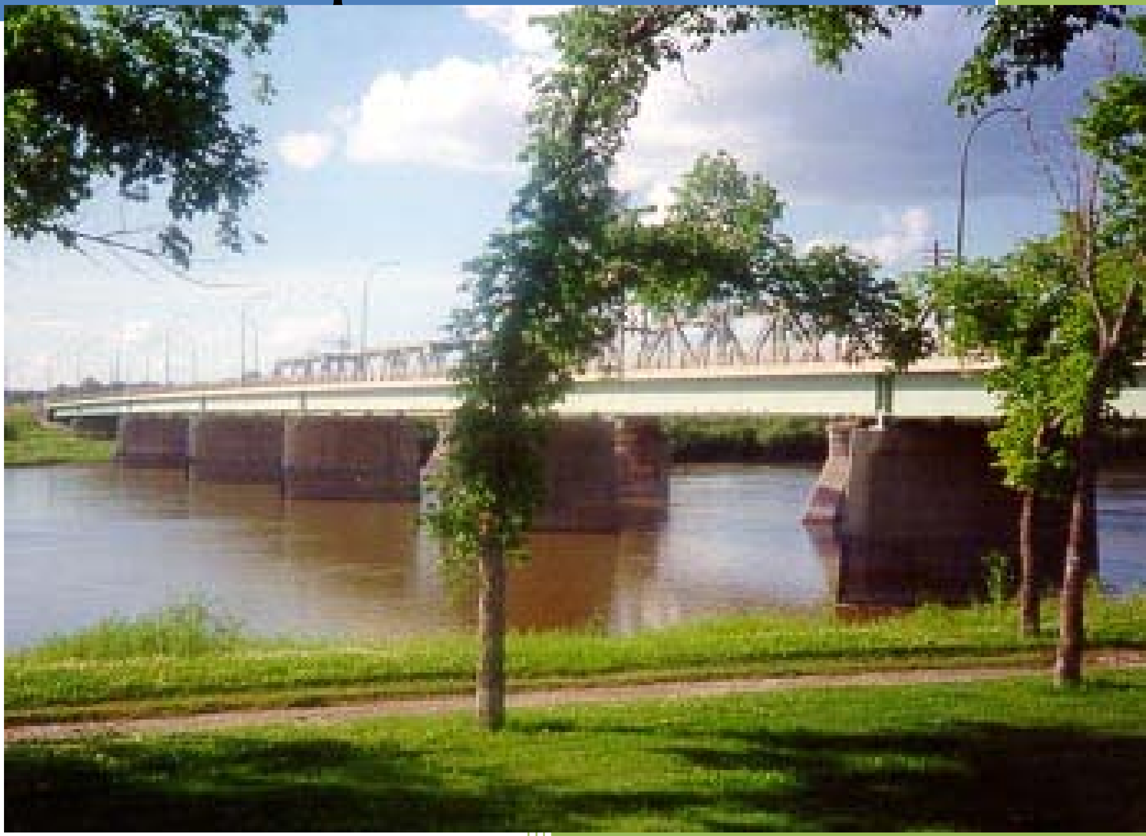
Contract Administration and Construction Inspection Manual



Manitoba

Infrastructure and Transportation

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PART A - GENERAL

A.1 INTRODUCTION

This manual, appendices and references are intended to be used by Engineering Service Providers (ESPs) who have been retained by Manitoba Infrastructure and Transportation (MIT) for the provision of contract administration and/or construction inspection services.

This manual details the processes to be followed by the ESP in administering and inspecting the project from the time a construction contract has been entered into by MIT and the Contractor, to the end of the contract warranty period.

It is MIT's intent that the ESP and MIT maintain a positive line of communication and flow of information throughout the duration of the project, so that the contract administration and construction inspection services can be performed correctly and in an effective manner.

This manual is divided into 3 distinct Parts:

- A - General
- B - Contract Administration
- C - Structure Construction Inspection

Due to the evolving nature of policies, standards, guidelines and contract specifications, portions of this manual may require periodic updating. In as much as it is practical to do so, MIT will provide any updates required and/or advise the ESP of any significant changes that affect the required processes or responsibilities. Where a discrepancy exists between this document and the documents prepared specifically for a project (e.g. Terms of Reference), the latter shall take precedence.

All guidelines, manuals or other documents referred to in this manual are the current edition or version unless specifically noted.

MIT hereby gives permission for the ESP to copy this manual solely for use within the firm.

A.1.1 DEFINITIONS

For the purposes of this manual, the following definitions will apply:

Acceptance	Work is accepted by MIT without detailed checking of the engineering principles and calculations.
Agreement	Engineering services agreement between MIT and the ESP, normally called the “ESP Agreement”.
Approval	Subject work shall be “approved” by MIT for matters relating to things such as MIT policy, funding or agreement extensions.
As-Built Drawings	Updated contract drawings that show any changes that occurred during construction. Also referred to as Record Drawings or As-Constructed Drawings.
Bridge Structure	Structure typically built on the provincial highway network and water control system that cross waterways. Major bridges include channel and box precast girder bridges and I-girder bridges. Typically major bridges are river crossings, and major structures are highway overpasses/underpasses or railway crossings.
Contract	The contract between MIT and the Contractor covering the performance of the work.
Contract Price	The original value of the Contract as determined at the tender opening.

Contractor	The person or company that has entered into a construction contract with MIT.
Engineering Service Provider (ESP)	The person or company that has entered into an engineering services agreement with MIT.
Final Contract Administration Package	The package of information that must be compiled and submitted at the completion of construction. A detailed description of the requirements of this package is provided in Part B - Contract Administration.
Final Progress Payment	Total amount payable to the Contractor (including adjustments for liquidated damages and other deductions).
FIPPA	Government of Manitoba legislation entitled "Freedom of Information and Protection of Privacy Act."
Land Surveyor	A person registered to perform land surveys in the Province of Manitoba.
MIT	Manitoba Infrastructure and Transportation
Overexpenditure Approval Record	Issued during the actual prosecution of the work to authorize anticipated expenditures in excess of the Contract Price.
Professional Engineer	A person registered to practice engineering in the Province of Manitoba under the APEGM Act.
Road Drainage Culverts	Culverts with an equivalent diameter of less than 2.0 meters that are typically included with the road design and construction packages
Significant Bid Item	Any bid item with an extended value greater than 7% of the Tender Price or $100,000 in value
Sub-ESP	A person or company that enters into an agreement with the ESP to carry out part or all of the work covered in the Agreement
Surety	Contractor's bonding company providing the performance and material bonding for the Contract.
Terms of Reference (TOR)	A document that describes the assignment, scope of the work to be performed, schedules and expected deliverables.
Work	All or any part of the work to be performed under the Contract by the Contractor, whether complete or incomplete, as originally set forth or as revised by MIT, and any or all of the Plant and Material supplied by or for the Contractor.

A.2 PROFESSIONAL REQUIREMENTS

A.2.1 Professional Registration

All ESP's engaged to provide engineering services for MIT shall be registered with the Association of Professional Engineers and Geoscientists of Manitoba (APEGM) and shall abide by the Association's regulations, code of ethics and bylaws. Any Sub-ESP's hired by the ESP shall also be registered with the Association of Professional Engineers and Geoscientists of Manitoba (APEGM) and shall abide by the Association's regulations, code of ethics and bylaws.

Land surveyors who are doing legal surveys for MIT must be registered Manitoba Land Surveyors.

A.2.2 Professional Seal

The ESP and Sub-ESP's shall sign, seal and date all Drawings, tender packages, cost estimates and any other engineering documents they produce, check and/or approve. The seal shall consist of the APEGM member stamp or seal and the permit stamp.

A.3 ROLES AND RESPONSIBILITIES

A.3.1 ESP

A.3.1.1 General

The ESP is retained by MIT to administer a construction contract between MIT and a Contractor and inspect the Work to ensure that it meets the requirements of the Contract. The ESP is the single line of communication between MIT and the Contractor concerning issues arising out of the performance and administration of the Contract. It is the ESP's responsibility to confirm the extent of his authority on contract administration issues with MIT prior to the commencement of the project. Any decisions required on contractual issues that fall outside the authority granted to the ESP shall be referred to MIT.

The ESP shall complete the assignment as described in the Agreement and shall supply all personnel, materials and equipment required to provide the services in accordance with the Agreement and the Project Terms of Reference (TOR). The ESP shall be solely responsible for all work performed under the Agreement, including work done by any Sub-ESP's. The ESP shall ensure that any of his personnel who are involved in making decisions concerning the Contract are entirely familiar with this manual, MIT's "Standard Construction Specifications" and the terms of the Contract. Also, the ESP shall ensure that any of his staff, including any sub-ESPs, who have knowledge of the Contractor's contract bid prices, keep this information confidential.

The ESP shall monitor all aspects of safety and health and environmental protection measures as they apply to the Work that is being undertaken.

A.3.1.2 Responsibilities

The responsibilities outlined below are offered to clarify working relationships with MIT's Project Manager, Contractor and other stakeholders. The list is not intended to be exhaustive, nor does it supersede any of the obligations outlined in other manuals or the Agreement.

Generally, the ESP is responsible to:

- Undertake the work in accordance with the prescribed scope, standards and specifications provided by MIT.
- Liaise with MIT's Project Manager and provide reports as described in this manual and the Terms of Reference (i.e. Weekly Construction Reports, Project Expenditure Reports, QC/QA test results, progress payments, cost estimates, invoices for fees, estimated final expenditures for the Agreement, etc.).
- Keep MIT's Project Manager informed of progress, issues and problems.
- Liaise with other Departments, agencies and the public, as required.
- Ensure that Utility Companies are contacted to determine if there are impacts to the existing plant.
- Be proactive in identifying and addressing any landowner or stakeholder issues.
- Manage work undertaken by Sub-ESP's.
- Notify MIT's Project Manager of any potential scope changes that may affect the fees payable in a timely manner before any additional work is done.
- Maintain documentation to support all fees and disbursements claimed from MIT.

<u>Contract Administration</u>

- Arrange and attend Pre-Construction Meeting (which is chaired by MIT's Project Manager).

- Act as MIT's on-site representative for construction and liaise with the Contractor during construction.
- Monitor the Contractor for compliance to the Construction Contract and take appropriate action when the standards or specifications are not being met.
- Hold weekly on-site meetings with the Contractor, take Minutes of the Meetings and distribute these minutes to the Contractor, MIT's Project Manager and other stakeholders.
- Monitor the Contractor's compliance with the Traffic Control Plan and take action (including suspension of work) when the plan is not complied with.
- Advise MIT's Safety Officer, in a timely manner, of serious or ongoing safety issues that are not being resolved by the Contractor.
- Monitor the Contractor's compliance with the environment requirements and take action (including suspension of work) when the requirements are not complied with.
- Advise MIT's Project Manager, in a timely manner, of serious or ongoing environmental management issues that are not being resolved by the Contractor.
- The ESP's on-site representative, after having sought and received his own corporate input, may request specification interpretation or other direction from MIT's Project Manager.
- Discuss with MIT's Project Manager any substantial issues or problems (i.e. structural issues, specification compliance problems, significant cost increases, safety concerns, claims possibilities, potential cost over-runs, etc.) and seek approval/direction/concurrence.
- Notify MIT's Project Manager of any potential Extra Work in a timely manner before any additional work is done.
- Meet with Contractor every month to review progress payments.
- Promptly notify MIT's Project Manager of all claims and potential claims. Recommend, in a timely manner, a response to potential claims.
- Arrange for interim inspection of construction project to obtain the Department's input as to the acceptability or otherwise of the project. Invite the Contractor, MIT's Project Manager(s) and other stakeholders to the interim inspection (as necessary) and prepare and distribute deficiency list.
- Participate in the Construction Completion Inspection (which is called by the Contractor), record and prepare a deficiency list if any deficiencies are noted and distribute the deficiency list to the Contractor and MIT's Project Manager.

