Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

GNWT STRUCTURES INSPECTION STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOP) for Structures Inspection

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Revision	Description	Author	Date	Quality Check	Date
V1.5	75% Draft	RME	2020-12-05	ZK	2020-12-05
V2.2	90% Draft	RME	2023-03-15	ZK	2023-03-15
V2.5	100% Draft	RME	2023-06-30	ZK	2023-06-30
V2.6	100% Final	RME	2023-09-18	ZK	2023-09-18

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Acronyms / Abbreviations

GNWT	Government of Northwest Territories
OSIM	Ontario Structures Inspection Manual
WSCC	GNWT Workers' Safety and Compensation Commission
UBIV	Under bridge Inspection Vehicle
BMS	Bridge Management System (software)
RPAS	Remotely Piloted Aircraft System (UAV/Drone)

Glossary

Structure	In this document, the term ‘structure’ includes bridge structures on the public highway system and culverts having a diameter equal to or greater than 1.5 m, referred as ‘bridge-culverts’.
Bridge	In this document the term ‘bridge’ is used primarily and may be taken to include bridges and bridge-culverts unless specified otherwise.
Bridge-Culvert	Bridge-culvert refers to culverts having a diameter equal to or greater than 1.5 m.
Culvert	i.e. Bridge-Culvert. Can also refer to culverts that are less than 1.5 m in diameter.
Under bridge Inspection Vehicle (UBIV)	An inspection truck specifically designed for bridge inspection that provides articulated access to the underside of bridge structures from the deck.
Snooper	A type of mechanical access equipment that can provide inspection access. Licensed to operate on highways can be driven to the worksite. Also known as a bucket truck.
Manlift	A type of mechanical access equipment that can provide inspection access. These are not licensed to operate on highways and must be towed to the worksite.
Cherry Picker	Another name for snooper or bucket truck.

1 Introduction

Each fiscal year, the Government of Northwest Territories (GNWT) is responsible for allocating operation & maintenance and capital budgets to support its programs and fulfill its long-term strategic goals and objectives. To justify the allocation of funds for highway structures, elected officials need to know how changes in bridge maintenance and capital funding will impact the GNWT's ability to serve the traveling public safely and efficiently.

INF as part of the GNWT is responsible for planning, design, construction, acquisition, operation and maintenance of public buildings and transportation infrastructure and systems. The GNWT through the Department of Infrastructure (INF) is responsible to the public to make well-informed decisions and present them effectively to elected officials, the public, and the stakeholders. The role of the Structures Section of the Transportation Division, is to keep GNWT's bridge programs on a firm, justified and defendable financial footing where annual funding is adequate to maintain an efficient, sustainable level of service over the long-term, and to be able to quickly analyze how changes in budgets affect the typical highway bridge network performance measures.

To meet these challenges, INF manages a robust structure inspection program which entails regular inspection of bridges and culverts and measuring and reporting risk and condition performance measures. Based on this program, INF can develop operation and capital plans that work towards meeting targets while minimizing lifecycle costs. Asset management plans can be developed that help the department meet its goals, and results can be reported regularly. In this way, INF can meet asset management standards and expectations of the public.

The entire process from inspection to decision making, prioritization, and development of operation and capital plans is aided by the use of the GNWT Bridge Management System (BMS) a specialized commercial product in use in various jurisdictions across Canada. While the BMS significantly contributes to the successful management of these important transportation assets, the backbone of the program is the inspection program, and it is important that resources and standards are provided to support the inspection program.

This document provides the standard operating procedures for bridge and culvert inspection including goals, types of inspections, roles and responsibilities, safety, link to asset management, and quality assurance and control.

1.1 History of GNWT Inspection Program

Prior to 2011, INF carried out inspections using various inspection rating methods over the years. These were simplified deterministic methods such as that used by Alberta Transportation which rates bridge components using a 0-9 scale. INF lacked a Bridge Management System and the manual task of managing the inventory was onerous. As the demands and expectations for asset management increased, it became necessary for the department to modernize the program.

In 2010, INF initiated a request for proposals for a turn-key Bridge Management System (BMS) for use by planners, managers, and technical staff to support the complete bridge management cycle, including bridge inspections and inventory data collection and analysis, recommending an optimal preservation policy, predicting needs and performance measures for bridges and bridge size culverts and developing optimized projects to include in the Department's Capital Plans.

The project included adoption of a new inspection methodology and a comprehensive bridge inspection training course for INF staff.

Completed in 2013, the BMS is being used by INF as a decision support tool to deal with individual bridge projects, as well as system-wide decision-making regarding the whole highway bridge network serviceability, level of service, budgets, work prioritization, and policies development.

1.1.1 INSPECTION METHODOLOGY

At the heart of INF's bridge management strategy is the inspection program using the Ontario Structure Inspection Manual (OSIM) inspection methodology. OSIM inspection satisfies structure safety inspection, collects information used to report the bridge condition performance measure 'Bridge Condition Index' (BCI), determines bridge maintenance needs, as well as information needed to determine urgency of repairs and manage risk. For reference, a sample OSIM bridge inspection report template is provided in Appendix A.

As with any method, the results depend on the judgement of the inspector but modern methods such as the OSIM methodology remove most of the subjectivity from the process by recording and monitoring growth defects and using established definitions for severity and extent. Modern inspection methods such as OSIM also provide sufficient information to make informed decisions and report performance following good asset management principles. These are some of the reasons that today, the OSIM methodology is the most common inspection method applied by the Provinces and Territories across Canada.

1.2 Roles and Responsibilities

1.2.1 GNWT

The government's mission is to establish an infrastructure assets operating procedure that will maintain a level of service for public safety, comfort, and convenience and ensure an acceptable standard for structures within an economic framework.

