Digital Twin
Ontario

Digital Records Requirements and Standards

Digital Twin Ontario

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Digital Twin Ontario

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I. Executive Summary

Digital Twin Ontario's (DTO) Digital Records Requirements and Standards Document (also referred to as the Document) provides an overview of the expectations and requirements of Delivery Partners in sharing Data with the province for relevant Infrastructure Projects in Ontario. These requirements have been formed in accordance with national and international standards focusing on sharing Building Information Modelling (BIM) and Geographic Information System (GIS) Data. Central to the requirements is the expectation for Delivery Partners to implement a robust Data Taxonomy Hierarchy with five levels of organization, and the application of standards adherence for efficient Data exchange and secure Data management.

Delivery Partners are required to provide Data on a regular cadence (of which the frequency is to be established) as it becomes available. When providing Data, Delivery Partners are required to abide by the requirements and standards outlined in this document as they apply.

The Document requirements in Sections I through IV set the expectation for Delivery Partners to share Data in a structured manner as per the Data Taxonomy and relevant standards. For BIM Data, this includes the ISO 19650 series standards, in addition to standards such as ISO 19650-1, ASCE 38-22, and CSA S25020. Additionally, the Document provides specific guidance on Infrastructure Type and Candidate Model specifications with standards such as IFC 4.3, ISO 16738-1, Uniclass 2015, IFC, and LandInfra. Delivery Partners sharing GIS Data are required to adhere to ISO19100 series and ISO 8601 standards. Lastly, the importance of Data Security and governance is highlighted, noting the expectation that Delivery Partners follow ISO/IEC 38500 and ISO/IEC 27001 in establishing IT governance and an Information Security Management System (ISMS).

By adhering to the requirements and standards in this Document, Delivery Partners will experience a number of benefits. These include (but are not limited to) Interoperability, improved Data Sharing and Collaboration, higher Data Quality and Consistency, improved Data Integration and analysis, and Global Compatibility.

II. Introduction

1. Purpose of the Digital Records Standards and Requirements Document

Digital Twin Ontario's (DTO) Digital Records Requirements and Standards Document (also referred to as the Document) provides an overview of the expectations and requirements of Delivery Partners in sharing Data with the province for relevant Infrastructure Projects in Ontario. These requirements have been formed in accordance with national and international standards focusing on sharing Building Information Modelling (BIM) and Geographic Information System (GIS) Data. These requirements have been formed in compliance with various ISO, CSA, and ASCE standards, in addition to others that have been outlined below in Part 3 of this introduction.

By following the requirements and standards in this Document, Delivery Partners will experience a number of benefits. These include (but are not limited to) Interoperability, improved Data Sharing and Collaboration, higher Data Quality and Consistency, improved Data Integration and analysis, and Global Compatibility. Details on these benefits are provided below in Part 5 of this Introduction.

2. Overview and Structure of Document

The Document is divided into four main sections:

- **Data Taxonomy for Digital Records:** This section focuses on the concept of Data Taxonomy, which involves organizing and categorizing data based on its source, type, format, and relevance to various infrastructure elements. The purpose of Data Taxonomy is to structure data in a consistent way, making it easier for various delivery partners to manage, search, analyze, and use.

- **Building Information Modelling (BIM) Standards**: This section outlines the standards and requirements for effective Data exchange in BIM. It emphasizes the use of international standards like ISO 19650 for interoperability and consistency.

- **Geographic Information System (GIS) Standards**: This section outlines the GIS standards and requirements for sharing GIS data. It covers aspects such as Conceptual Modeling, Transfer Formats, Encoding, Spatial Representation, Spatial Referencing, Temporal Characteristics, Data Quality, Portrayal, Geographic Information Services, Object Catalogues, and MetaData.

- **Data Governance and Security Standards**: This section outlines Data Governance and security standards for Data sharing. It covers aspects such as governance frameworks, Information Security Management Systems, and data management guidelines.

The Glossary, found at the end of the Document, provides a reference description for all capitalized terms in the Document.

3. Compliance with Standards

The Document complies with and references the standards listed in **Figure 1** and **Figure 2** (below). Note that each of the requirements set out in this document specify whether Delivery Partners must adhere to an entire standard or to a certain section of a standard. All Delivery Partners must adhere to the requirements and the respective standards, or sections of standards, that are referenced in each of them.

Figure 1: Relevant BIM Standards by Section

Section	Relevant Standards
Candidate Model	Uniclass 2015 Industry Foundation Classes (IFC) LandInfra Model for Underground Data Definition and Integration (MUDDI) Construction Operations Building Information Exchange (COBie)
Infrastructure Type	2022 IFC 4.3 ISO 16738-1: 2018 Uniclass 2015 ISO 12006-2:2015 ASCE 75-22 CSA S25020 ASCE 38-22
Data Type	ASCE 38-22 ASCE 75-22 CSA S25020 ISO 19650 ISO 19650-1 BS EN ISO 1192-4

Data Sources and Production	Construction Operations Building Information Exchange (COBie) ISO 19650 2018 ISO 19650 2019 BSI PAS 91
Data Format	ISO/IEC 27001 ISO/IEC 27002 ISO/IEC 27035 ASCE 38-22 ISO 19650

Figure 2: Relevant GIS Standards by Section

Section	Relevant Standards
Conceptual Modelling and Application Schemas	ISO 19101:2014 ISO 19109:2015
Transfer Formats	ISO 19118:2011
Encoding	ISO 19118:2011
Spatial Representation	ISO 19107:2019
Spatial Referencing	ISO 19111:2019 ISO 19112:2019
Temporal Characteristics	ISO 8601 ISO 19108:2019
Data Quality Description and Evaluation	ISO 19157:2013
Portrayal	ISO 19117:2012
Geographic Information Services and Interfaces	ISO 19119:2016 ISO 19128:2005
Object Catalogues	ISO 19110:2016
MetaData	ISO 19115-1:2014 ISO 19115-2:2009

4. Use of this Document

Delivery Partners are required to provide Data on a regular (i.e., quarterly) cadence as it becomes available. When providing Data, Delivery Partners are required to abide by the requirements and standards outlined in this document as they apply.

5. Benefits of Adherence to Standards and Requirements

This section of the Digital Records Requirements and Standards Document outlines the multitude of benefits that are associated with adhering to the standards and requirements set out in this Document.

These standards and requirements, which are applicable across both private and public organizations, present a strategic investment opportunity for organizations. By investing in digital records and standardized processes, organizations may experience several benefits, including but not limited to enhanced collaboration, improved data accuracy, cost savings, increased safety, better asset management, and streamlined processes. Moreover, the interoperability and technology compatibility facilitated by these standards ensure that the benefits of such an investment can be realized by all Delivery Partners involved, including funders, partners, and future asset operators, across the design, build, operation, and maintenance of an asset.

Benefits of adhering to the requirements and standards outlined in this Document include (but are not limited to) the following:

C. Enhanced Collaboration and Coordination

- Adhering to standards and requirements improves collaboration between Infrastructure Owners and Delivery Partners by providing a common language and framework for describing, sharing, and using Data. Use of appropriate tools (e.g., BIM software, IoT Sensors, etc.) also facilitates collaboration and real-time Data sharing among Delivery Partners. Providing guidance on requirements in one place can save time and resources between Delivery Partners in a Project, enabling efficient decision-making and issue resolution.

- Adhering to standards promotes consistency in Data exchange, facilitating better collaboration and coordination among Delivery Partners. This promotes efficient Projects by preventing duplication of Data collection and storage processes.

- Standardized Data sharing practices facilitates coordination, preventing damage during construction or excavation and ensure a safer working environment. This improves collaboration between Delivery Partners, enabling improved Information exchange for more efficient Project delivery.

- 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, thereby enabling enhanced collaboration.

D. Interoperability and Compatibility

- The ISO 19100 series, specific to GIS Data, provides a common framework and standardized Data models for the exchange and integration of Geospatial Data, enhancing interoperability between different systems, platforms, and organizations. Interoperability is important as it allows Data to flow efficiently between systems and parties to support effective collaboration and communication.

- By applying internationally recognized sets of standards, such as ISO 19100 for GIS Data, Ontario can create compatibility with global Geospatial data initiatives and facilitate the exchange of geographic Information across national and international boundaries.

E. Improved Data Accuracy and Quality

- Adherence to standards helps to ensure accuracy and easier integration of drawings into a common Data hub 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.

- Following standards and requirements helps to ensure accurate, reliable, and high-quality Infrastructure Data, enabling informed decision-making and better Asset Management.

- Use of digital tools and platforms enables precise Data collection and standardized Data formats, ensuring consistent and accurate Asset Information, reduced errors, and improved Data quality across Projects.

- For GIS Data, standards promote Data quality by defining standardized MetaData elements, Data models, and specifications, creating consistent Data structures, accurate descriptions, and reliable Data quality assessments that can improve decision-making.

- Adopting Uniclass 2015 standardizes construction Information, ensuring consistent and comprehensive Infrastructure Data across Projects, also enhancing efficiency and accuracy.

- Submitting engineering and design deliverables to a standardized 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.

F. Cost Savings in Asset Management

- Long-term maintenance costs will be reduced by minimizing errors and avoiding rework through adherence to the standards and requirements. Accurate and reliable drawings enable efficient Asset Management, reducing the need for costly corrective measures.

- Standardized processes across Projects streamlines workflows, improves operational efficiency, reduces Data processing time, resulting in cost and time savings for Delivery Partners.

- Providing Digital Asset and records as per the standards and requirements can eliminate the need to physically mark underground Infrastructure (e.g., during Locate Requests). This can save time and money by eliminating the need for locators to visit the field for marking.

- 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.

- Leveraging digital tools and standards relating to comprehensive Asset Management aspects lead to cost savings by optimizing Asset performance, reducing maintenance costs, and improving lifecycle management.

G. Increased Safety and Risk Reduction

- Following and complying with standards and requirements enhances safety by mitigating the risk of strikes and minimizes rework through improved Asset coordination.