The following are examples of typical issues or matters that would normally be referred to MIT's Project Manager by the ESP:

- Issues related to construction schedules
- Adjustments to bit item quantities and/or subsequent projected change in total bid item in excess of 10%
- Extra Work
- Contract claims resolution
- Overexpenditure Approval
- Contract Changes
- Discussions with adjacent land owners or stakeholders
- Discussions with the owners of the infrastructure or adjacent property (e.g. RM's, CN, CP, City of Winnipeg, City of Brandon)
- Discussions with utility companies
- Progress and final payment for construction contracts
- Extensions to the contract completion date

The ESP is responsible for monitoring, inspecting and testing the Work performed by the Contractor to confirm compliance with the terms of the Contract. The ESP has the authority to reject defective work and to prohibit any proposed work method or procedure that will result in a finished product failing to meet the standards required under the Contract. The ESP also has the authority to order the Contractor to suspend the Work where, in his opinion, the Contractor fails to adequately provide for the safety of all workers on-site and the traveling public, for re-occurring safety issues or when the Contractor fails to comply with orders issued by the ESP regarding traffic accommodation operations. The ESP also has the authority to order the Contractor to suspend the work, where, in his opinion, the Contractor fails to adequately meet the environmental requirements as stipulated in the environmental approval documents and the environmental protection requirements.

It is essential that the ESP maintain accurate and complete records of all activities, quantities of work performed by the Contractor and significant issues arising from the performance of the Contract.

It is MIT's expectation that the ESP administer the Contract with a view to bringing the project to completion, on time, within budget, and in accordance with the terms of the Contract. Further, MIT encourages the ESP to monitor the performance of the project design throughout the course of construction and consider and recommend any changes that may facilitate or assist in achieving these objectives. Any significant changes to the project design must be referred to MIT's Project Manager for approval prior to implementation.

The ESP can not change the terms and conditions of the contract documents. Any changes to the Contract require written agreement by both MIT and the Contractor.

The ESP is fully responsible for accurate and timely reporting of progress and final payments and forecasting fiscal expenditures. Discrepancies and misrepresentations in individual projects can have significant impact on MIT's ability to make maximum use of its allocated funding. Throughout the project and fiscal year, MIT will monitor this reporting for its accuracy and timeliness and is a measurable item in performance evaluation.

The ESP is totally responsible to ensure he fulfills his obligations in accordance with all applicable provincial and federal legislation and regulations.

The processes and procedures to be followed by the ESP are outlined in this document and the Agreement. In the event a discrepancy exists or appears to exist between this document and the Agreement, the ESP must immediately contact MIT's Project Manager for clarification.

A.3.2 MIT

A.3.2.1 General

MIT is responsible to ensure that the ESP fulfils his obligations in accordance with this document and the Agreement and to address any issues or matters related to the Contract that do not fall within the limits of the authority delegated to the ESP.

The Project Manager is a MIT employee who is responsible for the delivery of a project from the time a construction contract has been entered into by MIT and the Contractor, to the completion of construction and the end of the warranty period for the project. MIT may also assign a Project Co-Manager who is responsible for a particular major component of the work on a combined project (e.g. associated road works).

A.3.2.2 Responsibilities of Project Manager

The responsibilities outlined below are offered to clarify working relationships with the ESP, the Contractor and other stakeholders. The list is not intended to be exhaustive, nor does it supersede any other responsibilities or obligations contained in other manuals or the Agreement. The Project Manager:

<u>General</u>

- Ensures funding and approvals are in place prior to issuing a RFP or requesting work from an ESP.
- Prepares TOR for the project, reviews the proposal and participates in the selection process.
- Chairs Project Initialization Meeting.

- Ensures that the project-specific engineering services are completed to proper standards and within approved budget and time frame.
- Liaises closely with the ESP to monitor quality, schedule, compliance and overall performance of the ESP.
- Obtains input from appropriate Regional personnel (Director, Construction Engineer, Technical Services Engineer, etc.) or other Branch/Divisional personnel.
- Liaises with various Branches of MIT (administrative, technical, contractual, right-of- way, etc.) and other departments and agencies as required.
- Liaises with ESP's during all phases of the work and reviews reports, Meeting Notes, test results, expenditures, invoices, etc.
- Reviews and administers Changes in Scope, project team changes and contract date extensions for the engineering service assignment. Ensures funding and approvals are in place for all scope and contract changes.
- Assesses the performance of the ESP on a continual basis and prepares the final ESP performance evaluation rating in a timely manner.
- Reviews and recommends approval of all ESP invoices.
- Ensures financial coding is accurate on all invoices.

<u>Contract Administration</u>

- Chairs Pre-Construction Meeting.
- In order to assess the performance of the ESP and to ensure consistent application of standards and specifications, the Project Manager (or designate) visits projects that are in progress and advises the ESP regarding any project problems that are noted and/or addresses issues brought forward by the ESP.
- May issue instructions to the ESP to have any construction related problems rectified. If instructions are contrary to what the ESP has advised the Contractor, the Contractor may have to be compensated. MIT and the ESP will review such matters.
- Works with the ESP for interpretation of specifications and/or potential claim situations.
- Reviews and administers Extra Work Orders and completion date extensions.
- Liaises with the ESP, not the Contractor, on contractual matters during construction. The ESP deals directly with the Contractor. During site visits, discussions may be held between MIT staff and the Contractor, but directions are not given to the Contractor unless of an urgent nature.
- Monitors the work to ensure that any safety deficiencies identified by MIT's Safety Officer or Workplace Safety & Health representative are corrected by either the ESP or the Contractor.
- Monitors the work to ensure that any environmental management deficiencies identified are corrected by the Contractor.
- Near completion of construction, the Project Manager attends an interim inspection of the work (organized by the ESP) at which time all aspects of the work which are not satisfactory, are brought to the attention of the ESP. Attendance by the Contractor is strongly advised at this time. A list of deficiencies is produced prior to the departure of the Contractor from the site.
- Upon completion of construction and rectification of the deficiencies, the Project Manager attends the Construction Completion Inspection (which is organized by the Contractor). He ensures that any input from other MIT personnel is gathered prior to the inspection. The Project Manager represents MIT and is responsible for the construction completion acceptance. Any further deficiencies identified during the inspection are recorded by the ESP and provided to both the Contractor and the Project Manager in writing. The deficiency list must also include time-lines for the completion of the deficient work.
- Assists with MIT's resolution of Construction Contract Claims and ensures that all correspondence to the Contractor is handled in a timely manner.
- Reviews and recommends all Contractor Progress Payments.
- Ensures funding and approvals are in place for all Extra Work and contract changes.

A.3.2.3 Responsibilities of Project Manager and Project Co-Manager

In combined projects that include both associated road works and structure construction, the roles of the Roadworks Project Manager and Structures Project Manager are to some extent integrated. It takes considerable communication and co-ordination during the process of delivering a combined project from contract award to the construction warranty inspection. For such a combined project, either the Roadworks Project Manager or the Structures Project Manager will be the overall Project Manager for the entire project. This will depend largely on the predominance of the roadwork and structure work involved as well as the specialty of the work.

On combined projects, the Project Manager and Project Co-Manager are responsible for the following:

- The Project Manager is responsible for the Terms of Reference after obtaining input from the Project Co-Manager, technical specialists, and others as required and will circulate Requests for Proposals for review.
- The Project Manager will distribute copies of the ESP's proposals to the Project Co-Manager and other team members for review.
- The Project Manager chairs Project Initialization Meeting. Areas of responsibility and reporting procedures will be outlined so that the ESP can effectively communicate with the respective Project Manager/Project Co-Manager.
- The Project Manager will deal with administrative processes, approvals, Changes in Scope, changes to the Agreement, project team changes, fee schedules, etc., after input from the Project Co-Manager is received. He/she will also deal with technical aspects in his/her area of expertise.
- The Project Co-Manager can deal directly with the various ESP staff involved with the project in so far as the technical aspects are concerned and shall apprise the Project Manager of all communications.
- The Project Manager and Project Co-Manager will co-ordinate and monitor the updating of invoices, progress payments, Weekly Construction Reports, Project Expenditure Reports, test results, etc.
- The Project Manager is to conduct periodic meetings with MIT staff to provide an update on the status of the project and discuss any issues that have arisen.
- ESP Performance Evaluations are completed by both Project Manager and Project Co-Manager.
- Each will ensure that communication is maintained and necessary information is exchanged with all necessary parties during the course of the project.
- Substantial Completion and Construction Completion Inspections can be attended by both, as needed.
- Deliverables are to be submitted to the Project Manager for review and approval.

A.4 COMMUNICATIONS

A.4.1 General

MIT will designate a representative to act as the Project Manager on behalf of MIT. It is expected that the ESP will also designate a representative to act as the Project Manager on their behalf. MIT's Project Manager and Project Co-Manager (if applicable) will have the overall responsibility of ensuring that the work is planned, coordinated and executed in accordance with the Agreement and MIT's requirements.

MIT's Project Manager will liaise between the ESP, and other stakeholders to resolve any administrative, technical or contractual matters. It is MIT's intent that communications necessary between MIT and the ESP concerning any issues arising from the Contract or the Agreement be handled using a "one window" approach between the ESP and MIT's Project Manager. However, MIT recognizes that to administer the Contract effectively, it may be necessary for the ESP to communicate directly with other persons in MIT or stakeholders who are involved in the project and open, interactive communication between the ESP and the Stakeholders involved in the project is promoted. When this occurs, it is the ESP's responsibility to immediately advise MIT's Project Manager of the issues arising from these communications.

A.4.2 Project Initialization Meeting

MIT's Project Manager is responsible for ensuring that each activity and phase of the work is completed as scheduled. To do this, prior to any work commencing on a project, MIT's Project Manager will normally call a Project Initialization Meeting with the ESP, and any appropriate stakeholders, to clarify the assignment, expectations and staff roles, to review the scope of the work to be done, safety strategy, reporting requirements, time frame for the overall project, as well as any significant milestone dates within that time frame for specific activities.

Project administration information such as invoicing requirements, sample forms, revised procedures, etc. will also be provided to the ESP at this meeting.

Details on the ESP Performance Evaluation process will be discussed at the Project Initialization Meeting. MIT's Project Manager will advise the ESP of appropriate form(s) to be used, and as required, also identify the criteria/weighting/timing that will be used as the basis in the evaluation process. Further information on the Performance Evaluation process can be found in the "ESP Engagement and Administration Manual."

A.4.3 Communications with the Contractor

The ESP should communicate any instructions, orders, approvals or decisions on any significant issues directly to the Contractor's superintendent. All such instructions, orders, approvals, or decisions shall be documented in the ESP's Project Diary.

A.4.3.1 Quantity Records, Contract Progress Payments and Final Payments

If requested by the Contractor, the ESP shall make contract quantity records available for examination. The project data may be examined at the ESP's office or MIT's office by appointment at a mutually agreeable time and in the presence of the ESP. The Contractor is permitted to make notes during such examination. Under no circumstances are original records to be removed from the office. Project Diaries, internal memoranda and reports, materials quality assurance test results, or correspondence with other parties shall not be provided to the Contractor.