1.2.2 STRUCTURES SECTION - BRIDGES

Structures Section - Bridges is responsible for

- Safety Inspection of all highway bridges and culverts on public roads within Territorial boundary.
- Development of bridge and culvert inspection policies and procedures, including quality assurance and quality control measures.
- Establishing minimum standards for condition of structures.
- Developing maintenance, rehabilitation and replacement programs for the GNWT bridge and culvert inventory.
- Setting targets and monitor performance measures for condition and risk for bridges and culverts.
- Developing risk and performance-based asset management plan for highway bridges and culverts to meet targets.
- Preparing an annual Summary Report / Asset Management Plan (AMP).

Structures Section - Bridges is also responsible for the follow up of critical findings. If critical findings are found the department shall:

- Make engineering judgement for need to close lane or bridge/structure.
- Secure the structure to ensure safe operations.
- Assess and implement traffic management if required.
- Inform Regional Superintendent/ Regional Operations Manager immediately.
- Inform Manager, Structures-Bridges immediately.
- Prepare the corrective course of action and implement after approvals by Manager Structures.

1.2.3 REGIONS

The Regions/ Regional Staff have responsibilities in the management of the bridge structures in the GNWT highway system. Bridge inspection to be carried out by the region with the objective to determine from visual observation that the highway structure is safe for the intended use. The level of service is as follows:

- Routine visual overviews while travelling on road patrol.
- An annual visual inspection will be made in the spring (after the spring run-off) when water has dropped sufficiently to permit inspections to be performed safely.
- Non-routine inspections after the following events:
    - Accident or vehicle collision with structure
    - Heavy rains and flood

  - Periods of prolonged extremely high temperatures and fire hazards.
  - Where perceived problems exist.
  - Other special circumstances.
- The Regionals Superintendent / Regional Manager, Highway Operations may collaborate with the Manager, Structures for the assignment of staff or additional personnel for these duties.

1.3 Compliance with NWT Acts / Regulations (trained supervisor)

All work should be in accordance with relevant NWT Acts and Regulations including but not limited to the following:

- Mandatory supervisor training (https://my.hr.gov.nt.ca/courses/supervisor-safety-training) which encompasses the Safety Act and Regulations
- Highways Act (https://www.justice.gov.nt.ca/en/files/legislation/public-highways/public-highways.a.pdf)
- GNWT policy (https://www.eia.gov.nt.ca/en/government-northwest-territories-policies)
- Traffic Control Person Code of Practice, June 1, 2015 (https://www.wscc.nt.ca/documents/traffic-control-plans)
- Transportation Canada (https://tc.canada.ca/en/rail-transportation/guidelines/guideline-bridge-safety-management/part-bridge-inspection)
- Large Vehicle Control Regulations (https://www.justice.gov.nt.ca/en/files/legislation/motor-vehicles/motor-vehicles.r9.pdf)
- RPAS Regulatory Approval. (https://tc.canada.ca/en/aviation/publications/knowledge-requirements-pilots-remotely-piloted-aircraft-systems-250-g-including-25-kg-operating-within-visual-line-sight-vlos-tp-15263)

1.4 NWT Bridge Management System

The GNWT Bridge Management System (BMS) is a comprehensive asset management tool that enables the Department to fully manage the inventory of bridges and culverts including storing and retrieving all information on the assets and managing the inspection program including all documentation and multimedia files pertaining to the inspections. In addition, the BMS provides powerful decision support tools to report current condition and risk. The BMS uses deterioration models to forecast future condition based on specified budget levels. The BMS is a complete asset management solution and fulfills the expectations of Auditors, ISO 55000 Standards for Asset Management, etc.

Together with the annual inspection program, the BMS is an integral part of the management of the transportation network and the goals of maintaining a safe and efficient highway system. The BMS is in use by many other provinces and municipalities across Canada.

The GNWT licenses the BMS annually from the vendor, Stantec Consulting Ltd. who also provide training in the use of the system. Updates to the BMS are provided regularly to ensure agencies have the latest research. Annual refresher training is provided to staff as part annual software license.

2 Structures Inspection Program

The Inspection Program is the backbone of the structures' asset management program. It is important that accurate and timely inspections are completed, and the program requires adequate resources and support.

In this document, the term 'structure' includes bridge structures on the public highway system, as well as culverts having a diameter equal to or greater than 1.5 m, referred as 'bridge-culverts'. Throughout the document the term 'bridge' is used primarily and may be taken to include bridges and bridge-culverts unless specified otherwise.

2.1 Purpose and Goals of Structures Inspection Program

The main goals of the Structural Inspection Program are:

- To maintain structures in a safe condition.
- To protect and prolong the useful life of structures.
- To identify maintenance, repair and rehabilitation needs of structures.
- To provide a basis for the Bridge Management System and asset management in the planning and funding of maintenance and rehabilitation program.

2.2 Types of Inspection

Regardless of the applicable jurisdiction, inspection programmes usually include different levels of inspection ranging from brief visual inspection, to detailed visual inspection usually within arm's length perhaps, to detailed visual supplemented by non-destructive testing. In addition to these levels of inspection one might also have an annual brief safety inspection perhaps performed by a non-bridge inspector at one end, and then very detailed investigations or emergency inspections at the other extreme.

In general, the higher the level of inspection the better the quality of information obtained and the better-informed decisions that can be made. The most common type of inspection is the detailed visual inspection where sufficient information is obtained to satisfy safety and also inform decision making and asset management considerations. This is because once the inspector is on the site, the additional effort to collect more detailed observations compared to a brief inspection is minimal compared to the other costs.