- Ensuring Infrastructure Data is properly identified can prevent accidents and reduce the risk of Infrastructure damage. For example, proactively notifying Infrastructure Owners when a utility has been located helps maintain a safe working environment and mitigates potential liabilities for Delivery Partners.

- Digital Assets and their respective standardization can help Delivery Partners identify areas where maintenance is required, or safety hazards exist and schedule repairs before problems occur.

- Digital Assets, especially when formed using the standards and requirements outlined in the, 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.

H. Better Asset Management and Maintenance

- Improved integration of Data with other relevant information as a result of standardization enables proactive maintenance planning and asset condition monitoring.

I. Operational Sustainability and Technology Compatibility

- Adhering to a set of common standards helps to ensure compatibility with emerging technologies, allowing for seamless integration with technologies and advanced analytics to enhance Infrastructure operations and decision-making.

- Adopting standardized 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.

- 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 Infrastructure Data and enables seamless integration with new tools, platforms, and technologies.

J. Streamlined Processes and Increased Efficiency

- Access to standardized Data provides Infrastructure owners and other Delivery Partners with time sensitive information (i.e., repairs and maintenance data, etc.) which in turn avoids construction delays.

- Following the standards and requirements with respect to Data sharing provides clear requirements 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.

- 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 through standardized processes, and effective risk management due to prompt issue resolution.

K. Ease of Regulatory Compliance

- Digital Assets and records enable Delivery Partners to more easily comply with timelines and regulatory requirements set out in legislation. For example, Delivery Partners can respond faster and more efficiently to Locate Requests by eliminating field visits.

L. Enhanced Transparency

- Providing deliverables and relevant Information to a system of reference in accordance with standards and requirements can generate transparency in Project operations, which can build trust across Delivery Partners and enhance Project delivery.

M. Improved Project Management

- By following the standards and requirements with respect to Data sharing, Delivery Partners are provided with a clear process to review, approve, and transmit shared Data. This supports proper acknowledgement and standardized transmission of Data to relevant Delivery Partners.

- 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.

N. Improved Data Management

- Adhering to standards, including Common Information Model (CIM) standards enables the integration and analysis of Data, allowing for valuable insights, proactive Asset Management, maintenance planning, and optimization of Infrastructure operations.

- By following the standards and requirements with respect to Data sharing, Delivery Partners can mitigate confusion and helps ensure that the correct Data is shared with other relevant Delivery Partners on time. Additionally, Delivery Partners can request and receive timely updates and participate in regular reviews to support accuracy and relevance.

O. Data 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 models of Infrastructure.

P. Intellectual Property Safeguarding and Data Protection

- Compliance with standards and requirements helps safeguard valuable intellectual property from unauthorized access, theft, or infringement. Further, following these standards and requirements ensure effective management and safeguarding of sensitive Data, reducing the risk of unauthorized access or Data breaches.

III. Data Taxonomy for Digital Records

Data Taxonomy involves organizing and categorizing Data based on its source, type, format, and relevance to various Infrastructure Elements. Data Taxonomy helps to structure the Data in consistent way, making it easier for various Delivery Partners to manage, search, analyze and use.

The required Data Taxonomy hierarchy, when sharing Data with the province of Ontario for both BIM and GIS Data, has 5 hierarchical levels for categorization: the Candidate model; Infrastructure Type; Data Type; Data Source; and Data Format.

An example of the Data Taxonomy hierarchy for shared Data is as follows:

- **Candidate Model:** Uniclass 2015
    - **Infrastructure Type:** Public Buildings and Public Facilities
        - **Data Type:** Design Data
            - **Data Source:** Architectural Firm

- **Data Format:** RVT (Autodesk Revit)
  - Model Element
  - Model Interfaces
  - Model Objects

Delivery Partners are expected to organize their Data using this hierarchy, and the specified categories, to ensure efficient and effective Data sharing. Each hierarchal level is explained in more detail below.

1. Candidate Model

- Candidate Model is the first or highest level of the Data Taxonomy.
- A Candidate Model is the specific framework or structure for organizing and interpreting Data. Candidate Models, in this context, are international or national standards that define how certain Data Types should be organized, what they should consist of, and how different pieces of Data relate to each other.
- The Candidate Models required to enable the requirements of this Document include (but are not limited to) IFC, Uniclass 2015, MUDDI, and LandInfra.

2. Infrastructure Type

- Infrastructure Type is the second or second highest level of the Data Taxonomy.
- Infrastructure Types within this Document are defined for the purpose of categorizing Data for Projects and Data sharing.
- Infrastructure Data should be categorized based on their Industry and function, including but not limited to the following seven (7) categories:

1. Transportation Infrastructure
2. Energy Infrastructure
3. Water and Wastewater Infrastructure
4. Telecommunications Infrastructure

5. Public Buildings and Public Facilities
6. Environmental Infrastructure
7. Industrial Infrastructure

3. Data Type

- Data Type is the third highest level of the Data Taxonomy.
- Data Types define the specific categories in which Data is classified and organized for purposes of adhering to requirements. Data Types provide a comprehensive view of the construction, from its physical characteristics to its usage and maintenance history.
  - Environmental Data
    - Data related to environmental conditions surrounding Infrastructure that can impact its performance and longevity. This includes Data on weather patterns, climate change projections, soil quality, seismic activity, noise level, and air quality.
  - Design Data
    - Data related to the design and construction of Infrastructure Assets. This includes architectural plans, engineering drawings, and material specifications.
  - Geospatial Data
    - Geospatial Data includes geographic information such as maps, satellite imagery, and spatial Datasets that provide the physical context of the construction.
    - Geospatial Data is crucial for any Project as it provides Information about geographical locations, boundaries, and features. this includes GPS coordinates, elevation Data, land use Information, topology, and distances.
  - Operational Data
    - Data on how the Infrastructure is used. This includes usage patterns, maintenance records, traffic flow, energy consumption, and other operational aspects of the Infrastructure.
    - To exemplify this; for a road, this might include traffic volume and speed Data; for a building, this might include occupancy rates and energy usage Data.

- Maintenance Data
  - Data about the maintenance history of the Infrastructure. This includes inspections, repair records, replacements, upgrades, Asset performance, Asset lifespans, maintenance schedules, and energy consumption.
  - Maintenance Data can help predict future maintenance needs and identify potential issues before they become serious problems.
- Project Management Data
  - Project management Data relates to the construction or retrofit process itself. This includes construction schedules, budgets, resource allocation, and progress reports.
  - Project management Data can be useful for managing the Project and predicting its outcome.
- Regulatory Data
  - Data about relevant regulations and standards. This includes building codes, environmental regulations, and safety standards.
  - Regulatory Data is necessary for ensuring that Infrastructure and Projects comply with all relevant laws and guidelines.
- Sensor Data
  - Real-time Data collected from sensors embedded in the Infrastructure.
  - Sensor Data can provide insights on performance, wear and tear, condition monitoring, and predictive maintenance needs.
  - Modern Infrastructure often includes a variety of sensors that monitor conditions like temperature, pressure, vibration, and strain. This can include Data from IoT devices, such as traffic flow sensors.
  - This real-time Data can be used to create a dynamic Digital Asset record that reflects the current state of the Infrastructure, and can provide valuable insights into the performance, condition, and usage of Infrastructure Assets.
- Structural Data
  - Data related to the physical characteristics and properties of Infrastructure Elements. This includes dimensions, materials used, structural integrity, design specifications,

and load-bearing capacities.

- Structural Data can be derived from CAD drawings, BIM models, and/or structural analysis software.

- Utilities Data

  - Data Sourced from utility companies and organizations. Utilities Data includes Data about the utilities connected to the Infrastructure, such as water, electricity, and gas.

4. Data Source

- This Document identifies relevant Data Sources that will provide accurate, up-to-date, and comprehensive Information for the creation and maintenance of Data repositories.

- Data should be tagged with up to two Data Sources. This accommodates considerations for Data that fits into more than one Data Source category. For example, a Data Source from a utilities company or owner can be satellite/aerial imagery.

- Data Sources for this Document include Data from:

  - Architecture, Construction, and Engineering Firms
  - Environmental Agencies and Companies
  - Government Databases
  - Infrastructure Owners and Operators
  - IoT Devices (IoT refers to Internet of Things, meaning the collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves. IoT sensors are pieces of hardware that detect changes in an environment and collect Data.)
  - Public Records
  - Satellite Imagery, Aerial Imagery, and Remote Sensing
  - Transportation Agencies and Owners
  - Utilities Companies and Owners

5. Data Format

- Data Formats refer to the specific structure in which Data is stored and exchanged. Data Formats are syntaxes for structuring Data and dictate how Data should be represented and encoded, as well as organized and interpreted by different systems.
    - For example, in a Digital Asset record of a bridge, Data Formats could include a 3D Model and GeoJSON.

IV. Building Information Modelling (BIM) Standards

This section is intended to depict the requirements and standards necessary for effective BIM Data exchange between various Delivery Partners. The section includes requirements pertaining to international standards that govern the use, sharing, and management of BIM Data, ensuring Interoperability and consistency across different platforms and software. The Document also highlights best practices for Data Security and integrity when sharing BIM Data.

The requirements follow the Data Taxonomy hierarchy outlined in the previous section, including Candidate Model, Infrastructure Type, Data Type, Data Source, and Data Format.

By adhering to the standards and protocols outlined in this Document, Delivery Partners can ensure effective, accurate, and secure exchange of BIM Data, leading to more efficient Project execution and more coordinated Infrastructure development.

1. Candidate Model

A Candidate Model is the specific framework or structure for organizing and interpreting Data. Candidate Models in this context are international or national standards that define how certain Data Types should be organized, what they should consist of, and how different pieces of Data relate to each other.

Candidate Models required to enable the requirements in this Document include (but are not limited to) IFC, Uniclass 2015, MUDDI, and LandInfra.