Quantity information requested by sub-contractors may be provided upon approval from the Contractor.

Copies of monthly Progress Payments, including the Final Payment, shall be forwarded to the Contractor by the ESP prior to the last business day of each month.

A.4.4 Communications with the Surety

Any communication with the Contractor's Surety shall be by MIT only. The ESP may be required to complete project status reports and submit these reports to MIT's Project Manager. The forms for these reports shall be provided to the ESP by MIT's Project Manager. The Contractor will receive copies of any such correspondence with the Surety.

A.4.5 Communications with Municipalities

Prior to the commencement of the project, the ESP shall advise local authorities of impending construction activities in their areas, including the nature of the construction activities, the name of the Contractor and the scheduled startup date. MIT representatives will usually also attend this meeting with the local authorities. The ESP shall also advise of the haul roads to be used or any other issues the Contractor has proposed that may impact the local authority. The ESP shall notify MIT's Project Manager immediately following such discussions with local authorities.

When work takes place on service roads or access roads that are under the jurisdiction of the local authority, the ESP shall inform MIT's Project Manager when work on these roads has been completed.

The ESP shall also carry out a field inspection on the completed roads with the appropriate representative of the respective municipality. Any deficiencies noted are to be discussed with MIT's Project Manager.

Once the Construction Completion Inspection has been completed and it is agreed that the Contractor has met the terms of the Contract, the ESP shall provide the local authority with written confirmation of project completion.

A.4.6 Communications with News Media

MIT is responsible for all communication with the news media. The ESP may be required to provide technical and construction progress information to MIT for the purpose of communications with the news media.

Depending on the nature of the project and traffic characteristics, a News Release advising motorists of pending construction activities, delays, detours, etc., may be required. The issuance of a News Release shall be completed by MIT.

A.4.7 Changes to Scope of Work for Engineering Assignment

Any changes in the scope of work or the Terms of Reference of the Agreement that impacts upon the schedule or costs of the project shall be brought to the attention of MIT's Project Manager by the ESP. Changes to Scope of Work shall be in writing (using MIT's form) and include the estimated costs and schedule implications, if applicable. Changes to Scope of Work shall be submitted as soon as they become apparent, for review and approval.

NOTE: ***Except for emergency situations, the ESP shall not proceed unless a written authorization to do the work is given by MIT.***

A.5 CONTRACT ADMINISTRATION AND CONSTRUCTION INSPECTION PROCESS

A.5.1 Construction Specifications and Standards

MIT Contracts reference specific editions or portions of one or more of the following documents:

- "Standard Construction Specifications" - This document contains general contract requirements and technical specifications.
- "Manitoba Work Zone Traffic Control Manual - Provincial Roads and Provincial Trunk Highways" - This manual contains the roles and responsibilities of the Contractor and ESP associated with traffic accommodation, factors to be considered when providing traffic accommodation and standard drawings showing minimum temporary signing requirements for typical situations.

MIT strives to ensure that its contract documents and manuals detail all items required for the proper delivery of a project. Providing the required information in a clear and concise form helps ensure that all projects can be administered consistently and in accordance with MIT's intent.

A.5.2 Tender Documents and Construction Contracts

Construction tender documents are comprised of a schedule of bid items, standard technical specifications, special provisions and drawings. Technical specifications are "standard" for a particular type of work and generally do not change from contract to contract. However, the list of bid items, special provisions and drawings address the site specific items or issues on a project and are unique for each contract.

A Contract requires the completion of a specific type and scope of work in accordance with specified requirements and at agreed payment rates. Any work or project not covered by the terms of the Contract may not be undertaken without mutual written consent of MIT and the Contractor. Also, a condition of the Contract can not be deleted or modified without mutual written consent of MIT and the Contractor.

A.5.3 Commencement of Contact Work

A.5.3.1 General

Once the project commences, the ESP shall monitor the performance of the Work to confirm that the Contractor is in compliance with the terms of the Contract. Instances of non-compliance by the Contractor must be addressed by the ESP immediately and in a manner which will rectify the situation.

Verbal communications/instructions with the Contractor on significant issues shall always be confirmed in writing. The ESP shall provide MIT's Project Manager with copies of all written communication with the Contractor.

It is MIT's expectation that the ESP initiate and organize any meetings necessary between MIT's Project Manager, ESP, Contractor and other stakeholders in the project to discuss the status of the project or to address specific issues as they arise.

A.5.3.2 Pre-Commencement Meeting

Prior to the Pre-Construction Meeting, the ESP shall attend a Pre-Commencement Meeting with MIT to discuss expectations, levels of authority and any specific issues or concerns regarding the impending project. The Pre-Commencement Meeting may be held several days prior to the Pre-Construction Meeting or immediately prior to the Pre-Construction Meeting as determined by MIT's Project Manager.

A.5.3.3 PRE-CONSTRUCTION MEETING

The ESP shall arrange a Pre-Construction Meeting with MIT's Project Manager, MIT's Safety Officer, the Contractor, and other stakeholders as required. The ESP shall notify the Contractor that a representative from each of his subcontractors (if any) should also attend. The ESP shall also confirm the need for attendance by the local municipality, regulatory agencies and utility companies with MIT's Project Manager. The ESP shall prepare and confirm the agenda for the meeting with MIT's Project Manager. This meeting is chaired by MIT's Project Manager. Minutes of the Meeting shall be recorded by the ESP and distributed to all attendees within five (5) working days of the meeting.

Typical items that should be discussed at the Pre-Construction Meeting include, but are not limited to the following:

- Administration procedures
- Special requirements of the project
- Traffic Accommodation
- Work schedule and working hours of the Contractor
- Compliance with the Workplace Safety and Health Act and Regulations and any other applicable Acts
- Prime Contractor roles and responsibilities
- Environmental requirements and issues
- Quality Control and Assurance
- Utilities
- Progress Payments
- Property and R.O.W. issues
- Coordination of sub-contractors
- Illumination
- Survey requirements
- Aggregate sources for associated road works
- Specific structure issues
- Sub-completion dates, Construction Completion Inspection and requirements for project completion

A.5.3.3.1 UTILITIES AND APPURTENANCES

Normally, the ESP shall use the Pre-Construction Meeting to go over scheduling and special requirements of the project. On complex projects or projects with a large utility component, the ESP should hold a separate meeting involving the Contractor and the utility company representatives to review all aspects of utility move scheduling and coordination. When necessary, meetings should also be supplemented by an on-site meeting to further define roles and responsibilities involved in the utility moves.

The ESP shall provide the Contractor with copies of all finalized utility plans/drawings and any other relevant documentation not already contained in the Contract.

Generally, the ESP's role involving utility relocation is to ensure compliance with the Contract.

A.5.3.4 COMMENCING WORK ON THE PROJECT

Work may commence on a project after the Contract has been signed by the Contractor and MIT, the Contractor has provided MIT with the necessary documentation including insurance and Worker's Compensation Board, Pre-Construction Meeting has been held and all necessary traffic control measures are in place.

A.5.4 PROJECT REPORTING REQUIREMENTS

A.5.4.1 GENERAL

To keep MIT informed of the status of the project, the ESP shall submit standard reports within specified timelines. MIT's Project Manager will provide the ESP with sample forms and summary sheets. Report forms developed by the ESP will be acceptable only if all the required information is reported in the same layout as the MIT form.

If stipulated in the Project TOR or at the Project Initialization Meeting, there may be a requirement to send copies of correspondence to other persons and/or stakeholders.

Weekly Site Meetings shall be called by the ESP and attended by the Contractor, MIT's Project Manager (or designated representative), MIT's Project Co-Manager (or designated representative) and stakeholders as required. The ESP shall take Minutes of the Meetings and distribute these minutes to the Contractor, MIT's Project Manager and other stakeholders within 5 working days.

Electronic reporting is to be used when available and MIT programs will be made available to ESP's unless restricted by licensing or other requirements.

A.5.4.2 PROJECT DIARIES

Project diaries are a complete record of the project and of utmost importance in dealing with claims and Extra Work. Separate diaries shall be kept for each project site and only information pertaining to that site is recorded. It is essential that the Resident Engineer and/or Inspector maintain the Project Diaries on a daily basis. A detailed description of the information to be documented in Project Diaries is included in Part B – Contract Administration.

A.5.4.3 WEEKLY CONSTRUCTION REPORTS

The ESP shall complete a Weekly Construction Report for each project. The Weekly Construction Report covers the period from Sunday to the following Saturday (inclusive) and shall be submitted MIT's Project Manager on the following Monday. Weekly Construction Reports shall be submitted regardless of whether or not work was performed during the previous week. A separate Weekly Construction Report is to be submitted for each project. A detailed description of the information to be included in the Weekly Construction Reports is included in Part B – Contract Administration.

A.5.4.4 CONTRACT PROGRESS PAYMENTS AND FINAL PAYMENTS

A Progress Payment is a payment to the Contractor for the specific Work completed on a project up to and including an agreed upon date. A Final Payment is the last Progress Payment for the Contract and contains the total actual quantities of work performed to project completion. The Final Payment shall have "final" written beside the payment number and is usually submitted with the Final Contract Administration Package. A detailed description of Progress Payments and the Final Payment is included in Part B – Contract Administration.

A.5.4.5 PROJECT EXPENDITURE REPORT

A Project Expenditure Report must be submitted to MIT's Project Manager by the 26th of each month. When the ESP is estimating costs on this report such as "Project Fiscal Expenditures" and "Carry Over", it is important that the estimate reflects what the ESP believes will be the actual costs, and not inflated values. The costs estimated must not include any contingencies for unsubstantiated items. This estimate is used for MIT budget control purposes and further adjustments to the project costs can be made in the event of any unforeseen changes in the work. The Project Expenditure Report form will be provided to the ESP by MIT's Project Manager.

A.5.4.6 BI-WEEKLY EMPLOYMENT EQUITY SUMMARY

The Contractor may be responsible for completing and submitting a bi-weekly Employment Equity summary report. This requirement would apply to projects that include a local labour clause. The ESP shall obtain the completed report from the Contractor, audit the report for accuracy, and submit it to MIT's Project Manager with the Weekly Construction Report.

A.5.4.7 ESP DOCUMENTS AND FIPPA

Any information collected or generated by an ESP, when providing engineering services, is the sole property of MIT. This information is subject to FIPPA. When asked to give out information, the ESP must contact MIT's Project Manager prior to doing so, in order that FIPPA is not violated in regards to privacy and personal information.

A.5.5 APPROVAL OR ACCEPTANCE

The following, and other unforeseen matters, shall be referred to MIT's Project Manager for approval or acceptance unless authority is delegated elsewhere:

- Approval – Refer to Section A.1.1 for definition
  - Change of project personnel
  - Changes to project funding requirements
  - Design Changes (after tender)
  - Changes to scope of work and fee increases for ESP assignment
  - Specified start and/or completion dates for the contract and any other conditions related to construction schedules and contract extensions
  - Contract claims resolution
  - Extra work
  - Contract Overexpenditures
  - Progress and Final Payment for Construction Contracts

- Acceptance – Refer to Section A.1.1 for definition
  - Final Contract Administration Package

A.5.6 COST ESTIMATES

Accurate and timely submission of cost estimates is important for MIT's programming and fiscal control functions.

The ESP shall provide the following fiscal expenditure documents:

- Earned Value Reports for engineering services, including projected fiscal expenditure

- o Progress and Final payments
- o Project Expenditure Reports (on a monthly basis)

A more detailed explanation of the items listed above is contained in Part B - Contract Administration.

