility Quality Level C (QL-C), Utility Quality Level B (QL-B), and Utility Quality Level A (QL-A). Used to determine the accuracy of location of underground utility Assets.
Quantity Surveyor	The Quantity Surveyor is a professional who specializes in cost management for construction Projects. They estimate and monitor the costs of materials, labor, and equipment needed for a Project. More context is provided in Section 1.5.
Raster	Raster is used for textures or images that need to be incorporated into a design. Note, they are not usually used for the primary design Elements, and are not prioritized in CAD and BIM, but are likely to be included for visual effects/descriptions.

Reality Capture	Reality Capture is the process of using various technologies to capture the physical characteristics of a building or Project site, and then creating a Digital Model of that Information.
Record Modeling	The creation of a of the As-Constructed graphical and Non-Graphical Information relating to an Asset.
Refinement Process	The process of refining and improving the accuracy and quality of the Data used in the development and operation of Digital Models.
Request for Information	A documented Request for Information on a matter from one party to another. Typically managed through formal procedures agreed by members of the Project Team.
Responsible Organization	A Responsible Organization completes the activities and tasks that have been delegated to them. Source: ISO 19650-2 Clause 5.1.1 and 5.3.1
Road Geometrics	Engineering concerned with the positioning of physical roadway Elements according to standards and constraints. The basic Objectives in geometric design are to optimize efficiency and safety while minimizing cost and environmental damage.
Road Occupancy Permit	A Road Occupancy Permit is required by some municipalities when working within the municipal Right-of-Way. Activities that require a Road Occupancy Permit include temporary lane closures or construction related road closures, mobile crane work, temporary scaffolding, or hoarding, crossing the boulevard for temporary construction site access, disposal bins located in the roadway or public laneway, storage of materials and equipment located in the roadway or public laneway, workers on the road or the blockage of sidewalks. Some municipalities may not require this permit and need only to be notified.
Security Compliance	Requires Delivery Partners to identify security risks and adopt the security regime set out in the governing legislation and regulations of this Manual to mitigate said security risks. Security Compliance requires the following approvals: At senior management/board level in an Organization that owns or operates the Observable Element; or Where physical Assets in multiple ownership comprise the Observable Element, by a group with appropriate governance arrangements that represents the Asset Owners/Asset Users.

Soft Landings	Process for the graduated handover of a new or refurbished facility/ facility, where a defined period of aftercare by the design and construction team is an Owner's requirement that is planned and developed from the outset of the Project. Source: BS 8536-1
Space	The physical area occupied by an Infrastructure Asset, which can be represented in a Digital Twin model.
Subject Matter Experts	The individuals or teams with specialized knowledge and expertise in the development and operation of Digital Models of Ontario's Infrastructure Assets.
Subsurface Utilities	The utilities and Infrastructure Assets that are located underground, such as water and gas pipelines.
Subsurface Utility Engineering	A branch of engineering practice involving classifying and reducing the uncertainty of the presence and location of underground Utility Infrastructure by delivering Data about that Infrastructure. For example, reports and utility mapping at appropriate Utility Quality Levels, and using this Data for purposes including Utility Coordination, utility relocation design and coordination, utility condition assessment, communication of utility Data to concerned parties, utility relocation cost estimates, implementation of utility accommodation policies, and utility design.
Task Information Delivery Plan	For each Task Team, the Task Information Delivery Plan identifies and records the specified level of Information needed for the task.
Task Team	A person or group of people performing a specific task. E.g., the architecture team or the subcontractor who is designing/ construction curtain walling.
Technology	Refers to the tools, systems, and processes used to create and manage Digital Twins. This includes both hardware and software components, as well as the underlying Data and analytics that enable the Digital Twin to accurately represent the physical Infrastructure.
Technology Lead	The Technology Lead designs and owns the platform architecture decisions and coordinates Technology decisions across external Partners.
Third Parties	The entities or Organizations that are involved in the development and operation of Digital Models of Ontario's Infrastructure Assets but are not part of the primary Organization responsible for those models.