A. Description of Relevant Candidate Models

- Uniclass 2015: Uniclass 2015 should be used as the governing Candidate Model for Project management Data.
    - Uniclass 2015 is a unified classification for the United Kingdom construction Industry, to be adopted and modified as necessary for Ontarian Infrastructure. Uniclass 2015 is used to classify Data for use in all aspects of construction, from organizing libraries and cost Information to structuring Project Information.
    - Each of the Uniclass 2015 tables features a four-level classification hierarchy, with each level providing a greater level of detail.
    - The Uniclass 2015 Level Format is as follows:
        - Level One: Group (Xx_00)

    - Level Two: Subgroup (Xx_00_00)
    - Level Three: Section (Xx_00_00_00)
    - Level Four: Object (Xx_00_00_00_00)

- Industry Foundation Classes (IFC): IFC should be used as an option for the governing Candidate Model for structural Data.
    - IFC is an open, Object-oriented file format to facilitate Interoperability in the building Industry. IFC is used to describe, exchange, and collaborate on building or Infrastructure Data.
- LandInfra: LandInfra should be used as an option for the governing Candidate Model for structural Data.
    - LandInfra is a standard for land and civil engineering Infrastructure that supports 3D and 4D modeling.
- Model for Underground Data Definition and Integration (MUDDI): MUDDI should be used as an option for the governing Candidate Model for structural utilities.
    - MUDDI is a standard for urban Data exchange and integration.

B. Distinguishing Between Uniclass 2015 and IFC

- Use 2022 IFC 4.3 and ISO 16738-1:2018 (IFC for Data Sharing in the Construction and Facility Management Industries Part 1: Data Schema) to facilitate Interoperability between different software applications used in the construction Industry (regarding software interactions and Data exchanges).
- Utilize Uniclass 2015 and IFC in conjunction with one another. 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.

C. Asset Classification Standard Based on Uniclass 2015

- To assist in understanding the Uniclass 2015 standard, use 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. Ro – Roles
9. FI – Form of Information
10. PM – Project Management
11. TE – Tools and Equipment
12. Zz – CAD

D. SUE and BIM Requirements

- For SUE and BIM practices, follow an Asset Classification Standard based on Uniclass 2015 and IFC for software interactions.
- Delivery Partners are required to follow these standards for agreements, intellectual property, and ownership.
- The standard for exchange of information about a facility is administered through the requirement of the Construction Operations Building Information Exchange (COBie) international standard.

E. SUE and IFC Requirements

- The use of IFC in the context of SUE 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 secured 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.

5. Capture geometry and attributes Information for underground utilities and geological zones.

F. Requirements for Project Close-Out (ISO 19650 Process)

- Ensure both the duration and manner of storage of information (including format) is clear within the appointment documentation.

Relevant Standard(s):

- ISO 19650
- Uniclass 2015
- Industry Foundation Classes (IFC)
- LandInfra
- Model for Underground Data Definition and Integration (MUDDI)
- Construction Operations Building Information Exchange (COBie)

2. Infrastructure Type

Infrastructure Types are defined for the purpose of categorizing Data for Projects and Data sharing. There are seven main Infrastructure categories which include: Transportation Infrastructure; Energy Infrastructure; Water and Wastewater Infrastructure; Telecommunications Infrastructure; Public buildings and Public Facilities; Environmental Infrastructure; and Industrial Infrastructure.

A. Infrastructure Categories and Subcategories

Delivery Partners are required to classify Data into specific categories, particularly Infrastructure Types, for purposes of adhering to requirements. Delivery Partners must classify Data into the following Infrastructure Type (note - this is not an exhaustive list of examples for each Infrastructure Type):

- Telecommunications Infrastructure: Delivery Partners are required to classify Data under the Telecommunications Infrastructure Type when it pertains the following (including but not limited to):
  - Fiber Optic Network
    - Provides high-speed internet access to homes, businesses, and institutions.
  - Cellular Network

    - Enables wireless communication and Data transfer.
  - Data Centre
    - Houses servers and Infrastructure for storing and processing digital Information.
  - Wired Infrastructure
    - Include details with respect to fibre optic cables, conduit structures, network terminals, splicing points/closures, and other physical wired Infrastructure.
  - Wireless Infrastructure:
    - Provide Information related to cellular towers, antennas, radios, transceivers, and other wireless communication Infrastructure.
- <u>Transportation Infrastructure:</u> Delivery Partners are required to classify Data under the Transportation Infrastructure Type when it pertains to the following (including but not limited to):
  - Highway or Road
    - Includes major highways like the 401, 407 ETR, and QEW, as well as local and regional roads.
  - Bridge or Tunnel
    - Infrastructure that connects different areas and facilitates transportation over water bodies or through mountains.
  - Airport
    - Includes major international airports like Toronto Pearson International Airport and Billy Bishop Toronto City Airport.
  - Port or Harbor
    - Infrastructure that facilitates shipping and maritime activities, such as the Port of Toronto and Port of Hamilton.
  - Railway
    - Includes both passenger and freight railways, such as GO Transit and Canadian National Railway.

- Energy Infrastructure: Delivery Partners are required to classify Data under the Energy Infrastructure Type when it pertains the following (including but not limited to):
    - Power Generation Facility
        - Includes nuclear, hydroelectric, natural gas, and renewable energy power plants.
    - Transmission and Distribution Network
        - Transfers electricity from power generation facilities to homes, businesses, and industries.
    - Natural Gas Pipeline
        - Transports natural gas from production areas to distribution centres and consumers.
- Water and Wastewater Infrastructure: Delivery Partners are required to classify Data under the Water and Wastewater Infrastructure Type when it pertains to the following (including but not limited to):
    - Water Treatment Plant
        - Treats raw water to make it safe for drinking and other uses.
    - Water Distribution Network
        - Transports treated water to homes, businesses, and industries.
    - Wastewater Treatment Plant
        - Cleans and treats wastewater before it is released back into the environment.
    - Sewer System
        - Collects and transports wastewater from homes, businesses, and industries to wastewater treatment plants."
- Public Buildings and Public Facilities: Delivery Partners are required to classify Data under the Public Buildings and Public Facilities Infrastructure Type when it pertains the following (including but not limited to):
    - Government Building
        - Includes legislative buildings, courthouses, and administrative offices.

    - School or University
        - Provides education and research facilities.
    - Hospital or Healthcare Facility
        - Offers medical services and care.
    - Community Centre or Library
        - Provides` public spaces for recreational activities and access to Information.

- Environmental Infrastructure: Delivery Partners are required to classify Data under the Environmental Infrastructure Type when it pertains the following (including but not limited to):
    - Waste Management Facility
        - Includes landfills, recycling centres, and composting sites.
    - Green Space or Park
        - Provides recreational areas and preserves natural habitats.
    - Conservation Area
        - Protects and preserves natural resources and ecosystems.
- Industrial Infrastructure: Delivery Partners are required to classify Data under the Industrial Infrastructure Type when it pertains to the following (including but not limited to):
    - Manufacturing Plant or Factory
        - Produces goods and products.
    - Warehouses or Distribution Centre
        - Stores and distributes goods.
    - Industrial Park
        - Provides space for industrial activities and businesses.

B. Relevant IFC Schema for Projects

- Follow the relevant IFC schemas for a Project based on 2022 IFC 4.3 and ISO 16738-1:2018 (IFC for Data Sharing in the Construction and Facility Management Industries Part 1: Data Schema).

C. ASCE and CSA Standards for Recording and Exchanging Utility Infrastructure Data

- Delivery Partners should:

    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.

D. Integrated Requirements from CSA S25020 Mapping of Underground Utility Infrastructure

- Ensure Reliability and Accuracy of Cadastral Parcel Data:

    - Derive Cadastral Parcel Data from authoritative provincial sources, preferably land registry systems.

        - Relate parcel mapping to topographical and geographical features to achieve required reliability and accuracy of the record.

- Correct Mapping Records:

    - Notify owner/operator of errors and omissions in mapping records.

        - 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.

        - Develop and educate key Project Partner groups on discrepancies between records and physical location of underground utility Infrastructure.

        - Categorize discrepancies based on risk and significance to drive urgency of record adjustment.

        - Submit observations to appropriate person or department with relevant Information.

- Obtain Information about Utility Infrastructure in Construction Area:

    - 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:

    - Consider the use of tracer wire, electromagnetic markers, or similar methods of locating for non-conductive underground utility Infrastructure.

    - Establish and follow a standard installation location to assist with mapping and locating of underground utility Infrastructure.

- Share received utilities mapping Information with relevant utilities Industry Delivery Partners for the Project.

- 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

Note: Failure to note errors or omissions in mapping records could result in future damage to the utility Infrastructure and impact public safety.

E. Techniques for Data Integration

- Use 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, air conditioning (HVAC), elevator systems, as well as fire protection systems.

F. Effective Data Management and Maintenance

- To ensure effective Data management and maintenance, measure and record the location of underground utility Infrastructure as-is according to CSA25020.

Relevant Standard(s):

- 2022 IFC 4.3
- ISO 16738-1: 2018
- Uniclass 2015
- ISO 12006-2:2015
- ASCE 75-22
- CSA S25020
- ASCE 38-22

3. Data Types

Data Types are the specific categories in which Data is classified and organized. Each Data Type requires specific methods for processing and analysis. A Data Type defines the structure and characteristics of the Information that will be used to create and maintain models of Infrastructure Assets.

A. Data Types Defined and Classification Requirements

- Delivery Partners are required to classify Data within the specific categories in which Data is organized for purposes of adhering to requirements. Data Types provide a comprehensive view of the construction, from its physical characteristics to its usage and maintenance history.

- Delivery Partners are required to classify Data within the following Data Type categories (including but are not limited to):

    - Environmental Data:

        - Data related to environmental conditions surrounding Infrastructure that can impact its performance and longevity.

        - This includes Data on weather patterns, climate change Projections, soil quality, seismic activity, noise level, and air quality.

    - Design Data:

        - Data related to the design and construction of Infrastructure Assets.