A.6 ENVIRONMENTAL REQUIREMENTS

A.6.1 GENERAL

The ESP shall be familiar with all environmental requirements of the Contract and ensure that all applicable permits, approvals, licenses and certificates are in place prior to commencement of construction. The ESP shall enforce the environmental protection requirements of the Contract.

All Weekly Construction Reports shall report on the Contractor's compliance with environmental requirements. Examples of items to be noted are:

- What physical or procedural measures are in place to address the Contract requirements and approvals and are the measures functioning as intended?
- Have incidents of non-compliance with the environmental approvals (i.e. permits, licenses) occurred? If so, what action was taken to correct the situation?

A.6.2 RESPONSIBILITIES

In order to maximize environmental protection during construction, it is critical that all parties to MIT's contracts, agreements, permits and authorizations, be aware of the environmental protections requirements and their respective responsibilities for those requirements. The primary responsibilities of the ESP, MIT and the Contractor are as follows:

A.6.2.1 ESP

The following are the primary responsibilities of the ESP concerning environmental protection during the administration of MIT contracts:

- Be familiar with the appropriate environmental requirements.
- Review the Contract and determine if there are any anticipated unique situations that will require special environmental protection measures.
- Review, in concert with MIT's Project Manager, the Contractor's submittals for conformance with the intent of the Contract prior to commencement of the work to determine if it is appropriate for the site conditions anticipated.
- Provide submittals from the Contractor required in the contract documents to MIT.
- Liaise with the Contractor to address any concerns with the proposed submittals.
- Liaise with MIT to address any concerns with the proposed submittals and the adequacy of the environmental protection measures implemented.
- Monitor the work site to ensure the Contractor implements and maintains the site in accordance with the Contract.
- Monitor the work site to ensure that the work is being carried out in accordance with the contract and, as the work progresses, to assess if the environmental protection measures stipulated in the Contract are suitable for each phase of the work and throughout the duration of the project.
- Advise the Contractor of any deficiencies in the environmental protection measures taken and direct the Contractor to take appropriate and timely corrective action.
- Order the Contractor to suspend work in cases of recognized non-compliance with the contract documents or where the Contractor fails to undertake appropriate and timely measures to protect the environment or fails to correct recurring deficiencies. Immediately notify MIT in cases where such orders are issued.
- Immediately notify MIT of any environmental incidents, complaints, and inquires as reported to the ESP by the Contractor.

A.6.2.2 MIT

MIT will perform the following functions:

- Identify appropriate environmental requirements to the ESP and Contractor.
- Review and evaluate, in concert with the ESP, if the Contractors' submittals are made in accordance with the Contract.
- Engage Environmental ESP's (if required).
- Liaise with the Federal Responsible Authorities and Provincial Regulators concerning environmental submissions, authorization requirements, monitoring, and follow-up.
- Obtain and comply with the necessary Fisheries Act, Navigable Waters Protections Act, and Water Rights Act approvals, and the Environment Act Licence.
- Inspect the work site. During such inspections, advise the ESP of any deficiencies noted in the environmental protection measures. An inspection report will be prepared and retained.
- Liaise with the ESP regarding any deficiencies in the submittals, environmental measures implemented, contract documents or other environmental matters that involve the Contractor.
- Order the Contractor to suspend work in cases of recognized non-compliance with the legal requirements or where the Contractor fails to take appropriate and timely measures to protect the environment. Typically, MIT would only take on this responsibility during a periodic inspection where the ESP cannot be contacted to issue the order to suspend work or the nature of the non-compliance is critical to the protection of the environment.
- Data and report management.
- Schedule management.

A.6.2.3 CONTRACTOR

The Contractor's responsibilities are established through the contract documents. The following are the primary responsibilities of the Contractor, concerning environmental protection on MIT contracts:

- Implement environmental protection measures in accordance with the related contract documents.
- Monitor the work site in accordance with the related contract documents.
- Maintain all environmental control and protection devices.
- Take appropriate and timely action to correct any deficiencies.
- Take action in consultation with the ESP (i.e. shut down work) where it is recognized that a considerable effect to the environment or a violation of any environmental regulation will occur.
- Ensure that staff and Subcontractors are trained and empowered to identify, address and report potential environmental problems.
- Report all environmental incidents to the proper authorities immediately and provide a copy of the incident report to the ESP in accordance with the related contract documents.
- Attend any meetings initiated by the ESP to address any concerns regarding the performance of the environmental protection measures implemented in accordance with related contract documents.
- Ensure that all Subcontractors comply with the related contract documents.
- Provide a knowledgeable individual at the work site to maintain the environmental control devices and address any environmental protection issues that arise. The Contractor must identify this individual and qualifications to the ESP at the pre-construction meeting.
- Identify knowledgeable individual(s) and qualifications at the work site to act as the on-site emergency response coordinator(s) who shall have the authority to redirect manpower in order to respond in the event of a spill or environmental emergency. The Contractor must identify the individual(s) to the ESP at the Pre-Construction Meeting.
- All requests for a change in environmental control measures initiated by the Contractor shall be forwarded to the ESP for submission to MIT.

A.7 WORKPLACE SAFETY AND HEALTH

A.7.1 GENERAL

It is MIT's policy that the responsibility for ensuring compliance with the Workplace Safety and Health Act and Regulations should reside with the person(s) performing the Work. Therefore, MIT through its Contracts, assigns the designation of "Prime Contractor" (as defined under the Workplace Safety and Health Act) to the Contractor.

The ESP shall familiarize themselves, their staff and their sub-ESP's with the terms of the Workplace Safety and Health Act and Regulations to ensure complete understanding of the responsibilities given and compliance required.The ESP shall ensure that he and his sub-ESPs comply with the Workplace Safety and Health Act and Regulations in the performance of their duties.

During contract administration services, the ESP shall take appropriate action in situations where he is aware that the Contractor is not complying with the Workplace Safety and Health Act and Regulations. In situations of recognized imminent danger, this would involve ordering suspension of the Work and immediately notifying MIT.

Some general administrative responsibilities of the ESP related to Workplace Safety and Health are:

- On complex projects or projects that involve the use of specialized work methods or equipment, require the Contractor to provide operational safety policies and plans specific to the work (i.e. safe work procedures for site specific hazards).
- Review the Contractor's operational safety policies and plans to ensure compliance with Workplace Safety and Health Act and Regulations.
- Notify the Contractor's site representative of any safety and health violations related to the Contractor's activities that the ESP is aware of or observes.
- Provide MIT with copies of any written correspondence on safety issues/concerns pertaining to the Contractor's activities.
- Provide MIT with copies of any orders issued to the Contractor by Manitoba Workplace Safety and Health.
- Provide to MIT, within 24 hours, copies of any worksite injury or accident report involving employees of the Contractor, Sub-Contractors or ESP. The ESP will be responsible for obtaining and forwarding reports provided by the Contractor.
- Attend the Contractor's project safety meetings whenever possible.
- Provide MIT with a copy of the Monthly Safety and Health Summary Reports (these reports are completed by the Contractor).

A.7.2 WORKSITE HAZARD

While undertaking site inspection for contract administration and construction inspection activities, the ESP has the responsibility to identify site hazards and develop operational safety policies, procedures and plans that are specific to the work being performed to ensure the safety of all staff on site, whether employed by the ESP or Sub-ESP. When requested by MIT's Project Manager, the ESP shall provide copies of these safety policies, procedures and plans to MIT prior to the commencement of the work.

If Workplace Safety and Health conducts a site inspection that results in "orders" being issued to the ESP or Sub-ESP, the ESP shall immediately supply copies of these orders to MIT.

During construction, the Contractor has the responsibility to identify worksite hazards and shall develop operational safety policies, procedures and plans that are specific to the work being performed to ensure the safety of all workers on site, whether employed by the Contractor or ESP. The impact of the public traveling through the work site must be considered when developing these plans (if applicable). When requested by MIT, the ESP shall provide copies of these safety policies, procedures and plans to MIT prior to the commencement of the work.

In cases of recognized imminent danger or when the Contractor or ESP fails to comply with safety orders issued or fails to rectify previously identified worksite hazards, MIT will order the cessation of the work until it is safe for the work to resume. Their interpretation of a worksite hazard will be considered as final in all cases.

A.7.3 ACCIDENT INVESTIGATION AT THE WORKSITE

When retained by MIT for contract administration services to act as MIT representative on site, the ESP shall ensure that all of the Contractor's operations meet the requirements of the Workplace Safety and Health Act and Regulations. The ESP may be required to communicate with Contractors and Utilities Companies and may have to arbitrate disputes between them when they are working in the vicinity of each other.

In the event of an injury or accident involving staff of the ESP, or his/her Sub-ESP, at the worksite as defined by the Workplace Safety and Health Act, the ESP shall conduct an accident investigation as required by the Workplace Safety and Health Act. In addition, the ESP shall supply a copy of this investigation report to MIT's Project Manager within 24 hours of knowledge of the occurrence.

Where there is a worksite accident involving the Contractor's personnel, the Contractor shall conduct the investigation and the ESP shall submit a copy of the Contractor's investigation report to MIT within 24 hours of knowledge of the occurrence.

A.8 PUBLIC SAFETY REQUIREMENTS (TRAFFIC ACCOMMODATION THROUGH THE WORK ZONE)

A.8.1 GENERAL

The ESP is responsible for ensuring that the Contractor is adhering to the traffic staging and signage as specified in the contract documents.

The ESP is also responsible for monitoring the traffic accommodation measures used by the Contractor to confirm compliance with the Contract and the "Manitoba Work Zone Traffic Control Manual" and that traffic is being safely and effectively accommodated through or around the work zone.

During the construction phase, the ESP shall be responsible for ensuring suitable traffic accommodation measures are installed and maintained by the Contractor in accordance with the contract documents.

If traffic control is found to be inadequate, the ESP shall take appropriate and timely action to rectify the situation.

A.8.2 FLAGPERSON

When required as specified in the Contract, the Contractor is responsible for providing qualified flagpersons to direct and control traffic. The ESP shall ensure that flagpersons are instructed in the use of proper traffic control procedures appropriate for the prevailing conditions. Flagpersons shall have proof of certification from a recognized training program on traffic control procedures through construction zones.

Flagpersons shall be dressed in accordance with the guidelines in MIT's "Manitoba Work Zone Traffic Control Manual – Provincial Roads and Provincial Trunk Highways".

During construction, the ESP shall ensure that flagpersons employed by the Contractor meet the requirements described above.

A.8.3 ACCIDENT REPORT

Should any third party accident involving highway users (vehicular or pedestrian) occur when the Contractor is undertaking construction activities on a roadway, the Contractor is responsible for summarizing the details of the accident and providing the ESP with a copy. The ESP shall provide MIT's Project Manager with a copy of the Contractor's report within 24 hours of knowledge of the occurrence.

If a fatal or major accident involving serious personal injury or major property damage occurs, the ESP shall immediately notify MIT's Project Manager of the incident.

The accident report will include a record of conditions at the time of the accident, photos, description of all pertinent signing and other traffic control devices in place at the time.

A.9 QUALITY CONTROL AND QUALITY ASSURANCE

A.9.1 GENERAL

Quality Control (QC) is the responsibility of the Contractor and is carried out by the Contractor's staff or by a testing agency retained by the Contractor. Basic minimum QC requirements are detailed in the "Standard Construction Specifications".

Quality Assurance (QA) testing conducted to confirm acceptance of materials and construction is carried out by MIT staff trained in materials testing or an independent certified testing agency retained by MIT.