Tolerance Report	Used to identify any discrepancies or deviations between the Point Cloud Data and the design specifications or existing conditions. Generated from Point Cloud Data collected during the scanning of a Project.
Transformation Artefacts	The Data and other artifacts that are created or modified in the process of transforming raw Data into usable Information for Digital Models.
Uniformat	A classification system for building Elements, including designed Elements, which forms the basis of Table 21 of the OmniClass system. A product of the Construction Specifications Institute (CSI) and Construction Specifications Canada (CSC).
Update Cycle	Refers to the frequency with which the Manual is reviewed and updated to ensure that it remains current and relevant. As innovative technologies and Leading Practice emerge, it is important to update the Manual to reflect these changes and ensure Delivery Partners are aware of the latest standards and guidelines for Data Sharing, BIM, and Utility Coordination.

Uniclass 2015	A UK classification system. Uniclass 2015 is a classification scheme for the construction Industry. It is intended for organising library materials and for structuring product literature and Project Information. Uniclass 2015 comprises tables, each of which represents a different class of construction Information and deal with different scale of Information. Each table can be used as a standalone table for the classification of Information, but, in addition, terms from different tables can be combined to classify complex subjects. Source: Uniclass 2015 Uniclass 2015 complies with ISO 12006-2. Uniclass 2015 is a unified classification system that is flexible enough to accommodate future classification requirements, is free to use, and is owned and maintained by the United Kingdom's National Building Specification (NBS) on behalf of the global construction Industry. Where Uniclass 2015 does not fulfill a specific classification need, the Appointed Party should work with the Client to develop an appropriate standardized classification system.
Use Case Lead(s)	The Use Case Lead(s) own the relationship with the end user entity and actively support the Product Owner in developing the vision and prioritizing the user stories for the Digital Twin.

Utility Coordination	Utility Coordination is the process of managing the location, design, installation, and maintenance of underground and aboveground Utility Infrastructure, such as water, gas, electricity, telecommunications, and transportation systems, to ensure that they are properly integrated and do not interfere with each other or with other Projects. Utility Coordination involves identifying and mapping the location of existing Utility Infrastructure, coordinating the design and installation of new Utility Infrastructure with other Projects, and managing the ongoing maintenance and repair of Utility Infrastructure. This would also involve sharing Data and Information about Utility Infrastructure with other Project Proponents, such as designers, contractors, and operators, to ensure that everyone has access to accurate and up-to-date Information. The goal of Utility Coordination is to minimize conflicts and disruptions, reduce costs and delays, and improve the overall efficiency and effectiveness of Projects.
Utility Coordination Plan	Is a drawing that depicts at a "high level" the locations of utility relocations and the timeline for when the relocation construction will occur. It prioritizes who and where and when utility relocation Projects will occur within the Project limits.
Utility Coordinator	The Utility Coordinator assumes the role of Engineer/Professional as defined in ASCE 38-22, which involves tracking changed conditions, training Project Team members on how to use BIM software and providing Utility Records assistance. Further context is provided in Section 1.5.
Utility Conflict Matrix	A document which describes the details of potential utility conflicts (this at minimum will include types of utility, utility size, and length of conflict).

Utility Infrastructure	Refers to the network of physical Assets and systems that provide essential services to a community, such as electricity, gas, water, and telecommunications. Utility Infrastructure specifically refers to the physical Assets and systems that support the delivery of these essential services in Ontario. Means any physical line, facility, system, equipment, installations, or appurtenances owned and operated by a utility Organization to facilitate the transmission, distribution, or deliver of electricity, communications and intelligence, gas, oil and petroleum products, water, sewage, or any other similar commodity, and includes underground, surface, and overhead Infrastructure.
Utilities Industry	The Utilities Industry refers to the sector of the economy that is responsible for providing essential services such as electricity, gas, water, and telecommunications to consumers and businesses.
Utilities Infrastructure Data	The Data related to the Infrastructure Assets used to provide utility services, such as electricity, water, and gas.
Utility Pole Owner	The entity responsible for owning and maintaining electricity (hydro in Canada) and/or utility poles.
Utility Provider(s)	A municipal corporation or commission or a company or individual operating or using communications services, water services or sewage services, or transmitting, distributing, or supplying any substance or form of energy for light, heat, or power. Any company or entity, whether publicly-owned or investor- owned, and whether regulated or unregulated, that installs, operates, and maintains Utility Infrastructure within highway Right-of-Way.
Vector	Digital images composed of mathematical equations that define paths and shapes, used as a foundation for creating other graphics or designs.
Vertical Structures (or Vertical Infrastructure)	Vertical Structures refer to Infrastructure that runs vertically, such as power lines and transmission towers, cell phone towers, and water towers. Structures located above ground are more visible and vulnerable to damage from weather and other environmental factors.