        - This includes architectural plans, engineering drawing, and material specifications.

    - Geospatial Data:

        - Geospatial Data which includes geographic Information such as maps, satellite imagery, and spatial Datasets that provide the physical context of the construction.

    - Operational Data:

        - Data on how the Infrastructure is used.

        - This includes usage patterns, maintenance records, traffic flow, energy consumption, and other operational aspects of the Infrastructure.

        - To exemplify this; for a road, this might include traffic volume and speed Data; for a building, this might include occupancy rates and energy usage Data.

- Maintenance Data:
  - Data about the maintenance history of the Infrastructure.
  - This includes inspections, repair records, replacements, upgrades, Asset performance, Asset lifespans, maintenance schedules, energy consumption.
- Project Management Data:
  - Data relating to the construction or retrofit process itself.
  - This includes construction schedules, budgets, resource allocation, and progress reports.
- Regulatory Data:
  - Data about relevant regulations and standards.
  - This includes building codes, environmental regulations, and safety standards.
- Sensor Data:
  - Real-time Data collected from sensors embedded in the Infrastructure.
  - Sensor Data can provide insights on performance, wear and tear, condition monitoring, and predictive maintenance needs.
- Structural Data: Data related to the physical characteristics and properties of Infrastructure Elements.
  - This includes dimensions, materials used, structural integrity, design specifications, and load-bearing capacities.
  - Structural Data can be derived from CAD drawings, BIM models, and structural analysis software.
- Utilities Data:
  - Data Sourced from utility companies and organizations.
  - Utilities Data includes Data about the utilities connected to the Infrastructure, such as water, electricity, and gas.

B. Standards for Deliverables Formatting

- Delivery Partners are required to comply with requirements for Subsurface Utility Engineering (SUE) deliverable formatting and recording in accordance with ASCE 38-22, ASCE 75-22, and CSA S25020.

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

  - 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.

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

C. Standardized Modeling and Documentation Practices

- To ensure effective modeling and documentation, Delivery Partners are required to implement the following practices:

  - Plan the modeling process

  - Determine the Model Location and Model Orientation

  - Establish naming conventions and structures; and

  - Defining the Level of Development (LOD)

D. Data Ingestion and Data Exploration

- To ensure effective Data Ingestion and Data Exploration, Delivery Partners are encouraged to implement the following practices:

    - Use visualization tools and techniques to analyze Data housed in the BIM Platform.

    - This includes scatter plots, 3D visualization, line charts, and heat maps to represent Data relationships.

E. Data Sharing and Collaboration

- Delivery Partners are required to follow the pre-appointment processes in ISO 19650 series. Clear statements of the duties, rights, and deliverables are set out with the ISO 19650 processes to be included in tender documents and appointments.

F. Key Information Requirements for BIM

- As a key Information requirement for BIM, Delivery Partners are required to provide and address classification challenges, such as inconsistent Data Formats or missing Information.

G. Building Information Modelling to Facility Management (BIM-to-FM)

- Delivery Partners are required to 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).

H. Effective Data Management and Maintenance

- Delivery Partners must adhere to key standards (e.g., ISO 19650 and BS EN ISO 1192-4) during a Project. In compliance with these standards, Delivery Partners must ensure the following key tasks are completed:

  - Create specific formats and means for Data sharing to ensure newly built Infrastructure Data can be ingested into the Delivery Partner's Data hub.

  - 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.

  - 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 (DEEP).

Relevant Standard(s):

- ASCE 38-22
- ASCE 75-22
- CSA S25020
- ISO 19650
- ISO 19650-1
- BS EN ISO 1192-4

4. Data Sources and Production

A Data Source is the origin or location from which Data is collected or obtained for use in the Digital Model environment. Data Sources represent the specific systems, devices, or sources that generate or provide the Data needed to create and maintain the Digital Model of Infrastructure Assets.

A. Data Sharing and Collaboration in Construction Projects

- Utilize Construction Operations Building Information Exchange (COBie) to facilitate effective Data sharing and collaboration in construction Projects.
- Divide Data into two broad categories:
  1. Data about the Asset Owner's Organization and its coverage; and
  2. Data about the Asset Owner's Assets.

B. Information Requirement Types

- Asset Information Requirements
  - Follow ISO:19650-1:2019 as it pertains to Data and Information requirements in relation to the operation of an Asset.
- Organization Information Requirements
  - Follow ISO 19650-1:2018 as it pertains to what, when, how, and for whom Information is to be produced in relation to organizational objectives.
- Exchange Information Requirements
  - Follow ISO 19650-1:2018, 3.19 as it pertains to how Data and Information is expected to meet specifications during the Project.

C. Data Ingestion, Exploration, and Consolidation

- Consolidate all Data Types and sources and import them into a BIM platform to create a comprehensive Digital Asset record of the Project. This ensures all Project-related Data is consolidated and synchronized.
- Implement a dynamo script and develop an API to streamline the Data Ingestion process.
- Utilize the BIM platform to access and analyze Data from various sources.
- Adhere to ISO 19650 exploration or visualization methods when sharing Data with the provincial government.

D. BIM Processes for Data Collection

- Demonstrate preparedness for a Project by using BSI PAS 91 with vendors and use the BSI PAS 91 optional question set for developments where BIM is required.

E. Key Information Requirements for BIM

As a key Information requirement for BIM, Delivery Partners are required to integrate Data from various sources, such as Reality Capture, GIS, and BIM as per ISO 19650.

F. Derive Absolute Geodetic Positions

- When deriving geodetic positions, use absolute geodetic positions for Data exchange purposes, although relative positioning is useful for some purposes.

G. Information Management Processes to achieve BIM ISO 19650 Standards

<u>Briefing Concept Phase</u>

In the Briefing Concept Phase, the following ISO 19650 Processes and Requirements should be considered:

- Delivery Partners should consider following the pre-appointment processes in ISO 19650 series. Clear statements of the duties, rights, and deliverables are set out with the ISO 19650 processes which can be included in tender Documents and appointments.

- Intentional decisions about the creation of digital records as per ISO 19650 should be considered at the onset of a Project such that the Project produces digital records at a sufficient quality.

<u>Defined Design Phase</u>

In the Defined Design Phase, the following ISO 19650 Processes and Requirements for Collaborative Production of Information should be considered:

- Ensure the obligations within the appointment documentation include, at a minimum, the matters detailed in Section 5.6.2 of ISO 19650-2.

- Requirements for Information Model Delivery (ISO 19650 Process)

- 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 accept or reject the Information.

- Review the Information, taking account of the matters listed in Section 5.7.4 of ISO 19650-2 and either accept or reject the Information.

H. Approach to the Build and Handover Stage and Master Information Delivery Plan

In the Build and Handover Stage, create a construction Master Information Delivery Plan combining the construction Task Information Delivery Plans from all Delivery Partners.

I. Approach to the Operate and Maintain Stage

- Maintain the Asset Information Model as required to support Data sharing by:
  - Ensuring that Data and Information are managed and shared in accordance with the Information Management plan.
- 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.

Relevant Standard(s):

- Construction Operations Building Information Exchange (COBie)
- ISO 19650 2018
- ISO 19650 2019
- BSI PAS 91

5. Data Format

Data Formats refer to the specific structure in which Data is stored and exchanged. Data Formats are syntaxes for structuring Data and dictate how Data should be represented and encoded, as well as organized and interpreted by different systems. Delivery Partners are required to classify Data into these Data Formats for purposes of adhering to requirements.

A. Asset Dataset Catalogue (Vector)

- For the Asset Owner's source vector Datasets, the following is required:
  - Deliver Transformation Artefacts
    - Provide two types of Transformation Artefacts to support Asset Owners, which are DataCatalogue.xlsx and Transformation.xlsx.
  - Enforce Consistent Format
    - Ensure that Asset Owner source files are delivered in a consistent format when resupplied, and related Data Ingestion specification documentation.

- Perform Change Control
    - Capture any changes in format or structure required in future iterations of this Document under change control.
- Provide Stamped Plans
    - Require stamped plans from Project teams involved in construction to depict horizontal and vertical structures at their achieved Quality Levels while meeting or exceeding the Quality Level B standard, in alignment with ASCE 38-22/ASCE 75-22/ CSA 25020 / ISO 19650 with some exceptions.

B. Asset Dataset Catalogue (Raster)

- Delivery Partners must deliver the Asset Dataset Catalogue (Raster) in Zip Compressed Format to facilitate Data transfer and storage. Delivery Partners must also provide summary Information about the Asset Owner's source Raster Datasets in a table.

- The table summarizing the Asset Owner's source Raster Datasets should include the following contents:

    1. <u>Dataset Name</u>: This is the unique identifier or name of each Raster Dataset. It allows for easy reference and organization.

    2. <u>Dataset Description</u>: A brief overview of what each Dataset represents. This could include the type of Data, the area it covers, and its purpose or use.

    3. <u>File Format</u>: The format in which the Raster Data is stored, such as TIFF, JPEG, PNG, etc. This is important for understanding how to access and use the Data.

    4. <u>File Size</u>: The size of each Raster Dataset. This can be useful for planning storage and transfer requirements.

    5. <u>Date of Creation/Last Update</u>: The date when each Raster Dataset was created or last updated. This helps to understand the timeliness and relevance of the Data.

    6. <u>Source/Origin</u>: Where the Raster Data came from or who created it. This could be a particular department, agency, contractor, etc.

    7. <u>Data Quality/Resolution</u>: Information about the quality or resolution of the Raster Data. This can affect how the Data can be used and interpreted.

    8. <u>Access Restrictions</u>: Any restrictions on who can access or use the Raster Data. This could include privacy considerations, licensing restrictions, etc.

9. MetaData: Any additional Information about the Data, such as the coordinate system used, the scale, Projection, etc.

C. Data Taxonomy

- Data Taxonomy involves organizing and categorizing Data based on its source, type, format, and relevance to different Infrastructure Elements.
- Delivery Partners should use Data Taxonomy to structure the Data in a meaningful way, making it easier to manage, search, and analyze.