A.9.2 TIMING OF QUALITY ASSURANCE TESTING AND SAMPLING

Sampling of field constructed materials for QA testing shall be conducted as soon as possible following the Contractor's completion of the Work, as allowed for in the contract specifications. Testing and reporting of the results to the Contractor shall be completed as soon as practical after sampling. The timeliness of the testing and reporting of the results to the Contractor is important to assure MIT and the Contractor that the quality of construction is acceptable while the Work progresses.

A.9.3 QUALITY ASSURANCE

The ESP shall review the quality assurance testing requirements with MIT's Project Manager at the beginning of the project.

A.9.3.1 QUALITY ASSURANCE - MATERIALS

The ESP is responsible to coordinate the sampling for QA testing of the materials and at the frequencies agreed upon by MIT's Project Manager.

The ESP shall verify that the required number of samples are obtained, properly identified and tested in a timely manner.

A.9.3.2 QUALITY ASSURANCE - MANUFACTURED MATERIALS

The ESP shall inspect materials supplied by the Contractor and obtain any quality control certification required by the contract documents from the Contractor.

A.9.3.3 QUALITY ASSURANCE – CONCRETE MIX DESIGNS

Concrete mix designs are the responsibility of the Contractor. Mix designs prepared by the concrete supplier shall be submitted directly to MIT prior to any mix production. The ESP shall not be affiliated with the Contractor's "mix design" or "quality control" ESP. Laboratory validation testing is normally required, specified in the "Standard Construction Specifications" but can be waived in certain situations as determined by the ESP and with prior approval of MIT's Project Manager. The ESP shall notify the Contractor of the status of his mix design submission in accordance with the contract specifications.

A.9.3.4 QUALITY PROBLEMS

In the event that quality problems are suspected, the ESP shall discuss such concerns with MIT's Project Manager to decide on the course of action required.

A.9.4 QUALITY ASSURANCE REPORTING REQUIREMENTS

Quality Assurance results shall be reported to MIT on a weekly basis or as directed by MIT's Project Manager. Report forms developed by the ESP shall be reviewed and approved by MIT.

The ESP shall ensure that the Contractor signs and dates the test reports indicating his receipt of the test results.

PART B – CONTRACT ADMINISTRATION

B.1 GENERAL

Construction Contract Administration includes the services necessary to assure that proper management of construction inspection, surveying, materials testing and contract administration activities are completed in accordance with the Project TOR, MIT requirements, the Contract, Workplace Safety and Health requirements and all other applicable laws and regulations. This may include some or all of the following:

- Ensure the Contractor performs all Work in accordance with the Contract;
- Maintain complete and accurate records of the activities and events relating to the project;
- Obtain necessary approvals and document significant changes to the project;
- Interpret Drawings, Specifications (Construction and material) and Special Provisions for the project;
- Resolve disputes which may arise in relation to the Contract;
- Resolve field problems as quickly as possible, including situations such as: out-of-place piling, out-of-tolerance Work, out-of-specification materials, structural defects, accidental damage, underground obstructions, etc. These problems may have a significant impact on the execution, progress and/or overall cost of the project. **It is, therefore, extremely important to resolve issues as expeditiously as possible.** Generally, field problems require some degree of engineering evaluation and decision.
- Prepare and participate in dispute resolution or litigation regarding the project.

With respect to contract administration, MIT engages an ESP to administer and manage contracts, with the exception of:

- Tendering and awarding of all construction contracts;
- Administering holdback and contract security; and
- Resolving Extra Work, construction contract related disputes and/or claims.

This “Contract Administration and Construction Inspection Manual” provides the following detailed information to the ESP:

- MIT’s requirements and standards for contract administration and construction inspection duties and responsibilities;
- Specific responsibilities and authorities of the ESP when performing these administrative and management duties and responsibilities; and
- Insurance of uniformity and consistency in these administering of these duties and responsibilities.

The following personnel deal with specific administrative and management functions for a Construction Contract:

- **MIT’s Project Manager** is appointed to oversee the project on behalf of MIT.
- **Contract Administrator** must be a competent Professional Engineer assigned by the ESP to the project with duties and responsibilities for overall Contract Administration and Management.
- **Resident Engineer** must be a competent Professional Engineer with responsibilities for a specific project. Normally, a Resident Engineer, in addition to the Contract Administrator, is only required on complex and/or difficult projects.
- **Inspector** must be a qualified inspector(s) assigned by the ESP to the project with duties and responsibilities for on-site inspection.

The Contract Administrator is responsible for promptly and effectively communicating the following contractual issues or matters to MIT’s Project Manager:

- Issues related to construction schedules
- Major issues that involve design changes
- Extra Work

- Contract claim resolution
- Contract cost overexpenditure
- Contract changes
- Progress and final payment for construction contracts
- Extensions to the contract completion date
- Variances between designed and constructed work quality and quantity

B.2 CONSTRUCTION CONTRACT

B.2.1 DEFINITION OF A CONTRACT

A Construction Contract is a legally binding agreement between MIT and a Contractor to accomplish specific Work at specified rates of payment. To be legal, any contract includes the following essentials:

- An offer (bid by the Contractor)
- An acceptance (Letter of Award by MIT)
- The capacity of both parties to contract, i.e. the Contractor must be capable of entering into a legally binding Contract, and MIT must have the funds available to make payment. Payments must be made for the work completed in accordance with the Contract terms.

B.2.2 SCOPE OF CONTRACT WORK

Work outside the scope of a Contract cannot be covered by the terms of the Contract without further mutual agreement between MIT and the Contractor. If further work becomes necessary, it must be agreed to and is governed by the provision for Extra Work as defined in the Contract (i.e. General Conditions). All decisions made regarding contract work must be in accordance with the Contract.

- Authority to approve changes to the Contract is the responsibility of MIT.
- MIT's Project Manager, Contract Administrator, Resident Engineer, Inspector and others involved in making decisions on contract work requirements, payments, standards, etc., must be entirely familiar with the terms of the particular Contract in question.

B.2.3 FORMAT OF CONTRACT

The standard format of the Contract is as follows:

- Title Page
- General Description of Work
- Work Schedule
- Bid Page
- List of Construction Specifications and other documents forming part and parcel of the tender
- Instructions to Bidder
- Special Provisions
- Environmental permits, licenses, approvals, authorizations
- Location Plan
- Addenda, if applicable
- Construction Drawings - accompany the Contract

The hierarchy of the contract documents in descending order is as follows:

- Addenda issued during the tender period
- Contract document, including Special Provisions
- Construction Drawings
- Standard Construction Specifications

B.2.4 GENERAL CONDITIONS

The “General Conditions” describe the general requirements for both the Contractor and MIT that are applicable to all contracts between MIT and the Contractors. They have been standardized to enhance familiarity for all persons involved. Highlights of the “General Conditions” include:

- The responsibilities of the Contractor relating to items such as control of Work, control of materials, work by others, legal responsibilities and permits, inspection of the Work and defective work.
- The General Conditions also deal with contractual relations between MIT and the Contractor and with items such as bonds and insurance requirements, and how completion dates and contract quantities can be adjusted.
- The General Conditions specify terms of payment to the Contractor, and if necessary, how the Contractor is to be compensated for Extra Work.

The Contract Administrator, Resident Engineer and Inspector must read and thoroughly understand the General Conditions and every item applicable to the Contract. MIT’s Project Manager should be consulted if there are any questions or concerns.

B.2.5 SPECIAL PROVISIONS

The Special Provisions included in the Contract are written for the specific work that is specific to the project. Special Provisions and information on contract drawings are set out for each project and can vary from contract to contract, even though the Standard Construction Specifications are uniform.

- Special Provision clauses will usually include the Scope of Work associated with project specific work that is to be completed. Usually, this project specific work is not covered in the Standard Construction Specifications.
- The Contractor is expected to provide all labour, equipment and materials required to compete this project specific work.

The Contract Administrator, Resident Engineer and Inspector must review these thoroughly and be completely familiar with every item.

B.2.6 SCHEDULE

The project schedule, with dates for either the completion of particular elements or a final completion date, is specified in the Contract.

- These dates are usually critical as other Contracts may have been entered into and work on the other Contracts may be dependent on the interim completion and completion dates being met.
- Failure to complete the project specific work by the specified dates may result in liquidated damages being assessed against the Contractor.

B.2.7 PAYMENT

It is important to note that each pay item may vary from contract to contract. However with some particular pay items, pier excavation for example, it specifically states in the Standard Construction Specifications what is considered extra excavation and what is considered incidental excavation.

The Contract Administrator, Resident Engineer and/or Inspector should be completely familiar with the method of payment for all the Contract items.

B.2.8 EXTRA WORK

B.2.8.1 General

MIT is responsible for approving all Extra Work.

Extra Work is defined in the Contract as work that is not included in the original scope of work and contract bid items, and is authorized by MIT to be completed by the Contractor.

When Extra Work is necessary, the Contract Administrator shall prepare an Extra Work Order that details the scope of the work, and the reason it is required. The Contractor then fills in the details of schedule implications and itemizes all quantities and costs. The Contract Administrator shall undertake any required negotiations with the Contractor to establish a suitable schedule for the completion of the work and a proposed method of payment. Once the Contract Administrator and Contractor agree, the Extra Work Order is submitted to MIT's Project Engineer for approval. Once MIT has agreed to the details of the Extra Work Order and authorized the work to proceed, the Contract Administrator will issue the signed Extra Work Order to the Contractor. All applications for approval of Extra Work shall be processed using the appropriate form.

The Extra Work shall not commence until approval from MIT has been issued.

It is the responsibility of the Contract Administrator to ensure that:

- Extra Work is required to fulfill the intent of the original contract,
- work is not covered by existing contract pay items,
- proposed method of payment is the most economical for MIT, and
- proposed costs are reasonable for the work involved.

B.2.8.2 EQUIPMENT RENTAL RATES

The current "Manitoba Heavy Construction Association Equipment Rental Rates Guide and Membership Roster" shall be used by the Contract Administrator as a guideline when negotiating equipment rental rates for payment of Extra Work.

In the case of Extra Work on contracts that carry over from one year to the next, MIT's policy is to utilize the Guide current for the period in which the work was performed unless the rate in the current Guide has decreased.

Where equipment not listed in the Guide is employed, the Contract Administrator shall provide MIT's Project Manager with documentation justifying the need for the new rental rate, the written rental rate quotes by the Contractor, and the Contract Administrator's recommended rental rate. MIT is responsible for determining the new rental rate.

B.2.9 EXTENSIONS TO SPECIFIED CONTRACT COMPLETION DATE

The Contract Administrator does not have the authority to adjust contract completion dates.

If the Contractor feels an adjustment to the completion date is warranted, he must submit a written request to the Contract Administrator. The Contractor's submission must contain justification of an impact to his schedule, preventing completion of the project by the date specified in the Contract. The Contract Administrator shall review the Contractor's submission and provide MIT's Project Manager with a detailed recommendation concerning an extension to the contract completion date.

B.3 RECORDS AND FORMS

B.3.1 GENERAL

To assist the Resident Engineer and/or Inspector in keeping adequate records of progress for a specific project, a number of forms have been developed by MIT. Conscientious attention to completing these forms fully, accurately, and on time will help to assure that the Resident Engineer and/or Inspector are fulfilling his/her duties and responsibilities.