Zip Compressed Format	A type of file format used to compress and reduce the size of large files. These files can be easily opened and extracted using a compatible software program. The Manual may include large files such as 3D models, Data sets, or other Digital Assets that are used in the creation and maintenance of Digital Models. By using this format for large files, the Manual can be more easily distributed and accessed by Project Proponents involved in the Project.

11. Abbreviations

BIM (Building Information Modeling)	Use of a shared digital representation of a built or to be built Asset to facilitate design, construction, and operation processes to form a reliable basis for decisions. Source: ISO 29481-1, 3.2 BIM is a subset of Digital Engineering that integrates Technology, process improvements, and Digital Information to radically improve Client and Project outcomes and Asset operations. BIM is a strategic enabler for improving decision=making for both buildings and public Infrastructure Assets across the whole lifecycle. It applies to new-build Projects, and supports the renovation, refurbishment, and maintenance of the Built Environment. Source: EU BIM Task Group Handbook
CAD (Computer-Aided Design)	A geometric/symbol-based computer drawing system that replicates hand-drawing techniques. CAD software can prepare 3D lines, surfaces or solids that are suitable for presentation on hardcopy plots of drawings, and/or as background Data for other 3D Data or BIM.
CDE (Common Data Environment)	Agreed source of Information for any given Project or Asset, for collecting, managing, and disseminating each Information container through a managed process. Source: ISO 19650-1, 3.3.15
COBie (Construction Operations Building Information Exchange)	Structured facility Information for the commissioning, operation, and maintenance of a Project, often in a neutral spreadsheet format, which is used to supply Data to the Asset Owner or Operator to populate decision-making tools, Facilities Management, and Asset Management systems. Source: PAS1192.2 COBie can facilitate transformation from document-centric to Information-centric handover processes to facility and Asset Operators post-construction.

CIM (Common Information Model)	In the context of this Manual, the CIM is a set of open standards that define a common representation of power system components. It facilitates the exchange of Data between different applications and Delivery Partners in the power Industry. The CIM covers various aspects of power system software Data exchange, including energy management systems, Asset tracking, work scheduling, customer billing, and electricity markets.
DTO (Digital Twin Ontario)	DTO is a not-for-profit industry funded organization dedicated to elevating the level of dialogue, raising standards, and promoting growth and innovation within the provinces public infrastructure sector. Our strength is our focus on the practical and leveraging our neutrality to lead the industry to practical solutions and collective engagement. The Utility Manual program is designed to mandate and standardize Information and Data Management to enable Digital Twins of Ontario's Infrastructure. The program's management system is called the DTO Framework, which is used to manage the program's operations.
GIS (Geographic Information Systems)	A system used for the design, capture, storage, management, and analysis of geographic Data.
GPS (Global Positioning System)	It is a satellite-based navigation system that provides location and time Information, which is used to track the movement of construction equipment and vehicles, surveying, and mapping during the construction of Projects.

IFC (Industry Foundation Classes)	A specification for a neutral Data format to describe, exchange, and share Information typically used within building and Facility Management Industry sectors. An IFC Data Model consists of definitions, rules, and protocols that uniquely define Data sets, which describe capital facilities throughout their lifecycles. IFC is the only non-proprietary, open global Data Model specification available. Source: BuildingSMART IFC for Data Sharing in the construction and Facility Management Industries. Note: In some circumstances where there is a concern about lack of Data readability or Interoperability with some specific tools or purposes, the native files can also be shared together with IFC files. A system for defining and representing standard architectural and construction-related graphic and non-graphic Information as 3D virtual Objects. Promotes Information exchange among BIM tools, cost estimation systems, and other construction-related applications in a way that preserves the ability to analyse those Objects as they move from one BIM system to another.
IP Policy (Intellectual Property Policy)	Intellectual property is a phrase used to define "a concept in which tangible expressions of intellectual/creative pursuits – such as inventions, designs, creative works, etc. – are treated in legal and social spheres as property, with all its attendant implications (e.g., ownership, use, economic transactions, etc.)." It is governed by the legal regimes of copyright, trademark, patent, and trade secret law. Each of these regimes addresses specific types of IP which includes copyright, trademark, patent, and trade secret. Source: Government of Canada