The terminology for these various inspections varies with jurisdiction. The standard detailed visual inspection, the Biennial OSIM inspection, is described in the next section. This inspection is a detailed

visual inspection of all elements of the structure. In some provinces, different terminology is used. For example, Alberta Transportation defines Level 1 BIM inspections as general visual inspections conducted using standard tools and equipment. Level 1 BIM inspections rate only the worst part of each element and do not take the overall element condition into account. Level 1.5 inspections require inspection of all elements and the use of specialised access equipment. Both Level 1 and 1.5 are not as detailed as the OSIM inspection and do not collect condition information for whole elements.

The various types of inspections are described further in the following sections.

2.2.1 BIENNIAL OSIM INSPECTION

The standard inspection of bridges is the biennial OSIM inspection. This is a detailed, element level inspection recording condition of entire elements. In addition to rating condition, OSIM inspections also include maintenance needs, performance deficiencies and recommended work. For reference, a sample OSIM bridge inspection report is provided in Appendix A.

In the OSIM manual, the inspection frequency is described as being performed every two years. The timeframe of the inspection is specified as calendar year and not necessarily within 24 months from previous inspection. Typically, every Department of Transportation has jurisdiction over the inspection methodology and frequency that is to be followed. GNWT has specified an inspection frequency of every three (3) years. The timeframe of the inspection is specified as calendar year and not necessarily within 36 months from previous inspection. It should therefore be noted that the term Biennial Inspection should be taken to mean every three (3) years.

For culverts with 1.5 to 6 metre spans the inspection interval can be increased to four (4) years if the culvert is in good condition and the engineer believes that the culvert condition will not change significantly before the next inspection. See Section 2.3 for further discussion on inspection frequency.

2.2.2 EMERGENCY INSPECTION

Emergency inspections are inspections that are in response to an emergency or other events such as accidents, post earthquake or flood. In some cases, such as for accidents where significant damage has occurred or there has been a fire, specialist structural support may be required.

2.2.3 UNDERWATER/SCOUR INSPECTION

Bridges that are vulnerable to scour shall have underwater scour inspections performed every 5 years and after any major flood event as determined by the Structural Assets Manager.

Bridges requiring underwater inspections must have a description of the underwater elements requiring inspection. Include the inspection frequency and the procedures in the inspection records for each structure. Hydrotechnical/bathymetric study for scour inspection as an alternative to diving inspection to be approved by GNWT.

Scour critical bridges must have a plan of action dictating monitoring requirements for known and potential deficiencies and to address critical findings.

Inspectors must follow the Occupational safety code for diving operations CSA Z275.2:20 for underwater inspection.

2.2.4 BASELINE INSPECTION

The first OSIM inspection is referred to as a Baseline Inspection since the data prepared forms the baseline for future inspections. The inspection team must map the elements of the structure including the type, material, and quantity of each element that comprises the structure. For this reason, the baseline inspection requires more effort than subsequent inspections. After the baseline inspection and the set up of the elements in the BMS, subsequent inspections require only a fraction of the time of the baseline inspection; reports are simply updated with changes in condition and any new recommendations.

It is recommended that in the case newly constructed structures, the baseline inspection should be provided at the time of final acceptance of the structure. This may be provided by design consultant if qualified and approved staff are available. Otherwise, Department staff should perform the inspection immediately after construction to provide the baseline for future inspections.

2.2.5 ANNUAL BRIEF SAFETY INSPECTION E.G. MAINTENANCE SUPERVISOR REGIONAL OFFICE

It is advantageous to perform a brief, annual safety inspection by staff in the region who may not be certified inspectors but have sufficient training to look for major issues such as beaver dams, broken elements, broken safety barriers, etc. This can be an important component of the department for structures in remote areas and/or structures with inspection frequencies more than the typical two years. This additional brief annual safety inspection can play a role in the overall risk management program employed by the department.

2.2.6 OTHER TYPES OF INSPECTIONS/INVESTIGATIONS

In addition to the inspection types mentioned above, there are other types of inspections which may be important depending on the type of structure, condition of the structure, river crossing and other considerations. Other types of inspections/investigations typically include the following:

- Material Condition Survey for:
    - Detailed Deck Condition Survey
    - Non-destructive Delamination Survey of Asphalt Covered Decks
    - Concrete Substructure Condition Survey
    - Detailed Coating Condition Survey
    - Detailed Timber Structure Investigation
    - Post-Tensioned Strand Investigation

- Underwater investigation
- Fatigue investigation
- Seismic investigation
- Structure evaluation
- Monitoring of deformations, settlement and movements
- Monitoring of crack widths
- Stream bathometric sedimentation survey
- Water or soil chemistry (resistivity, pH)

In some jurisdictions, such as Alberta Transportation, some of these condition surveys are referred to as Level 2 Inspection.

2.3 Frequency of Inspections

The frequency of inspection is generally 'biennial' and varies for bridges, culverts (depending on condition). Inspection frequency is discussed in more detail in the following.

2.3.1 BIENNIAL OSIM INSPECTIONS

The OSIM bridge inspection is a structure inspection performed every two years in accordance with the OSIM manual. The timeframe of the inspection is specified as calendar year not necessarily within 24 months from previous inspection.

For culverts with 1.5 to 6 metre spans, the inspection interval can be increased to four years if the culvert or retaining wall is in good condition and the engineer believes that the culvert or retaining wall condition will not change significantly before the next inspection.

It is possible to evaluate the potential for alternate inspection frequencies by applying risk principles. Based on GNWT risks analysis and evaluation including resources and logistics, it is possible to have inspection frequency of 36 months. The Structural Assets Manager may consider the factors that affect risk such as condition, age, replacement value, traffic volume, structural behaviour, structural failure modes, number of critical findings and the elements affected, etc. With each inspection, the BMS calculates a Bridge Criticality and Urgency Index (BCU) which indicates the criticality and urgency of defects and recommendations for a given structure and this is also used as input into the Risk Profile which categorises structures into risk categories of High, Medium-High, Medium, and Low (see also Section 7.3). Using these tools, it is possible to assign frequencies of e.g., 1 year for higher risk structures, and longer frequency for structures with low risk that are newer and in good condition e.g., 3-5 yrs.