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

- Delivery Partners are expected to adhere to an Iterative Cycle of sensing and ingesting Data from various sources.
- Classify Data based on criteria such as location, type, and time, refining it by analyzing and cleaning to remove errors or inconsistencies, deciding on potential issues, opportunities, and trends to make informed Project decisions, and finally acting or optimizing the Project based on insights from the Data analysis.

E. Application of Existing Standards in the Briefing Concept Stage

Record MetaData related to Projection and coordinate information along feature types, geometry types, and attributes, as specified in ASCE 38-22 and ISO 19650.

F. Document Requirements for Build and Handover Stage

- Create and finalize documents to include designs in the "As-Constructed" or "As-Built" format as well as all necessary information from the briefing concept stage. The Asset Information Model should be utilized during this process.
- Delivery Partners should use BIM during this 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.
- The Asset Information Model is maintained in accordance with the Digital Asset Objectives set by the proponent. This ensures that the Asset can deliver benefits to Ontario in a timely and effective manner.

G. Secure Data Transmission

- Delivery Partners must use secure methods for transmitting Data between organizations, in a Project, or interaction with other Delivery Partners. This includes using encrypted connections and secure file transfer protocols.

- Delivery Partners are expected to implement Transport Layer Security (TLS) and Secure File Transfer Protocol (SFTP), equivalent or more secure, as standard during Data exchange. TLS and SFTP are international standards for transmitting Data.

- Delivery Partners must implement encryption measures to protect the confidentiality and integrity of the transmitted Data. Delivery Partners must agree on Leading Practice for the encryption method(s) and protocol(s) used in Data transmission.

- At a minimum, Delivery Partners must annually review and update their secure Data transmission practices to align with Leading Practice(s).

- Delivery Partners are expected to make aware and train the organizational team and Project team members on the proper procedures for secure Data transmission.

- Any incidents or breached related to Data transmission should be promptly reported and addressed according to the established incident response procedures.

- Delivery Partners must ensure their compliance with ISO/IEC 27001, and ISO/IEC 38500 for Information security management, code of practice for Information security control, for cloud services, and Information security incident management. For more Information, please see Section VI of this Document.

Relevant Standard(s):

- ISO/IEC 27001

- ISO/IEC 27002

- ISO/IEC 27035

- ASCE 38-22

- ISO 19650

V. Geographic Information System (GIS) Standards

This section of the Document focuses on Geographic Information System (GIS) Standards and the requirements for sharing GIS Data among various Delivery Partners. In the realm of Infrastructure development and management, GIS has emerged as a pivotal tool, enabling the capture, management, analysis, and display of geographically referenced Information.

This section is designed to outline the GIS standards and Data sharing requirements, particularly emphasizing the protocols and requirements necessary for efficient Data exchange between diverse Delivery Partners. It details the international standards, such as those set by the Open Geospatial Consortium (OGC) and the International Organization for Standardization (ISO), that govern the use, sharing, and management of GIS Data, ensuring Interoperability and consistency across different platforms and software.

By adhering to the standards and protocols outlined in this Document, Delivery Partners can ensure effective, accurate, and secure exchange of GIS Data, leading to more efficient Project execution and superior Infrastructure development.

1. Conceptual Modelling and Application Schemas

Partners are expected to standardize the way they visualize the design of geospatial schemas by using a common a set of symbols and diagrams to represent different aspects of various schemas, including a schema's structure, behavior, and interactions.

A. Schema Type

- The application schema should be used to define the structure and type of Data that will be shared. This includes defining the classes, class properties, Data Types, relationships, constraints, and operations that can be performed on the Data.

- The schema should be based on the General Feature Model (GFM) defined in ISO 19109:2015, which provides a standard model for representing geographic features.

B. Schema Definition

- The schema should be defined in such a way that it can be easily understood and implemented by application developers. This includes providing clear definitions and descriptions for all classes, properties, and relationships.

- The schema should be designed to support Interoperability between different systems and applications. This means that the schema should be based on standard Data Types and structures and should avoid proprietary or system-specific features.

C. Conceptual Schema Language

- The schema should be defined using a standard conceptual schema language such as the Unified Modeling Language (UML). UML is recommended because it is a widely accepted standard for defining conceptual schemas, and it is supported by a wide range of tools and technologies.

- The use of UML also supports the requirements of ISO 19101:2014, which recommends the use of UML for defining geographic Information Models.

Requirements are based on the ISO 19101:2014 and ISO 19109:2015 standards and are designed to ensure the integrity and usability of the GIS Data. It is important that all partners adhere to these requirements when sharing Data with the province.

Relevant Standard(s):

- ISO 19101:2014

- ISO 19109:2015

2. Transfer Formats

Delivery Partners are expected to adhere to standards for the transfer of geographic Data to support integration and Interoperability. The transfer formats should accurately represent and maintain the integrity of the geometry, attribute Data, and their links, as well as the MetaData. Standardizing transfer formats involves leveraging a common set of encoding rules and Data Formats that adhere to ISO 19118:2011.

A. Transfer of Geometry

- All geometric Data should be encoded in a format such Geography Markup Language (GML) that maintains the integrity of the geometric structures as per ISO 19118:2011.

- The encoding format must accommodate the representation of both 2D and 3D geometric Data in accordance with the provisions of ISO 19118:2011.

- The geometric Data must be explicitly defined within the context of the utilized Coordinate Reference System (North American Datum 1983) as stipulated by ISO 19118:2011.

B. Transfer of Links Between Geometry and Attribute Data

- There should be a clear linkage between geometric Data and its corresponding attribute Data. This linkage should be maintained during the encoding process.

- The linkage Information should be encoded using the rules defined in ISO 19118:2011 to ensure that the relationship between the geometric and attribute Data is not lost or misrepresented in the transfer process.

- Encoding formats that facilitate a transparent linkage between geometry and attributes, such as Geography Markup Language (GML) or Keyhole Markup Language (KML), should be utilized in accordance with the specifications of ISO 19118:2011.

C. Transfer of Attribute Data

- All Attribute Data must be encoded in a format that preserves the integrity of the Data, conforming to ISO 19118:2011 standards.

- The encoding process should accommodate various types of Attribute Data including, but not limited to, numerical, textual, date/time, and Boolean Data Types.

- The attribute Data must be correctly associated with the corresponding geometric Data during the encoding process.

- Formats such as CSV, GML, or KML that are capable of effectively storing attribute Data should be utilized.

D. Transfer of MetaData

- All MetaData should be transferred along with the geographic Data. The MetaData should be encoded using the rules defined in ISO 19118:2011.

- The MetaData should include Information about the Data Source, Data quality, Data creation date, Data update frequency, attribute definitions, and any other relevant Information.

- The MetaData should be associated with the correct geographic Data during the encoding process.

- MetaData should be provided in a standard format such as XML or JSON following the schema provided by ISO 19115 for MetaData Information.

E. Transfer of LiDAR Data

- LiDAR Data should be captured using equipment and methodologies that meet the standard of accuracy as defined in ISO 19118:2011. The equipment and methodologies should be approved to ensure the reliability of the Data.

- The LiDAR Data should be encoded in a format that preserves the integrity of the point cloud Data. The encoding process must adhere to the encoding rules defined in ISO 19118:2011 to ensure compliance with the standard.

- The LiDAR Data must be georeferenced correctly in accordance with the spatial referencing by coordinates as stipulated in ISO 19118:2011. The Data should be associated with the corresponding Attribute Data during the encoding process to ensure the correct linkage between geometry and attributes.

- MetaData associated with the LiDAR Data, including but not limited to, the date and time of Data collection, the equipment used, and the Data processing steps, should be documented and transferred along with the Data. This MetaData should be structured and presented according to the guidelines provided in ISO 19115:2014 for geographic information MetaData.

Requirements are based on the ISO 19118:2011 standard and are designed to ensure the integrity and usability of the GIS Data. It is important that all partners adhere to these requirements when sharing Data with the Province.

Relevant Standard(s):

- ISO 19118:2011

3. Encoding

In the following section, the guidelines for GIS Data management related to encoding are outlined in accordance with ISO 19118:2011. By adhering to these standards, Delivery Partners can ensure that the GIS Data shared is accurate, consistent, and usable, thereby facilitating effective Data management and optimal utilization. The guidelines encompass recommendations on the encoding format, the storage of Data, the essential components of Data Format, and the validation process. Delivery Partners are to comply with these requirements to maintain Data integrity and ensure efficient Data retrieval and usage.

A. Encoding Format

- The Data should be encoded in an open standard format as per ISO 19118:2011. We recommend the use of XML (eXtensible Markup Language) or JSON (JavaScript Object Notation) as they are widely used, platform-independent, and support a wide range of Data Types.

- For the encoding of spatial Data, GML (Geography Markup Language) or GeoJSON should be used, as these formats are specifically designed to represent geographical features and are in line with the ISO 19118:2011 standard.

B. Data Storage

- The Data should be stored in a manner that maintains its integrity and ensures its longevity as per ISO 19118:2011.

- IO recommends the use of a relational Database management system (RDBMS) that supports spatial Data, such as PostGIS.

C. Data Format Components

i. Header: The header should contain Information about the file, including the file name, creation date, and the software version used to create the file, as per ISO 19118:2011. This provides the necessary MetaData for Data management and traceability.

ii. Index: An index should be created for each Data set to improve ability to retrieve Data. The index should be based on the spatial attributes of the Data, adhering to the ISO 19118:2011 standard which specifies that indexing should be based on the spatial and temporal attributes of the Data.

iii. Data Dictionary: This should contain definitions of all Data Elements, attributes, and other constructs. It should also include Information about the relationships between different Data Elements. This aligns with ISO 19118:2011's requirement for a detailed description of the Data structure and its semantics.

iv. Data Elements: Each Data Element should have a unique identifier and a clear, descriptive name. Data Elements should be structured and encoded in a consistent way to ensure Interoperability, in line with ISO 19118:2011.