QL-D (Quality Level D)	Utilized during Briefing Concept Stage. Utility records are requested, researched by the Utility Provider, marked-up and returned to the requester. Typical tasks by the engineer leading to utility QL-D are (adapted from clauses in ASCE 38-22): 1.1.4 Conduct utility records research to assist in identifying utility owners that may have facilities on or be affected by the Project. Sources of Information may include, but are not limited to (Project- and scope dependent): • Utility section of the state Department of Transportation or other public agency; One-call notification centre; Public Service Commission or similar Organization; Landowner, Internet or computer Database search visual site inspection, Utility Owners, County Clerk's office. 1.1.5 Collect applicable utility owner records. Applicable records may include: • Previous construction plans in area Conduit maps; Direct-buried cable records Distribution maps; Transmission maps Service record cards; "As-builts" and Record Drawings; Field notes; County; city; utility owner or other geographic; Information system Databases Circuit diagrams; and Oral histories. 1.1.6 Review records for: • Indications of additional available records; Duplicate Information and credibility of such duplicate Information Need for clarifications by utility owners. 1.1.7 Develop utility composite drawing or equivalent: • The engineer should also make professional judgments regarding the validity and location of topographic features on records versus current topographic features (when available) and conflicting references of utilities. And the engineer should indicate Quality Levels, utility type and / or ownership; date of depiction; accuracy of depicted appurtenances (QL-C vs. QL-D); end points of any utility Data; active, abandoned, or out- of-service status; size; condition; number of jointly buried cables; and encasement.

QL-C (Quality Level C)	Utilized during Briefing Concept Stage. Using surface surveying techniques, above ground features of Subsurface Utilities are identified and recorded. Typical tasks by the engineer leading to utility QL-C are (adapted from clauses in ASCE 38-22): 5.2.1 Perform tasks as described for QL-D. QL-C and QL-D tasks do not necessarily need to be performed in any prescriptive order. 5.2.2 Identify surface features on the topographic plan and ground surface that are surface appurtenances of existing Subsurface Utilities. 5.2.3 Survey such features if the features have not already surveyed by a registered professional. If previously surveyed, check survey accuracy and completeness for applicability with the existing Project. 5.2.4 Correlate applicable utility records to these surveyed features, considering the geometries and indications on the records of these surface features. 5.2.5 Determine when records and features do not agree and resolve discrepancies. This may be accomplished by depiction of a utility line at QL- D, effectively bypassing or disregarding (but still depicting) a surveyed structure of unknown origin. Additional resolution may result from consultation with utility owners.

QL-B (Quality Level B)	Utilized during Defined Design Stage. Using surface geophysical equipment and techniques, Subsurface Utilities are determined and are associated with the horizontal position on the ground surface. Typical tasks by the engineer leading to utility QL-B are (adapted from clauses in ASCE 38-22): 5.3.1 Perform tasks as described for QL-C. QL-C and QL-B tasks do not necessarily need to be performed in any prescriptive order. It may be more cost effective to perform some QL-B tasks before and / or in conjunction with QL-C or QL-D tasks. 5.3.2 Select an appropriate suite of surface geophysical methods (see the Appendix for discussions of methods, relative merits, and relative costs) to search for utilities within the Project limits or to perform a utility trace for a particular utility system. 5.3.3 Apply appropriate surface geophysics to search for utilities within the Project limits or trace a particular utility system if the scope of investigation is limited. 5.3.4 Interpret the surface geophysics. Depending on the methods, this may be performed in the field or in the office. 5.3.5 Mark the indications of utilities on the ground surface for subsequent survey. Local utility owners, Agencies, and / or one-call statutes may dictate, or suggest, the markings' colors, sizes, and / or other labeling. Care should be taken to differentiate markings placed on the ground for design purposes from those placed on the ground for damage prevention purposes. (Note: If a particular surface geophysical method allows for field Data collection or storage for future computer downloading and evaluation, if a utility search technique that allows for comprehensive area coverage is used, and if a survey grid or line is laid out that allows for future correlations of surface geophysical Data to points depicted on a map, then ground markings may be unnecessary.)