B.3.2 THE DIARY

The most important record of progress and activities at the project site will be the Resident Engineer and/or Inspector's dairies. The Diary must be written daily and must include, but not necessarily be limited to:

- Weather
- Location of Contractor's work area and description of work underway
- General progress of the work and an account of any extreme difficulties encountered by the Contractor accompanied with photographs
- Verbal instructions issued to the Contractor
- All information pertaining to the relocation of utilities and note of any delay to the Contractor
- Equipment and manpower hours
- Full description of construction photos or videos taken. All photos must have the date they were taken marked on them and they should be referenced in the diary.
- A record of visits from MIT and other stakeholders and any resulting instructions or decisions
- All changes from original plans and/or design quantities and an explanation of the reasons (maintaining "as constructed" drawings at all times)
- Changes to any item during the stages of construction, including any irregularities that may have developed
- Explanation of incompleteness of field records
- Explanations of defects and when and how they were rectified, including pertinent photographs
- Special notations or items pertaining to Extra Work or possible Extra Work
- The Contractor's claims, intention to claim, complaints, disputes, etc., including photographs if applicable.
- All discussions or dealings with property owners and other public
- All discussions or dealings with officials of municipalities or local authorities
- All discussions or dealings with safety officers pertaining to safety matters
- A record of all accidents within the contract limits and a record of conditions at the time of accident, with photographs, including a description of all pertinent signs in place at the time
- Traffic accommodation, detours, construction signs, flagpersons including photographs
- A record of events that could affect the Contractor's schedule
- Record of environmental issues
- Discussion with the Contractor with regard to work schedules and quality of work
- Assessment of the Contractor's working day

Project diaries shall contain the following identifying information in the front pages:

- structure site number
- contract number and project description
- name and address of the person maintaining the diary
- index

Entries in the Project Diaries shall be made by the Resident Engineer or, in his absence, the Construction Inspector acting on his behalf. Once the project has been completed, the Project Diaries shall be submitted with the Final Contract Administration Package to MIT's Project Manager.

Construction photos should also be included to back up Project Diaries. The photographs must be clearly identified by date, type of activity and location.

It is recommended that the ESP require the surveyors, materials inspectors, and any other key project staff to maintain separate diaries detailing any significant issues occurring during construction.

B.3.3 SURVEY BOOK

The Resident Engineer and/or Inspector must keep a Survey Book for all survey work for each project.

- Entries should include date, weather, names of persons doing the survey, and all readings and calculations made.
- The Resident Engineer and/or Inspector shall submit all survey books at the end of the project as part of the Final Contract Administration Package.

B.3.4 WEEKLY CONSTRUCTION REPORT

The Resident Engineer and/or Inspector shall complete a Weekly Construction Report for each project. The Weekly Construction Report covers the period from Sunday to the following Saturday (inclusive) and shall be submitted MIT's Project Manager on the following Monday. Weekly Construction Reports shall be submitted regardless of whether or not work was performed during the previous week. A separate Weekly Construction Report is to be submitted for each project.

- Daily entries must include a summary and the highlights of the Contractor's activities at the site and will usually be a summary of the Resident Engineer and/or Inspector's Diaries.
- The Inspector must measure and calculate the quantities of work items that the Contractor has constructed during the week.
- The Inspector must enter the appropriate quantities and submit the estimate to the Contract Administrator and/or Resident Engineer for checking and certification.

Copies of all quality control (QC) and quality assurance (QA) testing results for that week shall be submitted with the Weekly Construction Report.

B.3.5 MONTHLY PROGRESS PAYMENT

A Progress Payment is a payment to the Contractor for the specific Work completed on a project up to and including an agreed upon date. A Final Payment is the last Progress Payment for the Contract and contains the total actual quantities of work performed to project completion. The Final Payment shall have "final" written beside the payment number and is usually submitted with the Final Contract Administration Package.

The Progress Payment form will be provided to the Contract Administrator by the MIT's Project Manager. This form will contain a cost breakdown for the Contract, by project, workorder item code number, bid item, quantity completed and unit price.

The Contract Administrator shall complete the monthly Progress Payments and Final Payment forms by updating each bid item quantity to reflect the quantity completed in the respective pay period. Payment is made only for completed and accepted work done to date. All quantities must be supported by approved methods of measurement in the field. The units of measurement for each bid item are provided on the Bid Pages in the contract documents.

The Contract Administrator shall review the payment quantities for each item with the Contractor prior to finalizing the monthly Progress Payments.

The Contract Administrator shall sign the Progress and Final Payments certifying that goods and services as measured were received, or completed, that work complies with the terms of the Contract, and that the total value of work completed does not exceed the funds allotted to the project.

The "cut-off" for the monthly Progress Payments is the 23rd of each month. The Contract Administrator shall provide the original Progress Payment to MIT on the 26th of each month and shall forward a copy to the Contractor for his records. When applicable, the Progress Payments will include any Extra Work Orders and Overexpenditure Approval Record as backup information.

- The Resident Engineer and/or Inspector must measure and calculate the quantities of work items that the Contractor has constructed during the month.

- Whenever Extra Work is progressed, an approved Extra Work Order form with all supporting documentation is required to be attached to the progress payment.

B.3.6 MONTHLY PROJECT EXPENDITURE REPORT

A Project Expenditure Report must be submitted to MIT's Project Manager by the 26th of each month. When the Contract Administrator is estimating costs on this report such as "Project Fiscal Expenditures" and "Carry Over", it is important that the estimate reflects what the Contract Administrator believes will be the actual costs, and not inflated values. The costs estimated must not include any contingencies for unsubstantiated items.

This estimate is used for MIT budget control purposes and further adjustments to the project costs can be made in the event of any unforeseen changes in the work.

Process For Completing Month End Expenditure Reports

Lisa Wilhelm will print a copy of the latest cut-offs and provide a copy to all project managers

Lisa Wilhelm	By 23rd of every month

↓

Project Managers will submit the projected cash flows of each project to their Manager

MIT's Project Managers	By 26th of every month

↓

Managers will review cash flows and provide Lisa Wilhelm with all projected cash flows and final numbers

Manager	By 27th of every month

↓

Lisa Wilhelm will update CMS and print a final copy for the Director and Manager

Lisa Wilhelm	By 29th of every month

↓

Director reviews cut off reports. Once approved by Director send email with complete update to Mary Domaratzki Machado.

Director (review)	By 30th of every month
Lisa Wilhelm (email)	By 30th of every month

B.3.7 WRITTEN INSTRUCTION(S) TO CONTRACTOR

A Written Instruction to the Contractor shall conform to the following guidelines:

- Prior to any Written Instruction(s) being issued to the Contractor, the Resident Engineer and/or Inspector should discuss the matter with the Contract Administrator. Controversial instructions may lead to contract claims. The Contract Administrator may also want to receive concurrence from MIT's Project Manager prior to issuing the Written Instruction to the Contractor.

- A Copy of the Written Instruction(s) to the Contractor must be dated and kept by the Contract Administrator.
- The Contract Administrator must also forward a copy of the Written Instruction immediately to MIT's Project Manager.

Orders to the Contractor should first be given verbally in a polite manner; only when ignored should they be given in writing. The lapse of time between the verbal and written order will depend upon the urgency of the matter and is subject to the Contract Administrator, Resident Engineer and/or Inspector's judgment. Prior to issue of any order, it must be emphasized that the Contract Administrator, Resident Engineer and/or Inspector, must check the Contract, Drawings and Standard Construction Specifications, and make sure that he/she is correct. A copy of the Written Instruction is to be attached to the Weekly Construction Report.

B.3.8 EXTRA WORK

Extra Work must be authorized by MIT before any work can be done.

Whenever Extra Work is authorized by MIT, the "Extra Work - Daily Time Sheet" form **must** be filled out and properly signed by both the Contractor and Resident Engineer or Inspector **at the end of every day**.

- A record of all materials used and the names and positions of all labour must be documented.
- The make, model, serial number and any other pertinent data of each piece of equipment used must be recorded.

If there is a dispute whether the work being done by the Contractor is Extra Work, the above form must be completed. This information can then be used once the determination is made whether the work done is being considered as Extra Work or not.

B.4 CONTRACT OVEREXPENDITURES

B.4.1 GENERAL

This procedure applies to all contracts that are tendered on a lump sum or unit price basis, and is to be followed by the Contract Administrator in the administration of the Contract. The essence of the process is the early identification of potential contract overexpenditure, the evaluation of alternatives to overexpenditure, and the timely submission of proposals to MIT's Project Manager.

B.4.2 PROCEDURE

The Contract Administrator is responsible for the management and control of all potential contract overexpenditures. An Overexpenditure Approval Record should be made when the Contract Administrator is aware that the project has a potential to overrun, and referred immediately to MIT's Project Manager.

Under no circumstances shall the Contract Price be exceeded without a written Overexpenditure Approval Record, nor shall a Significant Bid Item be exceeded by more than 20% without written authorization from MIT.

The Overexpenditure Approval Record shall contain full details of the circumstances leading to the anticipated overrun, the evaluation of all alternatives considered feasible to prevent the overrun, a recommended course of action and a detailed cost estimate.

The Overexpenditure Approval Record shall be submitted in sufficient time to allow adequate evaluation of alternatives and the allocation of additional funding, without causing delay to the Contractor.

On all construction projects for which an Overexpenditure Approval Record has been issued, a Final Overexpenditure Report must be prepared and submitted with the Final Contract Administration Package outlining the following:

- Contract Price
- Summary of all Overexpenditure Approval Records and a total value
- Final progress payment value
- Difference between Final Payment and Contract Price, expressed as a percentage of Contract Price.

B.5 OVERSEEING CONSTRUCTION

B.5.1 CONFIRMING CONTRACT REQUIREMENTS

It is critical that both the Contract Administrator and the Contractor are aware of all contract requirements that may impact completion of the Contract. The Contract Administrator should confirm contract requirements with MIT's Project Manager prior to commencement of the Work and at regular intervals throughout the project as the need arises. This will allow the Contract Administrator to communicate any significant issues to the Contractor as the Work progresses, providing him with the opportunity to address them in an effective manner.

B.5.2 INITERIM INSPECTIONS

Throughout the course of the Work, MIT's Project Manager (or designate) and the Contract Administrator will conduct joint inspections to confirm that all Work is being completed to the required standards. The Contract Administrator will alert the Contractor of any items that require attention while the Work is in progress. The Contractor may participate in the interim inspection(s) to ensure that expectations are fully understood and nothing unexpected is identified during the Construction Completion Inspection.

A representative from the local municipality should also be invited to participate in the interim inspections if there is a significant impact to the municipality's infrastructure network or local issues are identified.

B.6 DISPUTES, NEGOTIATIONS AND CLAIMS

B.6.1 GENERAL

Contracts are not always perfect documents, therefore disputes may arise and negotiations may become necessary. MIT's philosophy has always been that the resolution of disputes and claims is based upon fairness and respect for the other party.

A dispute is a disagreement between the Contractor and the Contractor Administrator over application of the Contract, Standard Construction Specifications, Extra Work or measurement of quantities in the field. Not all disputes can be settled before they become claims against MIT. Initial negotiations can be conducted by the Contractor Administrator to resolve disputes wherever possible in a reasonable manner under the terms of the Contract.

A claim is a Contractor's demand for:

- compensation,
- costs he contends he has incurred, or
- losses he contends he has suffered during the performance of his duties under a contract.

The basis for a claim is often that the actual circumstances encountered were, in his opinion different than the terms described in the Contract. Claims are a means to settle disputes between MIT and the Contractor.

If a claim cannot be resolved by negotiation at the various levels, then arbitration or mediation may be recommended. Litigation is usually the **last** means for claim/dispute resolution.