D. Validation

- All encoded Data should be validated against the appropriate schema to ensure it meets the encoding requirements of ISO 19118:2011.

- Any errors or inconsistencies should be corrected before the Data is submitted.

- These requirements, in line with ISO 19118:2011, are designed to ensure that the GIS Data is received is accurate, consistent, and usable. All partners sharing Data with the Province must adhere to these requirements.

Relevant Standard(s):

- ISO 19118:2011

4. Spatial Representation

This section provides an overview of spatial representation in the context of GIS, focusing on raster and vector formats, Data collection and representation, and the use of geometric and topographic primitives in compliance with ISO 19107:2019. This standard guides the representation of continuous and discrete phenomena, the methodologies for Data collection and transformation, and the utilization of geometric and topographic primitives. By adhering to this standard, Delivery Partners can ensure the quality, accuracy, and Interoperability of their spatial Data.

A. Raster and Vector Formats

- Raster Data: which represents continuous phenomena such as temperature or elevation, should be represented as a grid of cells or pixels, with each cell representing a specific geographic area and containing a value representing the attribute of interest. This format is in line with ISO 19107:2019's requirements for the representation of spatial-temporal grids.

- Vector Data: used for representing discrete Objects or phenomena that can be clearly delineated, such as roads or buildings, should be represented using points, lines, and polygons. This format is consistent with the ISO 19107:2019 standard's geometric Object types.

B. Data Collection and Representation

- Data should be collected using accurate and reliable methods, such as GPS or remote sensing, to ensure the quality of the spatial representation. The method of Data collection should be documented as part of the MetaData, as required by ISO 19107:2019.

- The Data should be transformed from the field observations to the spatial representation using appropriate methods. For example, GPS coordinates should be transformed to map coordinates using a suitable map projection as per ISO 19107:2019's guidelines for coordinate transformation.

C. Geometric and Topographic Primitives

- Geometric primitives, such as points, lines, and polygons, should be used to represent the shape and location of spatial objects in vector Data. These geometric primitives should be defined using coordinates in a suitable spatial reference system, as outlined in ISO 19107:2019.

- Topographic primitives, such as terrain Elements, should be used to represent the surface characteristics of the earth in raster Data. The topographic primitives should be defined using values in a suitable attribute Data Type, in line with the specifications of ISO 19107:2019.

All aspects of spatial representation should comply with ISO 19107:2019, which provides a general framework for the representation of spatial Objects in a GIS.

Relevant Standard(s):

- ISO 19107:2019

5. Spatial Referencing

This section provides a detailed guide on the requirements for handling Raster and Vector Formats, Data Collection and Representation, and Geometric and Topographic Primitives in GIS Data, in accordance with ISO 19107:2019. It emphasizes the importance of accurate Data collection and appropriate Data representation, using the suitable geometric and topographic primitives for the different types of spatial Data. By following these guidelines, Delivery Partners can ensure that all spatial representations are accurately captured, effectively stored, and easily retrievable. These standards, in line with ISO 19107:2019, are crucial in maintaining the quality, reliability, and usability of the GIS Data.

A. Coordinate Reference System and Units of Measurement

- All GIS Data should adhere to a standard coordinate reference system. The North American Datum 1983 (NAD83) is recommended as it is widely used in Canada for geodetic and topographic mapping.

- All coordinates should be expressed in metres, the standard unit of measure in the NAD83 system, in accordance with the International System of Units (SI).

- Any potential errors or inconsistencies in spatial referencing Data should be reported and addressed promptly. As per ISO 19111:2019 and ISO 19112:2019, an error reporting and rectification process should be in place to maintain the accuracy and reliability of GIS Data.

B. Datum and Sequences of Access

- The datum for all GIS Data should be consistent with the North American Datum 1983 (NAD83).

- The datum defines the position of the origin, scale, and orientation of the axes of a coordinate system.

- Sequences of access, the order in which coordinates are read, should follow the Latitude, Longitude, and Elevation (if applicable) sequence in the NAD83 system.

C. Spatial Referencing by Geographic Identifiers

- All spatial referencing should also adhere to ISO 19112:2019. This includes the use of geographic identifiers to reference geographic locations according to locational attributes, gazetteer, and location-based services.

D. MetaData

- MetaData for spatial referencing must be provided, including the coordinate reference system, datum, units of measurement, and sequences of access used, to ensure Interoperability and accurate interpretation of Data.

The following requirements are aligned with the ISO 19111:2019 - Geographic Information - Referencing by coordinates, and ISO 19112:2019 - Geographic Information - Spatial referencing by geographic identifiers.

Relevant Standard(s):

- ISO 19111:2019
- ISO 19112:2019

6. Temporal Characteristics

This section presents guidelines for managing Temporal Reference Systems in GIS Data, following ISO 8601 and ISO 19108:2019. It covers the use of a standard temporal reference system, implementation of a consistent temporal schema, clear definition of temporal attributes, and the importance of temporal consistency and accuracy. It also underscores the necessity of comprehensive temporal MetaData to ensure accurate Data interpretation and Interoperability. Adherence to these standards ensures high-quality, reliable temporal Data in GIS.

A. Temporal Reference System

- A Temporal Reference System is a system of coordinates used to specify the positions of objects in time. It consists of one or more axes, each of which represents a different time scale. The positions of objects are specified by their distance from the origin, and the time at which they occur.

- All GIS Data should adhere to a standard temporal reference system. The Gregorian calendar is recommended as it is widely used internationally. All temporal Data should be expressed in the ISO 8601 standard format (YYYY-MM-DD for date and YYYY-MM-DDThh:mm:ss for date and time).

B. Temporal Schema

- The temporal schema for all GIS Data should be consistent with ISO 19108:2019. This includes the use of temporal primitives (instants, periods, durations), temporal topology (before, after, meets, overlaps, during, contains, starts, finishes), and temporal reference systems.

C. Temporal Attributes

- All temporal attributes should be clearly defined and associated with the relevant spatial Data. This includes the date and time of Data collection, the period of Data validity, and any significant temporal events related to the Data.

D. Temporal Consistency and Accuracy

- Consistency and accuracy in temporal referencing are paramount. All Data must be thoroughly checked for temporal referencing accuracy before submission. This includes ensuring that all dates and times are correctly formatted according to ISO 8601 and that temporal schemas are correctly applied according to ISO 19108:2019.

E. Temporal MetaData

- MetaData for temporal referencing must be provided, including the Temporal Reference System, temporal schema, and temporal attributes used, to ensure Interoperability and accurate interpretation of Data.

The following requirements are aligned to ISO 8601 - Data Elements and interchange formats - Information interchange - Representation of dates and times, and ISO 19108:2019 - Geographic Information - Temporal schema.

Relevant Standard(s):

- ISO 8601

- ISO 19108:2019

7. Data Quality Description and Evaluation

This section provides guidelines for ensuring Data quality in GIS Data as per ISO 19157:2013. Delivery Partners are required to maintain high positional, attribute, and temporal accuracy, logical consistency in Data structure, and complete inclusion of all required Data Elements. Deviations from these standards must be thoroughly Documented. Compliance with these guidelines ensures the integrity and reliability of GIS Data.

A. Positional Accuracy

- Positional accuracy refers to the degree of closeness between the position of a spatial Object in the Dataset and its true position in the real world. As per ISO 19157:2013

- All spatial Data must meet a minimum positional accuracy of 1 meter. This means that the location of any point in the Dataset should be within 1 meter of its true location in the real world.

- Any deviation from this requirement must be Documented in the MetaData, including the reason for the deviation and the expected impact on Data quality.

B. Attribute Accuracy

- Attribute accuracy refers to the degree of closeness between the attributes of a spatial Object in the Dataset and the true attributes of the corresponding real-world Object.

- All attribute Data must be 95% accurate. This means that the attributes of any spatial Object in the Dataset should match the true attributes of the corresponding real-world Object 95% of the time.

- Any deviation from this requirement must be Documented in the MetaData, including the reason for the deviation and the expected impact on Data quality.

C. Temporal Accuracy

- Temporal accuracy refers to the degree of closeness between the time of a temporal Object in the Dataset and its true time in the real world.

- All temporal Data must be accurate to within 1 minute. This means that the time of any temporal Object in the Dataset should be within 1 minute of its true time in the real world.

- Any deviation from this requirement must be Documented in the MetaData, including the reason for the deviation and the expected impact on Data quality.

D. Logical Consistency

- Logical consistency refers to the degree of adherence to logical rules of Data structure, attribution, and relationships.

- All Data must be logically consistent. This means that the Data structure, attribution, and relationships of all Objects in the Dataset should adhere to the logical rules defined for the Dataset.

- Any deviation from this requirement must be Documented in the MetaData, including the reason for the deviation and the expected impact on Data quality.

E. Completeness

- Completeness refers to the degree to which all required Objects, attributes, and relationships are included in the Dataset. As per ISO 19157:2013, the following requirements apply:

1. <u>Absolute Completeness of Dataset</u>: The dataset should be 100% complete. This implies that it should incorporate all the compulsory elements. The minimum required elements include:

    a. Objects: All pertinent objects associated with the Building Information Modelling data should be included in the dataset. These objects could be buildings, infrastructure, land parcels, or any other physical or conceptual entities.
    b. Attributes: These are the properties or descriptors of the objects. For a building

object, for instance, the attributes could encompass its location, dimensions, construction materials, age, and more.

c. Relationships: These refer to the linkages or associations between different objects. For example, the relationship between a building and a road might be defined as "proximity to", "distance from", etc.

4. Documentation of Deviations: If there are any deviations from the requirement of 100% completeness, they must be comprehensively documented in the metadata. The documentation should entail:

    a. Reason for Deviation: The specific causes leading to the deviation from complete data should be explicitly stated. This could be due to incomplete data, absence of certain objects or attributes, and so on.
    b. Anticipated Impact on Data Quality: An assessment of the potential impact of these deviations on the overall quality and reliability of the dataset should be conducted and documented. This could include potential inaccuracies, misinterpretations, or restrictions in data interpretation.