By applying risk-based inspection frequencies it is possible to devote resources to higher risk structures and less resources to newer structures in good condition.

2.3.2 UNDERWATER/SCOUR INSPECTION

Bridges that are vulnerable to scour shall have underwater scour inspections performed approximately every 5 years, as required, and after any major flood event as determined by the Structural Assets Manager. This frequency can be adjusted based on the vulnerability to scour which varies depending on the structure, foundations, and location.

2.4 Use of Bridge Management System (BMS)

The Bridge Management System (BMS) shall be used to manage the inspections and shall be the repository for inventory and inspection information. This ensures uniformity and adherence to OSIM requirements and enables all appropriate Department users readily available access to current and historical information for all structures. The BMS database and information shall be backed up following Department IT requirements which is generally daily.

The BMS shall be used to prepare blank inspection reports prior to inspections for the inspectors to complete in the field. The BMS is also used to prepare the final reports afterwards thereby ensuring uniformity of data and methodology throughout the process. Usually, the inspection team will take the checked-out database from the BMS for the inspections on a particular route. This provides the system for the inspectors to enter the inspection data and photos in the field. The BMS automatically synchronizes the information from the checked-out database with the master database when back in the office.

3 Inspection Teams – Composition, Qualifications, Experience, Training

For reasons of safety and workload efficiency, Department of Infrastructure inspection teams shall consist of a minimum of two (2) and preferably three (3) personnel. In addition to a Lead Inspector and assistant inspector(s) there is usually a requirement for a wildlife watch personnel and when required, there may be a special equipment operator, NDT specialist, etc.

In determining the makeup of the inspection team, the Lead Inspector and/or Structures Manager will consider the type of inspection, type of delicences expected, and need for special access, and traffic safety requirements.

The inspector staff categories and relevant qualifications and experience are described in the next section.

3.1 Inspection Team Composition, Qualifications, Experience

The **Manager Structures-Bridges** is responsible for the bridge program, of which the inspection program is one component. In the inspection program, the Manager Structures-Bridges is responsible for quality

assurance. The Manager Structures-Bridges must meet the minimum qualifications and experience listed in Table 1.

The **Structural Assets Manager** is responsible for the overall inspection program. This may include managing the inspection program, field inspection, review of inspections and inspection recommendations, inspection audits and quality control. The Structural Assets Manager must meet the minimum qualifications and experience listed in Table 1.

The **Lead Inspector** is in charge of the inspection team and is responsible for planning, preparing, and performing the field inspection of the bridge. The Lead Inspector is responsible for:

- Planning and preparing for the inspection
- Organizing methods of access
- Coordinating for the necessary inspection equipment, traffic control, and railroad track control plan if needed.
- Perform the field inspection.
- Prepare the inspection report.
- Identifying Repair and Maintenance Items.
- Communicating Need for any Immediate Follow-Up Actions.
- Carrying out Post Inspection Procedures.

The Lead Inspector must meet the minimum qualifications and experience listed in Table 1.

Table 1 Inspection Team Min. Qualifications and Experience

Role	Professional Credentials	Minimum Inspection Training	Min. Years Experience
Manager Structures-Bridges	P. Eng.	OSIM Two-Week Course	As required by GNWT Job description
Structural Assets Manager	P. Eng.	OSIM Two-Week Course	As required by GNWT Job description

Lead Inspector	P. Eng.	OSIM Two-Week Course	10 yrs. Bridge Engineering and 5 yrs. Inspection
Assistant Inspector	EIT or Tech.	OSIM Two-Week Course	
Wildlife Watch			Varies as required
Inspection Truck Operator (Snooper etc.)		Training/Certification as required by equipment manufacturer	As governed by GNWT and licencing jurisdiction Compliance and Enforcement Departments/policies https://www.idmv.dot.gov.nt.ca/
Traffic Control Personnel		Traffic Safety Training, familiarity with Department Traffic Control Manual and policies	Traffic Control Policy by WSCC (https://www.wscc.nt.ca/documents/traffic-control-plans)

Assistant Inspectors are responsible for assisting the Lead Inspector prior to and during the inspection. Typical functions include assisting in the inspection preparation, assisting in the field by taking notes, photos, recording dimensions, clearance and watercourse measurements. It is desirable that at least one assistant inspector have bridge inspection experience which leads to a more efficient inspection.

Wildlife Watch staff are responsible for keeping watch for wildlife to protect the inspection team and wildlife from harm.

The **Inspection Truck Operator** is responsible for operating the Under bridge inspection vehicle (UBIV), snooper, manlift etc. in a safe and proper way to provide the inspection team with safe access to the bridge during the inspection.

3.2 Inspection Team –Training

All Inspection team members must have successfully completed a two-week comprehensive bridge inspection training course. Refresher training must be completed every 2-3 years at discretion of the Manager Structures-Bridges. This minimum training may be supplemented by additional specialized training such as Fracture Critical Inspection.

All inspection staff and assistants shall have completed BMS software training and refresher training as offered by Department.

The sign-off on completion of SOP, OSIM and BMS training by Structural Assets Manager or Manager, Structures.

4 Duties of Inspection Team

There are seven (7) basic duties of the bridge inspection team:

1. Planning the inspection
2. Preparing for the inspection
3. Performing the inspection
4. Preparing the report
5. Identifying items for repairs and maintenance
6. Communicate the need for immediate follow-up for critical findings
7. Post inspection procedures

4.1 Planning the inspection

Planning is necessary for a safe, efficient, cost-effective inspection effort which results in a thorough and complete inspection.