MIT's strength in handling claims is based upon project documentation. The Contract Administrator is responsible for ensuring that the Resident Engineer and/or Inspector are keeping records as if claims were to be settled in court. Their diaries, weekly reports and reference to construction photos are important examples of project documentation. For approved Extra Work, the Resident Engineer and/or Inspector shall keep records of hours of work for the Contractor's manpower and equipment used in the performance of the Extra Work. A measure of the Resident Engineer and Inspector's performance is the completeness of documentation maintained for the duration of the contract, supporting MIT's stand in the event of a claim.

It is important that the ESP's staff and/or MIT employees do not give assistance, advice or gratuitous information to the Contractor to help him formulate the basis of his claim.

The Contractor must **not** have access to project diaries or correspondence or vice versa. Information relating to progress payments and quality assurance test results are to be given to the Contractor.

B.6.2 FIRST PARTY CLAIMS

B.6.2.1 Overview

The procedure for administering claims submitted by a Contractor to MIT is described in the General Conditions. This procedure is intended to guide the Contractor through the various levels of appeal available under the terms and conditions of the Contract.

The Contract Administrator is a key component in MIT's defense and avoidance of claims. In filling this role, the Contract Administrator must observe good project management practice which includes fair negotiation and judgment when dealing with disputes. The Resident Engineer and/or Inspector's detailed project documentation through project diaries, accurate quantity measurements and accurate recording of quantities and quality are a basic component upon which responses to claims are based. A basic rule to assist in the prevention of claims is that ESP's key representatives must have a thorough and detailed knowledge of the Contract.

B.6.2.2 PROCEDURE FOR CLAIMS AND APPEALS

When MIT receives a first party claim, the Contract Administrator will be requested to prepare written acknowledgement of receipt of the claim on MIT's behalf.

The Contract Administrator will then be required to analyze the claim and prepare a response on MIT's behalf. The Contract Administrator's analysis shall include:

- investigating the basis for the claim,
- producing a summary of facts, figures, test results, pictures, relevant project diary entries, videos (if available), and
- detailing a recommended course of action.

MIT's Project Manager and other staff, as required, will assist the Contract Administrator with the analysis and review of the claim and the development of a response to the Contractor.

The extent of the analysis will depend on the type and nature of the claim submitted. However, it must always include the contract documents and when possible the responses should contain reference to specific contract clauses.

It is MIT's intent that the analysis of the claim commence as soon as possible following the submission of the claim by the Contractor. Should the nature and complexity of the claim make it impractical to complete the analysis within a 2 week period, the Contract Administrator shall prepare a letter on MIT's behalf stating that the analysis is ongoing and that a formal response is forthcoming.

The Contract permits the Contractor to appeal the response to the next level in the claims resolution process. Members of the ESP's staff may be required to provide information to assist subsequent review levels with their assessment of the claim. In addition, should the claim fail to be resolved and be referred to the legal venue, the ESP's staff may be requested to participate in the proceedings.

B.6.3 THIRD PARTY CLAIMS

A third party claim is a claim against the Contractor or a sub-contractor by sub-contractors, suppliers, labourers, or others working on or providing material or services on the Contract.

Third party claims must be submitted in writing. Verbal statements are not sufficient. If the Contract Administrator receives a third party claim, he must immediately date stamp and forward any submission to MIT's Project Manager. Due to the time limitations under legislation, the Contract Administrator must submit third party claims to MIT the same working day as they are received.

B.6.4 DAMAGE CLAIMS

A damage claim (insurance claim) is a claim for injury, loss or damage arising in connection with the work. The most common damage claim is for cracked or broken windshields on construction projects.

If the Contract Administrator receives a damage claim, he must immediately inform MIT's Project Manager and forward the claim letter. MIT will then forward a covering letter and the claim letter to the Contractor, requesting that the Contractor deal with the claim. The claimant shall be copied on this letter so that he is aware that the claim has been forwarded to the Contractor.

The claimant is not to be provided with the Contractor's insurer's name. The claimant has the legal right to obtain the insurer's name from the Contractor but not from MIT or the ESP.

B.6.5 AVOIDANCE OF CLAIMS

Attention to the following items by the Contract Administrator, Resident Engineer and/or Inspector will help to avoid claims by the Contractor.

- Review of the Contract, Standard Construction Specifications and Drawings in detail in advance of the work is **essential**.
- The Contractor is only obligated to perform work in which he has contracted to perform.
- Documentation of the Contractor's work on the project should be thorough and accurate, as if litigation will take place. Accurate measurement and records of quantities and quality must be maintained at all times.
- The Contract Administrator, Resident Engineer and/or Inspector must apply fair judgment at all times.
- The Contract Administrator, Resident Engineer and/or Inspector must apply interpretation of contract documents reasonably and in the same way to all contractors.

The following items are some of the causes perceived by Contractors to entitle them to a claim:

- Changed conditions affecting:
    - Scope of Work
    - Soil conditions
    - Site access
    - Unforeseen difficulties
    - Unforeseen climatic conditions

- Inadequate standards, instructions, requirements of the Contract.
- Delays or acceleration in the Work.
- Delays due to late delivery of material supplied by MIT.
- The Contract Administrator, Resident Engineer and/or Inspector interfering with the Contractor's method of work.

These causes may result in a valid claim if they arise due to circumstances not reasonably within a Contractor's control or ability to predict at the time of tendering.

B.7 PROJECT FINALIZATION

B.7.1 DISCREPANCIES

There are occasions during the construction of a structure, when a Contractor does not perform the Work in exact conformance with the requirements of the specifications. Discrepancies during construction are a fact of life and must be dealt with professionally, on an item by item basis.

The Resident Engineer and/or Inspector have an obligation to notify the Contractor immediately of any variations in the work, from that specified. Discussions and open communication with the Contract Administrator will facilitate the appropriate course of action, in controversial situations.

- In some cases, where the Contractor's work does not meet the specifications, but it may appear that the intent of the specification has been met. The Resident Engineer and/or Inspector must discuss whether the discrepancy can be accepted with the Contract Administrator.
- In situations where the work is clearly unsatisfactory and repairs or replacement have to be carried out by the Contractor, decisions must be promptly communicated to the Contractor (by the Contract Administrator).

B.7.2 DEFICIENCIES

The Resident Engineer and/or Inspector must keep an accurate record of all deficiencies, and the deficient items that will require correction or replacement.

- An accurate record of all deficiencies, and Written Instructions to the Contractor must be kept.
- The Resident Engineer and/or Inspector should update the deficiency list on a regular basis, and review it with the Contract Administrator. The Contract Administrator will present the list to the Contractor and keep him informed of all the items which are considered to be outstanding deficiencies.
- The Contract Administrator must indicate to the Contractor which items must be re-inspected after being corrected before proceeding to subsequent stages of the work.
- **The Resident Engineer and/or Inspector must do his/her own independent inspection of the work.**
- The Resident Engineer or Inspector must not in anyway perform the Contractor's supervisory and/or quality control responsibilities.
- The Contractor shall perform his own quality control checking and correct any deficiencies before the Resident Engineer and/or Inspector do his "quality assurance" inspection.

B.7.3 FINAL SITE CLEANUP

Incomplete cleanup of construction debris, excess materials and damage caused by the Contractor's operations are deficiencies that must be corrected to the satisfaction of the Resident Engineer and/or Inspector. Site cleanup items include:

- Access berm removal
- Cleaning up and leveling disposal area
- Access road removal

- Public and private properties restoration
- Borrow pit reclamation
- Site debris removal
- Installation of permanent and temporary erosion control measures

B.7.4 FINAL ACCEPTANCE

B.7.4.1 General

At the completion of the project, the Contractor is required to request an inspection for Construction Completion. Prior to this final inspection, the Resident Engineer and/or Inspector must insist and ensure that the Contractor has corrected all deficiencies.

- The Construction Completion Inspection will usually involve MIT's Project Manager (or designate), Contract Administrator, Resident Engineer, the Inspector and the Contractor.
- Due to penalty clauses imposed for late completion, the Contract Administrator should make every effort to do the inspection promptly, when the Contractor has completed all work and is still on-site.
- The structure is only acceptable when all the items are satisfactorily completed, as the structure is accepted as a "whole" and not by the completion of each element.

B.7.4.2 Construction Completion Inspection

Construction Completion Inspections is initiated by the Contractor and is a joint inspection by the Contractor, Contract Administrator, Resident Engineer, Inspector, MIT's Project Manager and any other stakeholders that may be required to participate. This inspection should only be requested when both the Contract Administrator and the Contractor are in agreement that any significant items have been addressed and the Work appears to be complete.

The contract warranty period commences on the last date the deficiencies are satisfactorily repaired. If there are no deficiencies on the project, the warranty period commences on the date the project was ready for the Construction Completion Inspection.

In the event any defects in the Work are identified subsequent to the Construction Completion Inspection, such defects shall be considered a warranty item and will not require immediate repair. However, they must be documented by the Contract Administrator and repaired by the Contractor prior to the expiration of the warranty period.

B.7.4.3 Releasing Holdback

The Contract Administrator shall identify Holdback on each Progress Payment, including the Final Payment, in the amount detailed in the General Conditions.

In situations where substantial completion has been achieved, MIT may initiate a reduction in the amount of the holdback. MIT will retain a sufficient amount to cover the cost of completing the minor clean-up or correcting any deficiencies. In these situations, the Contract Administrator shall calculate the amount it would cost MIT to hire a separate contractor to complete the deficiencies/repairs and advise MIT. A reduction in holdback may also be considered when the Contractor has diligently prosecuted the Work but weather conditions force winter shutdown. In these situations, the remaining Work should be less than 2% of the Contract amount.

In cases where substantial completion has not been achieved, any reduction in the holdback must be initiated by the Contractor. Such requests shall be in writing to the Contract Administrator and must be accompanied by the written sanction of the Surety. The Contract Administrator shall review the request with MIT taking into account the reasons the Work is not completed, any unforeseen problems and the status of the project. MIT will consider the request for a reduction in holdback and may release an appropriate amount.

B.7.5 TERMINATION OF WARRANTY AND FINAL ACCEPTANCE

MIT may retain the Contract Administrator to perform the warranty inspection and to monitor any warranty work performed by the Contractor. The timing of the warranty inspection shall be determined by MIT.

In the event defects in the work have been identified subsequent to the Construction Completion Inspection and/or through the warranty inspection, the Contract Administrator shall immediately notify the Contractor in writing of the nature and location of the defective work and request a schedule from the Contractor detailing the timing and the nature of the corrective work. The Contract Administrator shall provide copies of all correspondence to MIT's Project Manager.

Prior to and during the performance of the corrective work, the Contract Administrator shall liaise with MIT's Project Manager to ensure that the timing of the corrective work and the final product is satisfactory.

The Contractor's contractual obligations to complete warranty work are guaranteed by the Contract. Any communication necessary between MIT and the Surety concerning the Contractor's warranty obligations shall be initiated by MIT.

B.8 FINAL CONTRACT ADMINISTRATION PACKAGE

B.8.1 GENERAL

The Final Contract Administration Package is a complete compilation of all details of the Work performed. This package serves as a means of verification of all quantities submitted for payment after completion and acceptance of Work on the project.