QL-B (Quality Level B) continued	5.3.6 Survey all markings that indicate the presence of a subsurface utility. This survey should be to the accuracies and precision dictated by the Project's survey control. 5.3.7 Depict all designated utilities. These utility depictions may follow the general guideline as presented in Section 6.0. Depiction is usually accomplished via computer-aided design and drafting or Manual plotting methods onto plan sheets, into geographic Information systems Databases, or onto other appropriate documents. QL-B Data should be reproducible by surface geophysics at any point of their depiction. 5.3.8 Correlate the designated utilities' depictions with utility records and / or surveyed appurtenances to identify utilities that may exist but were not able to be designated. 5.3.9 Resolve differences between designated utilities and utility records and surveyed appurtenances. This may take the form of additional surface geophysical searches or depiction of designated or non-designated utilities at a lower Quality Level. It may take the form of an upgrade at appropriate points to QL-A Information. Situations require judgment that a designated utility and a utility of record are identical, even if not interpreted as geographically coincident. 5.3.10 Recommend to the Project Owner additional measures to resolve differences if they still exist. Such recommendations may include additional or different surface geophysical methods, exploratory excavation, or an upgrade to QL-A Data.

QL-A (Quality Level A)	Utilized during Build and Handover Stage. Where existing records of underground site conditions may be incorrect, incomplete or have mul-tiple buried Utilities Elements over several years. QL- A allows the physical discovery of buried Utilities Elements. This is a large contributor to avoiding conflicts. Exposing and recording the size and configuration of a Subsurface Utility, and it is precise vertical and horizontal location is crucial. Using subsurface geophysical equipment and techniques, Subsurface Utilities are determined and recorded in three dimensions and are associated with the horizontal position on the ground surface. Typical tasks by the engineer leading to utility QL-A are (adapted from clauses in ASCE 38-22): 5.4.1 Perform tasks as described for Quality Level B at the appropriate Project location. QL-B, QL-C, and QL-D tasks do not necessarily need to be performed in any prescriptive order. 5.4.2 Select an appropriate method of gathering Data that will achieve the accuracies and precision required by the Project. These accuracies are currently typically set to 15- mm vertical and to appli-cable horizontal survey and mapping accuracy as defined by the Project Owner. Exposure and survey of the utility at each specific location where QL-A Data are obtained are currently neces-sary. 5.4.3 Excavate test holes exposing the utility to be measured in such a manner that protects the integrity of the utility to be measured. Exposure is typically performed via minimally intrusive exca-vation. In some cases, Data gathering during utility construction may eliminate the need for excava-tion of the utility, as it is already exposed. 5.4.4 Comply with applicable utility damage prevention laws, permits, and specifications, and co-ordinate with utility and other inspectors, as required.

QL-A (Quality Level A) continued	5.4.5 Determine (a) the horizontal and vertical location of the top and / or bottom of the utility referenced to the Project survey datum; (b) the elevation of the existing grade over the utility at a test hole referenced to the Project survey datum; (c) the outside diameter of the utility and con-figuration of non-encased, multiconduit systems; (d) the utility structure material composition, when reasonably ascertainable; (e) the benchmarks and / or Project survey datum used to determine elevations; (f) the paving thickness and type, where applicable; (g) the general soil type and site conditions; and (h) such other pertinent Information as is reasonably ascertainable from each test hole site. Resolve differences between depicted QL-A Data and other Quality Levels. This may take the form of additional surface geophysical searches or a depiction of adjacent or nearby Data points at a lower Quality Level. It may require that utilities already depicted at QL-B, QL-C, or QL-D should be re- de-picted to coincide with the more accurate QL-A Data. It may take the form of additional upgrades at ap-propriate points to QL-A Information.
RACI Matrix (Responsible, Accountable, Consulted, Informed Matrix)	A matrix that clearly sets out the roles and responsibility for Elements (such as scope, interfaces, Information etc.) of the Project at various points of the Project's life cycle. Roles and responsibilities of individual team members as well as the schedule of responsibilities for Deliverables of the overall team should be defined. The RACI matrix should be a core Element of the contractual obligations for all parties. With respect to Digital Engineering, roles and responsibilities of Data, interfaces, Information, intellectual property, and assumptions should be clarified early, prior to contract award. Note: Projects may use existing systems and frameworks to define roles and responsibilities more broadly for the Project. The RACI Matrix for the digital component of works may fall under those existing systems and frameworks.
UIE (Utilities Infrastructure Engineering)	The terminology Utility Infrastructure Engineering (UIE) is used to capture both above-ground and Subsurface Utility Engineering.

UML (Unified Modeling Language)	UML is a standardized modeling language used to visually represent and communicate the structure, behavior, and relationships of software systems and components. In the context of the CIM, UML can be utilized to model and describe the power system components, providing a common language and visual representation that aids in understanding and integrating the CIM with other systems and standards.

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