Basic activities include:

- Determination of the type of inspection
- Selection of the inspection team, which includes a qualified Lead Inspector on site for all initial, routine, in-depth, fracture critical and underwater inspections. It is a good practice to provide a Lead Inspector for damage and special inspections.
- Evaluation of required activities (e.g., non-destructive evaluation, traffic control including use of flaggers, utilities, confined spaces, permits, hazardous materials such as pigeon droppings, lead paint and asbestos removal, etc.)
- Establishment of a schedule which includes the inspection duration.

The inspector shall:

- Develop a travel plan, including accommodations, truck rental, helicopter access plans, as applicable.
- Decide the duration and schedule for the inspection.
- Prepare / make arrangements for equipment including methods of access, any required special equipment, and traffic safety equipment such as truck beacon light and straps.
- Identify bridges with fracture critical members. Inspection records of bridges with fracture critical members must identify the location of fracture critical members and describe the fracture critical members inspection frequency and procedures.

- Bridges requiring underwater inspection, and bridges that are scour critical.
- Develop a traffic control plan including use of flaggers as required.
- Develop a confined space plan, as required.
- Develop a safety boat plan as required.
- Identify complex bridges. Complex bridges have specialized inspection procedures and additional inspector training and experience is required.
- Consider the weather forecast for the travel and inspection schedule.
- Develop unmanned arial vehicle (UAV) drone operation plan if applicable.
- Obtain permission from the railway company if the bridge is over railway tracks, and mobile platforms or other special equipment is going to be used in the track area.
- Develop a utility de-energizing plan, if applicable

4.2 Preparing for the inspection

- Obtain and review existing records of the structure prior to field work, including design and “as-built” drawings, previous inspection reports, correspondence and details of repairs, rehabilitations or modifications carried out after original construction.
  Note: It is often useful for the inspector to take to the field a one- or two-page summary of general inventory data and information on previous rehabilitation work.
- Prepare inspection forms, for each structure to be inspected.
  Note: elements should be selected to completely describe the structure under consideration. The BMS facilitates this process.
- If not already available in the BMS, record dimensions and calculate the quantities for the bridge elements under consideration as described in OSIM manual.

4.3 Performing the Inspection

The basic duties of the inspection team include performing a visual examination of all bridge elements, recording condition and performance of the structure, and recommending repairs. This includes all on-site work of examining and assessing bridge elements including streams and waterways if applicable. The inspection shall be performed in accordance with the Ontario Structure Inspection Manual (OSIM). Other reference manuals are listed in the References.

For any element that has maintenance need (MN), recommended work (RW), or a performance deficiency (PD) (as defined in OSIM), the inspector shall assign the element a criticality rating (CR). In all cases, any critical defect causing immediate safety concern shall require a phone call to the Structural Assets Manager to report the situation. If deemed critical enough, the inspector may consider closing the structure or lanes on the structure, calling emergency services such as police or fire department.

The main responsibilities of inspectors are:

Responsibilities	**OSIM Section Reference**
Identify and inspect all elements that comprise the structure	OSIM Part 2
Record all areas of material defects for each element, and categorise them under a defined Condition State	2.4

Identify suspected Performance Deficiencies	2.5
Note areas of the structure where maintenance is required	2.6
Make recommendations for repairs and rehabilitation of the structure	2.7
Indicate the suggested time frame or urgency of the proposed work	2.6, 2.7
Rate the criticality rating (CR) for each element as applicable.	
Identify additional detailed investigations that are required	2.7, Part 3
Prepare complete inspection report	
Enter all inspection data, photos, sketches etc. into the BMS and save to folder.	
Ensure that appropriate actions are taken or initiated to address safety concerns	1.1.2.2, 2.1.5.3

4.4 Preparing the Report

The inspection report shall be prepared in standard form from the BMS which automatically includes inspection photos. The report should be sent to all reviewers and filed according to Department policy. Reports shall be completed and in the system within 6-8 weeks after the inspection or not later than November 30th each year.

4.5 Identifying items for Repairs and Maintenance

OSIM provides a prescribed list of maintenance activities and codes for each type of bridge and culvert elements. These should be used for basic maintenance items. In addition, other repairs or rehabilitation needs should be identified and recommended by the inspector. The inspection report should clearly identify these recommended maintenance and repair activities.

4.6 Communicate the Need for Immediate Follow-up for Critical Findings

The critical findings to be communicated to the Structural Assets Manager and Manager Structures Bridges for appropriate action.

5 Inspection Equipment and Methods of Access

The inspection method and equipment to be used will depend on the type of inspection as described in Section 2 and from information gained from a review of previous inspection reports and bridge plans. The inspection team shall ensure that basic inspection equipment, cameras, and hand tools for cleaning, hammer sounding, and measuring are readily available for all inspection work. Assemble additional equipment, such as waders and non-destructive testing supplies, as necessary to facilitate an efficient,

thorough inspection. In planning the inspection, a pre-inspection site visit by the Lead Inspector may be helpful.

5.1 Typical Inspection Equipment

The inspection team should ensure appropriate inspection tools and equipment are available during the inspection either as individual tools or tools that are available in the truck. When planning an inspection route, the tools necessary for the entire route shall be prepared and available during the inspection.

A list of typical tools is provided in **Table 2** below. All inspection personnel should be equipped with and be thoroughly familiar with the proper use of this equipment. Note: this list is not exhaustive, and tools not listed here may be necessary in some inspections. Consult inspection manual for further list.