Data quality is a critical aspect of Geographic Information System (GIS) Data. As per ISO 19157:2013 - Geographic Information - Data quality, the following requirements must be adhered to for partners sharing Data:

Relevant Standard(s):

- ISO 19157:2013

8. Portrayal

ISO 19117:2012 provides a schema for portrayal of geographic Information, defining portrayal rules, symbols, and their properties. Modelling and Application Schemas are about the structure and organization of the Data, while Portrayal is about how that Data is visually represented. Both are important for managing and using GIS Data effectively.

A. Portrayal Principles

- The portrayal of GIS Data must adhere to the principles set out in ISO 19117:2012, Geographic Information - Portrayal. This standard provides a schema for describing the portrayal of geographic Information for visualization, analysis, and Data Exploration.

- Portrayal should be designed to facilitate understanding of the geographic Information being presented, considering the intended audience and the purpose of the Data sharing.

B. Data Portrayal Methods

- Delivery Partners must use methods that are consistent with ISO 19117:2012 to portray the Data. These include direct portrayal (where the Data is displayed directly) and indirect portrayal (where the Data is transformed before display).

C. Computer Graphic Standards

- Delivery Partners are required to use computer graphic standards such as OpenGL, PHIGS, and GKS for Data portrayal. These standards are consistent with the requirements of ISO 19117:2012 and provide a framework for creating and manipulating visual representations of Data.

D. Visualization of Geometry Using Attributes

- When visualizing geometry, Delivery Partners must use attributes in a manner consistent with ISO 19117:2012. This includes using attributes to determine the size, shape, colour, and texture of the geometric Elements.

- The use of attributes should be designed to enhance the understandability of the Data, with consideration given to the perceptual characteristics of the intended audience.

E. Cartographic Symbols

- Cartographic symbols used in the portrayal of Data must be consistent with the requirements of ISO 19117:2012. This includes using symbols that are clearly distinguishable, easily recognisable, and appropriate for the Data being portrayed.

- Partners must provide a legend or key explaining the meaning of all cartographic symbols used.

F. Portrayal Rules

- The portrayal of Data should be guided by a set of portrayal rules, as specified in ISO 19117:2012. These rules define how the Data is to be displayed, including the use of symbols, colours, and textures.

- Portrayal rules should be designed to ensure consistency in the portrayal of similar Data across different Datasets and to facilitate comparison and analysis of the Data.

Relevant Standard(s):

- ISO 19117:2012

9. Geographic Information Services and Interfaces

This section outlines the requirements in accordance with ISO 19119:2016 and ISO 19128:2005. It emphasizes the necessity for geographic Data to be accessible and manipulable via standard protocols and APIs, compatible with open standards, secured using Industry-standard protocols, and compliant with Data privacy regulations. It also underscores the importance of Data Interoperability for seamless integration with other Datasets. Adherence to these guidelines ensures the secure, efficient, and effective use of geographic Data.

A. Web Server Interface Requirements

- Geographic Data should be accessible via HTTP/HTTPS protocols as per ISO 19119:2016.
- All Data should be compatible with RESTful APIs, enabling users to access and manipulate geographic Data over the network, as specified in ISO 19119:2016.
- Web services should support JSON and XML Data Formats for Data interchange, as per ISO 19119:2016.

B. Open Information Technology Environment Requirements

- Geographic Data must be compatible with open standards such as OGC (Open Geospatial Consortium) and W3C (World Wide Web Consortium) as referenced in ISO 19119:2016.
- Data must be accessible and manipulable via standard SQL queries, as per ISO 19119:2016.

C. Remote Database Querying and Control Requirements

- Partners must provide necessary APIs and/or SQL access points to allow users to query remote Databases, as per ISO 19119:2016.
- Partners must provide a mechanism for users to control Data processing, such as filtering, sorting, and aggregation, in line with ISO 19119:2016.

D. Security and Privacy Requirements

- All Data transfers must be secured using Industry-standard security protocols, such as SSL/TLS, as outlined in ISO 19119:2016.
- Partners must comply with all relevant Data privacy regulations, as per ISO 19119:2016.

E. Interoperability Requirements

- All geographic Data must be interoperable, meaning it should be possible to combine it with other Datasets without losing meaning, as per ISO 19119:2016.

ISO 19119:2016 provides a framework for geographic services, including their classification and components, while ISO 19128:2005 provides a standard for Web Map Service Interface.

Relevant Standard(s):

- ISO 19119:2016
- ISO 19128:2005

10. Object Catalogues

This section outlines standardization requirements under ISO 19110:2016, covering theme categorization, feature cataloguing, Data consistency, and compatibility. It emphasizes the need for Data Interoperability and regular updates, including maintaining a record of changes. Compliance with these requirements ensures Data relevance, accuracy, and easy integration, supporting efficient Data use and management.

A. Theme Standardization Requirements

- All Data shared must be categorized under standardized themes including, but not limited to, transportation, utilities, broadband network Infrastructure, water, administrative units, and land use as per ISO 19110:2016.
- Partners must ensure that the theme categorization is done at the application level to facilitate easy access and retrieval of Data, as per ISO 19110:2016.

B. ISO Feature Cataloguing Methodology Requirements

- Delivery Partners must utilize the ISO feature cataloguing methodology to develop a comprehensive Data dictionary for all Data features as per ISO 19110:2016.
- The Data dictionary must include clear definitions of each Data feature, the authority for each feature, and the relationships between features as per ISO 19110:2016.

C. Data Consistency and Compatibility Requirements

- Delivery Partners must ensure that all Data is consistent within its theme and compatible with other Data within the same theme, in line with ISO 19110:2016.
- Delivery Partners are required to ensure that their Data is interoperable with other Datasets, allowing for seamless integration and use, as per ISO 19110:2016.

D. Data Update and Maintenance Requirements

- Delivery Partners must commit to regularly updating their Data to ensure its relevance and accuracy, as per ISO 19110:2016.
- A record of all updates and changes made to the Data must be maintained and made accessible to users, as per ISO 19110:2016.

Relevant Standard(s):

- ISO 19110:2016

11. MetaData

This section outlines key requirements for MetaData in GIS Data, as per ISO 19115:2014 and ISO 19115-2:2009. It covers Identification, Distribution, Quality, Lineage, and MetaData Details requirements. By adhering to these guidelines, Delivery Partners can ensure comprehensive MetaData that improve Data Interoperability, searchability, and usability. Compliance with these standards is crucial for maintaining Data quality and reliability.

A. Identification Requirements (MD_Identification)

- MetaData must include identification Information such as the title (citation.title), abstract (abstract), temporal and geographic range (extent), the principal investigator or creator (pointOfContact), and point of record for Information or Data, as per ISO 19115:2014 and ISO 19115-2:2009.

- MetaData must include keywords (descriptiveKeywords) related to the Dataset. These keywords should be attributed to a recognized thesaurus (thesaurusName) to improve Interoperability and searchability, as per ISO 19115:2014 and ISO 19115-2:2009.

B. Distribution Requirements (MD_Distribution)

- MetaData must provide clear distribution Information (distributionFormat and distributor) to help users find the Data files. This includes the title of the Dataset, the point of contact for the Data (distributorContact), and the URL where the Data and any related Information can be accessed (onlineResource), as per ISO 19115:2014 and ISO 19115-2:2009.

C. Quality Requirements (DQ_DataQuality)

- MetaData must include Information on the quality of the Data. This should detail the precision and accuracy of the Data (DQ_AccuracyOfaNumericalQuantity), any known issues or limitations with the Data, and reference Information such as the source of the Data and the methods used for Data collection, as per ISO 19115:2014 and ISO 19115-2:2009.

D. Lineage Requirements (LI_Lineage)

- MetaData must provide clear lineage Information. This includes details on the origin of the Data (source), how it was collected and processed (processStep), and any actions taken on the Data since its original collection, as per ISO 19115:2014 and ISO 19115-2:2009.

E. MetaData Details Requirements (MD_Metadata)

- MetaData must specify the schedule in which the records are updated (MD_MaintenanceInformation), and the MetaData authority and point of contact (contact). This ensures users have the most current and accurate Data and know who to contact for further Information, as per ISO 19115:2014 and ISO 19115-2:2009.

ISO 19115-1:2014 provides a schema for describing MetaData of geographic Information, and ISO 19115-2:2009 extends this to include MetaData for imagery and gridded Data.

Relevant Standard(s):

- ISO 19115-1:2014
- ISO 19115-2:2009

VI. Data Governance and Security Standards

This section of the Document focuses on Data Governance and Security Standards for Data sharing, outlining standards that all Delivery Partners must follow to meet these Data Security requirements. This is accomplished by ensuring practices follow the highest standards of Data Governance and security, as prescribed by international frameworks such as ISO/IEC 38500 and ISO/IEC 27001, and the Data Management Body of Knowledge (DAMA DMBOK). In addition, this section emphasizes the importance of adhering to regulations such as FIPPA and PIPEDA, to ensure Data sharing upholds confidentiality, integrity, and availability across the Asset Management lifecycle.

A. ISO/IEC 38500 – Corporate Governance of Information Technology (IT)

ISO/IEC 38500 is an international standard that provides a framework for effective governance of IT to assist those at the highest level of organizations to understand and fulfill their legal, regulatory, and ethical obligations in respect of their organizations' use of IT. The standard is applicable to Delivery Partners and organizations of all sizes, including public and private companies, Government Entities, and not-for-profit organizations.

B. Six Principles of Corporate Governance of Information Technology

Delivery Partners should follow the six principles defined in ISO/IEC 38500 for the corporate governance of IT:

i. Responsibility: Individuals and groups within the organization understand and accept their responsibilities in respect of both supply of, and demand for IT.

ii. Strategy: The organization's business strategy considers the current and future capabilities of IT; the strategic plans for IT satisfy the current and ongoing needs of the organization's business strategy.

iii. Acquisition: The organization has proper controls over its IT acquisition processes to ensure that all acquisitions are consistent with its business strategy.

iv. Performance: The organization ensures that IT performs its required functions correctly and reliably, meeting the needs of the organization.

v. Conformance: The organization ensures that its IT complies with all laws and regulations. The organization also has policies and practices to ensure its IT conforms with the organization's own policies and procedures.

vi. Human behavior: The organization recognizes the impact of human behavior on the success of IT.