Table 2 Typical Inspection Equipment

- Binoculars
- Camera
- Chalk, markers and paint markers
- Inspection forms and clip boards
- Flashlight (focusing type)
- Chain drag (2 m)
- Light chipping hammer
- Measuring tape (3 m)
- Measuring tape (30 m)
- “Workers ahead” signs
- Mirror on a swivel head with an extension arm
- Plumb bob
- Pocket knife or multi-tool
- Range poles
- Safety belts and lanyard
- Boots, hat, gloves, vest
- Flotation vest
- Safety cones and flashing light
- Scraper
- Screwdriver (large)
- Sounding line (lead line)
- Straight edge (1 m)
- Air thermometers
- Wire brush
- Re-chargeable drill with bits
- Grinder
- Wood borer and treated plugs
- Eye level and hand level
- String-line
- Shovels
- Satellite Phone
- Radio Set
- Wind Gauge
- Laser distance measure
- Endoscope camera
- Wisk broom
- Ice pick
- Hand brace and bits
- Increment borer
- Lighted magnifying glass
- Dye penetrant
- Calipers
- Optical crack gauge
- Tiltmeter and protractor
- D-meter (ultrasonic thickness gauge)
- Field book
- Center punch
- Lap-top computer
- “P-K” surveyor’s nails
- C-clamps
- Insect repellant
- Cellphone
- Survey equipment
- Other equipment as required

5.2 Specialized Equipment

The most common types of specialized equipment for inspection include the following:
Note: this list is not an exhaustive listing of specialist equipment. Specialized training may be required for use of some types of specialized equipment.

- Cover meter
- Copper-copper/sulfate electrode half-cell is (CSE Half-Cell)
- Rapid chloride test kit
- Magnetic particle NDT kit
- Ultrasonic NDT equipment
- Water velocity measuring device
- Water testing kit

5.3 Methods of Access and use of RPAS

Certain locations on a structure may not be accessible for inspection without special equipment. This special access equipment may only be required on some structures periodically during Enhanced OSIM inspections and not during all biennial inspections. Inspectors should prearrange with the appropriate parties, for the use of the special equipment such as:

- Extension or folding ladder (3.5 m)
- Boat or barge
- Scaffolds – mobile, cable supported or stationary.
- Scissors Lift
- Truck mounted inspection bucket on a hydraulically operated boom off a truck
- “Cherry Picker”
- “BridgeMaster”
- Lane closure devices
- Rope access climbing equipment
- Underwater diving equipment

In selecting the use of access equipment, consider the following items:

- The degree of proximity to bridge components necessary to successfully accomplish the inspection, and the difficulty in accessing those components. Select the best equipment/method to accomplish the task at hand.
- The ability of the soil, pavement, and/or bridge structure to safely support the access equipment.

- The need for traffic control or lane closure depending on the type and location of the equipment, as well as the impact to motoring public. Use Traffic Control Plans (WSCC) and/or other local requirements as a guide in planning such measures.
- The need for special care to prevent accidents if utilities are present.
- The need for permits, flagman, and other special considerations for bridges over railroads.

Use experienced, trained personnel to plan and execute inspections involving specialized access equipment.

In some cases, rope access may be the most efficient way to inspect certain structures or components of structures. Rope access inspection can be done with limited traffic control and is an efficient way to get hands on inspection including specialized inspection equipment (e.g., NDE, NDT) to some elements.

In some cases, it may be appropriate to consider the use of UAV (drone) inspection tools. It is mandatory to adhere to Territorial and Federal rules. Only properly trained pilots and assistants shall operate UAV inspections. Consideration to traffic safety is paramount and may require limitations on where the UAV is permitted to fly, such as not above road deck without traffic control.

5.4 Equipment for Specific Regions

Structural Assets Manager/Inspection lead should be aware that each region has specific needs and limitations to what type of inspection gear can be carried. Structural Assets Manager shall make arrangements to purchase and store the gear in the region where flying or carrying each time is not practical.

6 Safety

The following general safety guidelines shall be followed at all times:

6.1 Hazard Assessment

On arrival at site, perform hazard assessment, record, and provide instructions to the inspection team. Hazard assessment notes should be recorded in the general notes of the inspection form.

6.2 Personal Protective Equipment

All employees must wear proper boots, GNWT-approved vests, and hard hats at all times in the field. Approved high visibility vests are preferable for inspections occurring at night. Each inspection truck to be equipped with First Aid kit.

6.3 Traffic Control

Hard hats must be worn when working in an Under Bridge Inspection Vehicle (UBIV), bucket, manlift, cherry picker truck or other lift type equipment or when working in the vicinity of repair/construction work. Inspectors are required to wear harnesses at all times while working in the bucket of the UBIV, manlift, cherry picker truck or other lift type equipment and connected to the piece of equipment through use of an CSA-approved shock absorbing device.

6.4 Access

If using any Under bridge Inspection Vehicle (UBIV), manlift, cherry picker truck or other lift type equipment, the equipment shall be inspected daily prior to every use. The UBIV shall be operated on a bridge deck only on travel/parking lanes and shoulders. All Department safety protocols shall be followed at all times.

6.5 Traffic Control Safety

Inspectors are never allowed to cross live traffic. While walking a deck with sufficient shoulder width for inspection, always walk against the direction of traffic. In cases where the inspectors feel that they might need traffic control for the deck inspection it is recommended to arrange in advance and look for opportunities to group structures requiring traffic control on the same inspection trip.

6.6 Confined Space Procedures

Bridges identified as requiring confined space equipment and trained personnel require additional preparation time and coordination. Inspectors may require respirators while working in a confined space area and must use air quality monitors as well. The Lead Inspector and Special Equipment Operator must ensure trucks are equipped with required masks, monitors, jumpsuits, etc. Extra personnel may be required for outside monitoring of team located in the confined space. Refer to the NWT Respiratory Protection (from WSCC), CSA Z1006 on work in Confined Space and other applicable codes and standards.

Confined Space Procedures as outlined in CSA Z1006 shall be followed for all Permit-Required and Non-Permit Required Confined Spaces.

6.7 Railroad Safety

For structures over a railroad or carrying railroad, inspectors are never allowed to be near the tracks. For structures carrying a railroad, it is not necessary to inspect the top portion of the deck if the deck is completely covered by train tracks. For visible portions of the deck on the top surface, the inspectors are allowed to go on the top only if track control is available. Inspectors shall complete any required training on an annual basis for working around railroad traffic. In all cases, the railway owner shall be contacted in advance to arrange permission to carry out the inspection.

6.8 Waterway and Channel Safety

For inspection of bridges or culverts spanning a waterway, the inspectors can utilize waders to wade and inspect the structure if the water level (up to 750 mm maximum) is deemed safe to enter however, if the inspectors find that the channel bed is unsafe and could adversely affect the safety of the inspector, the inspectors shall not enter the channel.

7 Reporting

Reporting is an essential part of the inspection Program and one of the main deliverables of the Program. The findings and recommendations may have an effect on public safety, policy, planning, and budgets. It is essential that proper practices are followed in the reporting cycle each year.

The reporting activity may include the following:

- preparation of the annual inspection reports together with photos, findings, recommendations, and any critical actions.
- preparation of maintenance action reports to provide to maintenance crews.
- preparation of annual summary reports including repair, rehabilitation and replacement priorities, 5Y budgets, and reporting performance measures vs targets.

7.1 Annual Inspection Reports

All inspection field notes, photos, sketches and supporting documentation shall be filed as hard copies and/or electronically. The inspection photos shall be saved in the proper location on the network such that they are available to the BMS. The inspection reports shall be produced from the BMS including photos and filed as hard copy and PDF.

Any critical findings will have been communicated to Structural Assets Manager and Manager Structures-Bridges as appropriate during the inspection or shortly after. In addition, a summary report of critical findings shall be prepared and provided to the Structural Assets Manager annually.

7.2 Maintenance Action Reports

Based on the findings of inspections, the Structural Assets Manager will prepare maintenance action reports as required. This report can consist of summaries by maintenance region. The BMS should be used to facilitate and track these recommendations including date of completion.

7.3 Annual Summary Reports

The Structural Assets Manager will prepare an annual report summarizing the performance of bridges and culverts on the highway system. This annual state of structures report will include critical findings, key

performance indicator (KPI) targets such as bridge condition index (BCI), Risk Profile, Inspection completion rate, **Sufficiency In**dex, etc. The bridge management system (BMS) calculates and reports this information and can be used to facilitate the preparation of this report which shall include as a minimum:

1. Critical Findings. Critical Findings that have been reported in current year and how they have been addressed should be summarized.
2. Average condition (BCI) of bridges and culverts. E.g., All Bridges average BCI = 74.3 (out of 100 new) Culverts Ave. BCI = 72.1. As a Performance Measure, BCI is useful to report and compare condition on a scale of 0 -100 (like new) into categories "Good", "Fair", or "Poor" defined as follows:

   (BCI≥70) "**Good**" no rehab/replacement work required in next 5 years. Also called "State of Good Repair"
   (60≤BCI<70) "**Fair**" is defined as a 1 – 5 year need
   (BCI<60) "**Poor**" defined as a "Now" need

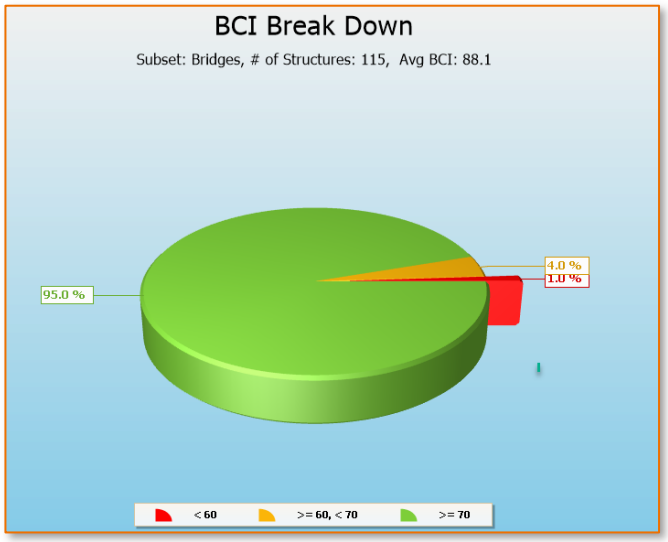
   Average BCI can be reported as All Bridges, All Culverts, Bridges on Primary Highways, Bridges on Winter Road etc. Average BCI is also used as a KPI such as Bridges on Primary Highways shall have Ave BCI = Good (≥70)

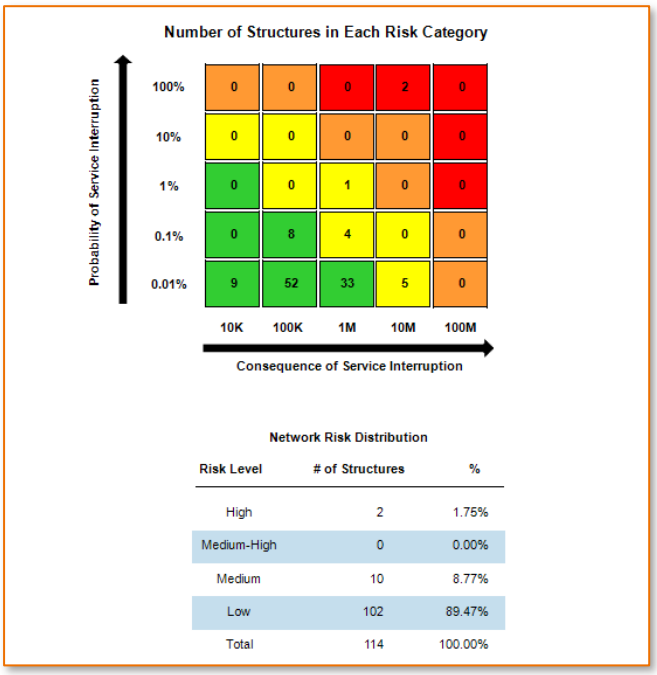
   Since BCI is used by other jurisdictions in Canada, it can also be used to compare average condition with other agencies.
3. BCI Breakdown into % **Good**, **Fair**, **Poor** and displayed as shown in **Figure 1 (a)**.