C. ISO/IEC 38500 and Data Security

In terms of Data Security, ISO/IEC 38500 supports Delivery Partners in having robust policies in place to manage and protect their Data Assets. To ensure effective management and protection, Delivery Partners should follow policies for Data access, Data encryption, Data backup, and Data breach response. This also includes the implementation of technical controls, such as firewalls, intrusion detection systems, and Data loss prevention tools.

D. ISO/IEC 27001

ISO/IEC 27001 is an internationally recognized standard that provides a framework for establishing, implementing, maintaining, and continually improving an Information Security Management System (ISMS). The Standard offers a structure for handling Information security threats, encompassing risks linked to Building Information Modelling and Geographic Information System Data. Delivery Partners should follow these standards to mitigate these risks efficiently and effectively.

E. Plan-Do-Check-Act (PDCA) Cycle

ISO/IEC 27001 is based on the Plan-Do-Check-Act (PDCA) cycle. To improve risk mitigation and Information security in accordance with this standard, Delivery Partners should abide by the following steps:

1. <u>Plan:</u> Establish the ISMS by setting the ISMS policy, objectives, processes, and procedures relevant to managing risk and improving Information security to deliver results in accordance with the organization's overall policies and objectives.

2. <u>Do:</u> Implement and operate the ISMS policy, controls, processes, and procedures.

3. <u>Check:</u> Assess and, where applicable, measure process performance against ISMS policy, objectives, and practical experience and report the results to management for review.

4. <u>Act:</u> Take corrective and preventive actions, based on the results of the internal ISMS audit and management review or other relevant Information, to achieve continual improvement of the ISMS.

F. ISO/IEC 27001 and Data Security

In terms of Data Security, and by following ISO/IEC 27001, Delivery Partners should implement a robust approach to managing Data Security and building resilience. By establishing risk management processes, Delivery Partners can identify and mitigate the risk associated with Data breaches and other security incidents.

G. DAMA DMBOK

DAMA DMBOK provides a framework for managing Data, including BIM and GIS Data. By adopting this standard, Delivery Partners can ensure that their Data is managed effectively, securely, and in compliance with best practices.

H. 11 Data Management Knowledge Areas

Under DAMA DMBOK, Delivery Partners should organize Data into 11 knowledge areas:

i. Data Governance: Establishing methods, policies, standards, organization, decisions, tools, and responsibilities necessary for managing the organization's Data.

ii. Data Architecture Management: Defining the structure of Data Elements and setting standards for Data integration to ensure consistency.

iii. Data Development: Analyzing, designing, implementing, and maintaining Data resources based on the Data architecture.

iv. Data Operations Management: Providing control over Data Assets to ensure operational efficiency and effectiveness.

v. Data Security Management: Ensuring privacy, confidentiality, and appropriate access to Data across the enterprise.

vi. Data Quality Management: Defining, monitoring, and improving Data quality.

vii. Reference and Master Data Management: Managing shared Data to reduce redundancy and ensure better Data quality.

viii. Data Warehousing and Business Intelligence Management: Using Data to support business decision-making processes.

ix. Document and Content Management: Managing Data found in unstructured formats, including email, Documents, images, and video.

x. MetaData Management: Providing MetaData (Data about Data) to support Data management.

xi. Data Integration and Interoperability: Combining Data from different sources and providing a unified view.

I. DAMA DMBOK and Data Security

In terms of Data Security, DAMA DMBOK provides guidelines for establishing and implementing Data Security policies and procedures that Delivery Partners should follow. This includes Data access controls, Data encryption, Data masking, and Data breach response procedures.

J. Regulatory and Legal Compliance for Data Management

Delivery Partners must ensure that their Data Governance practices comply with all relevant laws and regulations. This includes the Freedom of Information and Protection of Privacy Act (FIPPA) in

Ontario, and other relevant legislation such as the Personal Information Protection and Electronic Documents Act (PIPEDA) at the federal level. Compliance should be regularly reviewed and updated to reflect any changes in the regulatory landscape. Compliance with existing laws and regulations will further enable Delivery Partners to enhance their Data Security, protection, and Confidentiality.

VII. Glossary

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.
"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*

Asset Classification System (Standard)	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 Digital Records Requirements and Standards Document.
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 Delivery Partners 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*

Assets Manager	Ensures that all relevant Data related to their organization's Assets is properly collected, stored, analyzed, and shared as needed by the Digital Records Requirements and Standards Document.
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.
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 Digital Records Requirements and Standards Document, the BIM Process involves the use of BIM software to create a Digital Model of the Assets, i.e., Ontario's Infrastructure Assets. The Digital Model contains Information about the physical and functional characteristics of the Assets, including location, condition, and utility connections.
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*
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.
Cadastral Parcel Data	Parcel data is a form of cadastral GIS Data showing the boundaries and attribute information about properties in a given area.

Candidate Model	Candidate Model is the first or highest level of the Data Taxonomy. A Candidate Model is the specific framework or structure for organizing and interpreting Data. Candidate Models, in this context, are international or national standards that define how certain Data Types should be organized, what they should consist of, and how different pieces of Data relate to each other. The Candidate Models required to enable the requirements of this Document include (but are not limited to) IFC, Uniclass 2015, MUDDI, and LandInfra.
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 Delivery Partners working together to input Data, review and validate Information, and make decisions based on the Digital Model.
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*
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 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 Delivery Partners 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 the Digital Records Requirements and Standards Document.
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 Data hub or Digital Model. 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*
Data Taxonomy	Categorize Data based on its type, source, and relevance to different Infrastructure Elements.

Data Type	Data Type is the third or third highest level of the Data Taxonomy. Data Types define the specific categories in which Data is classified and organized for purposes of adhering to requirements. Data Types provide a comprehensive view of the construction, from its physical characteristics to its usage and maintenance history. Data Types in the Document include: 1. Environmental Data 2. Design Data 3. Geospatial Data 4. Operational Data 5. Maintenance Data 6. Project Management Data 7. Regulatory Data 8. Sensor Data 9. Structural Data 10. Utilities Data
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 Document include Government Entities, the Utilities Industry, Project Consortium, and the Province. Delivery Partners can also include private sector companies, academic institutions, and other organizations involved in the development and management of Infrastructure Assets. The Digital Records Requirements and Standards Document provides guidance on how Delivery Partners can work together to facilitate Data sharing, Information Management, and Utility Coordination.

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.
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 Models 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.),

Data Format	Data Formats refer to the specific structure in which Data is stored and exchanged. Data Formats are syntaxes for structuring Data and dictate how Data should be represented and encoded, as well as organized and interpreted by different systems. For example, in a Digital Asset record of a bridge, Data Formats could include a 3D Model and GeoJSON.
Data Source	This Document identifies relevant Data Sources that will provide accurate, up-to-date, and comprehensive Information for the creation and maintenance of Data repositories. Data shall be tagged with up to two Data Sources. This accommodates considerations for Data that fits into more than one Data Source category. For example, a Data Source from a utilities company or owner can be satellite/aerial imagery. Data Sources for this Document include Data from: Architecture, Construction, and Engineering Firms Environmental Agencies and Companies Government Databases Infrastructure Owners and Operators IoT Devices Public Records Satellite Imagery, Aerial Imagery, and Remote Sensing Transportation Agencies and Owners Utilities Companies and Owners
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.
Document	"The Document" refers to the Digital Records Requirements and Standards Document.
Element	A component of an Infrastructure Asset that can be represented in the Digital Model.
Exchange Information Requirements	Information requirements in relation to a Project. *Source: ISO 19650-1*
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*
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.

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*
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 Type	Infrastructure Type is the second or second highest level of the Data Taxonomy. Infrastructure Type within this Document are defined for the purpose of categorizing Data for Projects and Data sharing. Infrastructure Data should be categorized based on their Industry and function, including but not limited to the following seven (7) categories: 1. Transportation Infrastructure 2. Energy Infrastructure 3. Water and Wastewater Infrastructure 4. Telecommunications Infrastructure 5. Public Buildings and Public Facilities 6. Environmental Infrastructure 7. Industrial Infrastructure

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.
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 Model of a building or Infrastructure Asset.
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 Management Specialist and Data Custodian in collaboration with other Project Team roles.
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 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.
Modeling Process	The process of creating a Digital Model of an Infrastructure Asset.

Natural Environment	All living and non-living things that exist on Earth affecting ecosystems and human life. *Source: BS ISO 21401:2018, 3.23*
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.
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.
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.
Project(s)	As prescribed under regulation, every Infrastructure Project where funding, in full or in part, has been provided through the Ministry of Infrastructure.

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 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 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.
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 Digital Records Requirements and Standards Document 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.

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.
Security Compliance	Requires Delivery Partners to identify security risks and adopt the security regime set out in the governing legislation and regulations of this Document 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.
Subsurface Utilities	The utilities and Infrastructure Assets that are located underground, such as water mains 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.

Temporal Reference System	A Temporal Reference System is a system of coordinates used to specify the positions of objects in time. It consists of one or more axes, each of which represents a different time scale. The positions of objects are specified by their distance from the origin, and the time at which they occur.
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 Digital Records Requirements and Standards Document 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 Digital Records Requirements and Standards Document 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 organizing 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, Delivery Partners should work with the client to develop an appropriate standardized classification system.
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.

Utilities Infrastructure Data	The Data related to the Infrastructure Assets used to provide utility services, such as electricity, water, and gas.
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.
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 Digital Records Requirements and Standards Document 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 Digital Records Requirements and Standards Document can be more easily distributed and accessed by Project Proponents involved in the Project.

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