   This is also be used as a KPI for example set target performance measure of amount of BCI Poor structures limited to certain % for structures on particular highway class. This is referred to as level of service (LOS) reporting. Refer to Section 7.4.
4. Condition forecasts for 5Y and 10 Y. Beyond current condition reporting, forecasted condition shall be reported for the assets. This should include average BCI and BCI breakdown after 5Y and 10Y for various budget levels. These forecasts are produced by the BMS.
5. Required Budgets to meet Specified Target Condition. Required Budgets to meet targets for the assets should be reported. These can be condition targets and/or LOS targets as described in Section 7.4.
6. Condition Risk analysis. The risks associated with unplanned repairs due to condition should be monitored and reported. The risk considered is the probability and consequences of unplanned road closure associated with a particular structure. Using the inspection data, the BMS reports a Risk Profile for the network or any subset of the network such as Bridges, Culverts, Bridges on certain corridor etc. The profile lists structures in one of four (4) risk categories - Low, Medium, Medium-High, and High risk. See **Figure 1 (b)**. The structures in high-risk category should be giving priority, inspected more frequently etc. The amount (%) of structures in High-Risk category can be specified as a Performance Measure and targets established depending on structure type and LOS.
7. Sufficiency Index. The BMS reports an overall sufficiency index (SI) which takes into account the appraisal of a given structure in terms of meeting standards for Load Capacity, Flooding, Scour, Seismic, Fatigue, Vertical and Horizontal Clearances, and Safety. **To be discussed**

8. Inspection Programme Performance. The degree of completion of the annual inspection program is reported as a performance measure. A target is set based on the percent % of overdue inspections and this is taken as a measure of the funding and support of the inspection program.
9. Funding Levels. A measure of any programme is the degree to which required budget levels are funded.
10. Resiliency? **To be discussed**
11. Steps taken to mitigate effects of climate change and extreme weather? **To be discussed**

Figure 1 a) Bridge Condition Breakdown **b) Risk Profile**





7.4 Level of Service Reporting

Defining and measuring levels of service is a key activity in developing transportation asset management plans (TAMP). Levels of service may be tied to physical performance such as condition or be defined via customer expectation and satisfaction such as load carrying capacity or clearance restrictions. The current standard in bridge management and asset management is to report a variety of PM and report these based on desired level of services (LOS). The following LOS standards are recommended:

1. Bridge Condition Index (BCI) average and breakdown in Good, Fair, Poor.
2. Load Carrying Capacity
3. Vertical Clearance

4. Inspection Completion (% overdue inspections)
5. Risk / Risk Profile (e.g., limit to x % High Risk Category)
6. Funding level meets Defined Needs from BMS

Using the recommended groupings and performance measures, the following target performance measures are recommended:

LOS Grouping	PM	Target
Lifeline Structures	Bridge Condition BCI	Ave BCI > 80%, with non-Poor
	Vertical Clearance	No restrictions
	Inspection Completion	0% overdue
	Risk Category	0% High or Medium High Risk
	Funding Level	100% Needs Met
Primary Hwys	Bridge Condition BCI	Ave BCI > 70%, with no more than x % Poor
	Vertical Clearance	No restrictions
	Inspection Completion	less than 10% overdue
	Risk Category	less than 5% High Risk
	Funding Level	75% Needs Met

8 Load Rating

If a load rating has already been performed on the structure to be inspected, then the load rating report should be reviewed prior to the inspection. Any areas or elements of the structure determined to be critical to the load carrying capacity should be closely inspected. Detailed measurements may be required (e.g., loss of section, crack widths or crack propagation).

If the structure is scheduled to have a load rating performed, detailed measurements may be taken and used to update the load rating.

Following an inspection, a load rating may be requested when recommended by the inspector (action item in the inspection), or by the Lead Inspector or Structural Assets Manager following office review of an inspection.

However, if at anytime, significant variation in critical defects or increases in damage at critical areas are noted during an inspection, the Structural Assets Manager should be notified.

9 Quality Assurance and Control

The Lead Inspector and Manager shall develop and follow quality control and quality assurance procedures to ensure a high degree of accuracy and consistency in the inspection program. The plan must include periodic field review of inspection teams, periodic bridge inspection refresher training for Structural Assets Manager and Lead Inspectors, and independent review of inspection reports and computations.

- QC Inspections and reports
    - Lead Inspector signs-off report when finalized, Structural Assets Manager reviews and signs-off.
    - Inspection is closed, which locks and creates next inspection date in BMS.
- QA Inspections and reports
    - Random QA audit 5%
- Auditing
    - Quality Assurance Review Report
    - Summarizes the results of each QA audit

APPENDIX

Appendix A Sample OSIM Inspection Report

https://diims.gov.nt.ca/gnwt/llisapi.dll/link/174363579

Appendix B OSIM Field Inspection Guide

https://diims.gov.nt.ca/gnwt/llisapi.dll/link/174363556

Appendix C OSIM (Ontario Structure Inspection Manual)

https://diims.gov.nt.ca/gnwt/llisapi.dll/link/174360115

Appendix D Stantec BMS General User Training Manual

https://diims.gov.nt.ca/gnwt/llisapi.dll/link/174361876