At project completion, the Contract Administrator shall be responsible for providing a Final Contract Administration Package for each structure including, but not limited to the following:

- A letter from the ESP stating that the construction contract administration and inspection has been performed in accordance with the Agreement and construction is in compliance with the Contract, Standard Construction Specifications, Drawings and MIT requirements.
- Project Summary Report (See Section B.8.2)
- Project Diaries
- Project survey books
- Copy of all Weekly Construction Reports
- Copy of all Progress Payments and the Final Payment, including supporting Extra Work Orders
- Copy of all Project Expenditure Reports
- Copy of any Written Instruction(s) to the Contractor
- Final Overexpenditure Report
- Pile driving, pile drilling, foundation records, etc.
- Concrete test results including a summary in an electronic format.
- Approved Contractor submissions – schedules of record, concrete requirements, steel material properties, stressing calculations, etc.
- Approved shop or fabrication drawings, erection drawings, formwork/falsework drawings, etc.
- Post tensioning and stressing records.
- Results of all material testing, including approved gradation analysis for backfill materials, clay seal, etc. (Culvert Installation Inspection Record and Culvert Barrel Measurements forms.)
- Copies of all correspondence to MIT and Contractor, including Minutes of Meetings.
- All final quantities with support documentation including detailed calculations where required.
- "As-Constructed Drawings" as well as mylars and electronic copies of the revised drawings (refer to B.8.3).
- Photographs with descriptive text, including video.
- Project Completion Safety and Health Review Report.
- Copy of any disputes and/or claims and analysis of dispute and/or claim by Contract Administrator

The Contract Administrator shall compile the Final Contract Administration Package and forward the complete original package to MIT's Project Manager within the time frames detailed in the Project TOR and discussed below. The Contract Administrator shall submit information for this package as outlined in this section and the ESP's Agreement with MIT. The information retained by the ESP shall be stored satisfactorily as per the Agreement.

The Contract Administrator should not wait until the Contract is complete to commence work on the Final Contract Administration Package. As soon as each bid item is completed, the Contract Administrator should summarize those particular items.

All final quantities must be supported by approved measurements in the field. All digital information must be submitted to MIT on CD ROM media.

Final cost information for structures shall be documented separately from the roadway cost information. Although the work may all be paid under one contract, the costs incurred for structure related work and road works must be separate and clearly documented for use in future analysis.

B.8.2 PROJECT SUMMARY REPORT

The Project Summary Report provides the written record of the project, forms part of the history of the structure and approach roadworks, and is an important project information source. The report must contain sufficient detail so that an independent reviewer either now or in the future can gain a clear understanding of the project. The Project Summary Report must be separately bound and submitted along with the Final Contract Administration Package. The Project Summary Report shall contain, but need not be limited to:

- Project title and contract number
- Scope of work, project description and site number
- Project and contractor staff, sub-contractors, equipment and suppliers
- Project schedule and key dates
- Work progress, problems and solutions
- Innovative and unique aspects of the project
- Safety, traffic accommodation and utility relocation
- Design and actual contract quantities and costs, and any cost overruns, contract extensions or Extra Work. Reasons for any significant variations in quantities and costs
- Environmental issues
- Comments on contractors performance and recommendations
- Photographs of key activities
- Final project costs including all contract costs based on Contract Price, liquidated damages, utility, and initial and final engineering costs. Reasons for any Scope Changes and engineering costs shown as a percentage of contract cost.
- Commentary on the materials testing results for concrete, steel, miscellaneous metal, granular backfill, asphalt pavement.
- All information which may influence the performance or future maintenance requirements of the structure.
- Suggested specification changes on any problems encountered with current specifications
- Any discussions or issues relating to quality or obvious defects
- Outstanding deficiency items

B.8.3 "AS-CONSTRUCTED" DRAWINGS

One complete set of Drawings, designated as the set for "As-Constructed" or "As-Built" drawings, shall be kept on-site on which any changes from the original plans shall be carefully noted during construction. These drawings shall be kept in a safe place and shall be used for no other than the above-stated purpose. This set of drawings is only to be used for the purpose of recording the details of any changes to the actual construction, as it is done. All pertinent features and deviations from the plans must be noted, such as:

- Exact footing elevations and dimensions.
- The pile penetrations shown should be an average, maximum and minimum for each element.
- Any additional piles required or defective piles.
- Any revision to pier or abutment shapes.
- Any variation in the placing of the reinforcing steel or additional reinforcing used.
- The actual dimensions of stone riprap or concrete slope protection.
- The elevation of the stream bed at each pier, and at other critical locations such as the toe of riprap.
- Extra concrete and tremie seals, even if these are not paid items.
- All quantities on each applicable drawing.
- Measurement of the gap in deck joints and the position of the expansion bearings along with the date and ambient air temperature when measured.
- The elevation for the “Bench Mark”.
- Measurement of clearance diagram on Railroad Underpasses and Grade Separations Structures.
- Exact location of the ends of drainage pipes or conduit in approach fills.
- A detailed description and location of all underground utilities and conduits, showing horizontal locations, elevations, size and type of utility, etc.

The Contract Administrator will check the information before it is submitted to MIT.

The Contract Administrator shall supply two sets of 3 mil matte finish mylars and two CD copies of all record drawings to MIT at the time the Final Contract Administration Package is submitted. The record drawings shall bear the original seal and signatures of the responsible ESP staff. In addition to the mylars and CD copies, the Contract Administrator shall also provide 3 full size sets (24 x 36”) of paper hard copies of all record drawings to MIT upon completion of the project.

B.8.4 PROCEDURE FOR PREPARING AND SUBMITTING

When work on a pay item is complete, the Contract Administrator shall verify that all measurements are recorded, check all calculations and compile all final quantities. The Contract Administrator certifies that:

- Goods and services were received or work was completed in accordance with the terms of the Contract
- Quantities and calculations are correct
- Policy and procedures outlined in this document and other applicable documents were applied to the administration of the Contract

The Final Contract Administration Package is certified correct and stamped with ESP’s corporate seal and the Professional Engineer’s stamp. The Contract Administrator submits the package to MIT’s Project Manager for record purposes.

B.8.5 TIMELINE FOR SUBMISSION

The maximum time for submission of the Final Contract Administration Package by the Contract Administrator to MIT’s Project Manager is four weeks after it has been determined that Construction Completion has been achieved by the Contractor. If for any reason the Contract Administrator is unable to meet the required time lines, he must immediately notify MIT’s Project Manager.

PART C – CONSTRUCTION INSPECTION
SECTION A - GENERAL

A.1 INTRODUCTION

"Informed inspection is the link between design and construction." This quotation summarizes the essence and importance of the Inspector's role. The ability to fulfill this requirement will be enhanced with experience.

The "Contract Administration and Construction Inspection Manual" should be reviewed regularly by even the most experienced Inspector, especially Part C – Construction Inspection. This Part of the manual describes the administrative duties and the role of the Inspector. Safety issues on structure construction projects are also reviewed. Subsequent sections deal with the more technical details of the inspection phases of the Contractor's Work and will assist in understanding the order in which things must be done.

The completion of a structure is a team effort between design, material, and construction personnel, requiring academic knowledge and many years of related experience. Successful completion of a structure depends on the efforts of the Contractor **and to a very large extent the quality of the inspection performed during construction**.

In order to ensure that a structure is constructed in accordance with the design and specifications, the requirements of "informed" inspection include:

- A knowledge of the principles of design
- Skill in interpreting drawings
- Skill in anticipating possible problems
- An understanding of the order in which things must be done
- Regular systematic inspection of structural elements
- Inspection and testing of materials
- Accurate vertical and horizontal (control) surveying and checking dimensions
- Keeping and maintaining sufficient records

A cheerful disposition and a positive attitude will help to maintain appropriate relations with the Contractor.

A.2 ROLE AND RESPONSIBILITIES OF INSPECTOR

A.2.1 GENERAL

The Contractor is responsible for constructing the structure in full accordance with the contract documents, Standard Construction Specifications (Specifications) and Drawings. The Inspector's role is to ensure that the structure to which he/she is assigned is built in compliance with the Contract, MIT's Specifications, Drawings, MIT requirements, Workplace Safety and Health Act and Regulations, as well as any other applicable laws. The Inspector may not authorize any changes in the Contract, Specifications or Drawings without first obtaining approval from the Resident Engineer or Contract Administrator.

In general, when a clarification of the Contract, Specifications or Drawings is required or a deviation from these appears to be required or any problem occurs, the Inspector shall contact the Resident Engineer or Contract Administrator.

- The Inspector's errors or neglect may lead to faulty and possibly even dangerous construction.
- The Inspector is responsible for a thorough knowledge of the Contract and to exercise good judgment.

- The Inspector's efforts will be reflected in the quality of construction.

In general, the Inspector is required to perform the following duties: survey control, quality assurance, record keeping, reports and "As-Built" drawings.

Prior to the commencement of construction, the Inspector should review the project with the Contractor to become acquainted with the Contractor's plan of action and to discuss anticipated difficulties. Particular attention should be given to ensure that aggregate samples and concrete mix designs have been submitted and approved by the Resident Engineer or Contract Administrator. The Inspector should also confirm with the Contractor that storage for concrete test cylinders is acceptable. The equipment to be used, methods for storing and handling materials, and the general sequence of the Contractor's operation should be discussed. This will enable the Inspector to arrange his/her inspection accordingly.

- A good start is important: fairness with firmness at the beginning of the job will tend to avoid bickering throughout the remainder of the project.
- An incorrect method or procedure must be corrected the first time it is practiced rather than after it has been in use.
- The Contractor is entitled to complete the Work at the lowest possible cost as long as the requirements of the contract documents, Specifications and Drawings are fulfilled.
- The Inspector must not in any way perform the Contractor's supervisory and/or quality control responsibilities.
- If the contract documents, Specifications or Drawings permit a choice of methods, the Inspector may offer suggestions if requested, but should not arbitrarily demand that a given method be employed.
- If non-conformance from the contract documents, Specifications and Drawings are proposed by the Contractor and appear to be reasonable, the Inspector may accept the proposal tentatively, making it understood that the matter must be referred to the Resident Engineer or Contract Administrator for final decision.
- Co-operating with the Contractor is in the Department's best interests and requirements. The Inspector gains the Contractor's respect and cooperation when inspections are made promptly and thoroughly.
- Conditions that may lead to unsatisfactory work should be anticipated whenever possible, and in any event should be pointed out (preferably in writing) to the Contractor at the earliest opportunity, to avoid waste of materials, labour and strained relations.
- The Inspector should not delay the Contractor unnecessarily, nor interfere with the Contractor's methods unless it is evident that unacceptable work will result.
- Demands should not be made on the Contractor that are not in accordance with the contract documents, Specifications and Drawings.
- The Inspector should not form any habits of procedure that might be anticipated by the workmen. Inspection of the various details and operations should be at irregular intervals.
- The Inspector should be on-site during the Contractor's daily working hours.

Inspection is a very important job and requires constant vigilance, diplomacy, firmness and patience.

A.2.2 CONTRACT DOCUMENTS

The Inspector must read the contract documents and become fully familiar with the Special Provisions as soon as he/she is assigned to a project. The reading of the contract documents should not be confined to the Special Provisions only. Specifications should also be read, since it is not likely that one would remember exactly what they state, and the Inspector may be on dangerous ground when dealing with the Contractor unless he/she is familiar with the ***exact*** wording of the Specifications and Special Provisions.

In order to meet the requirements of construction inspection, and to gain the confidence of the Contractor, the Inspector must be thoroughly familiar with the contract documents and Specifications.

- The Contract and Specifications must be thoroughly understood by the Inspector.
- The Specifications have been developed over many years, and are intended to be precise in their meaning.
- Special Provisions are more project specific items.
- Any Specifications or Special Provisions that are not clearly understood should be clarified through discussion with the Resident Engineer or Contract Administrator.

A.2.3 DRAWINGS

The Inspector must study and carefully check the Drawings for the following:

- All dimensions and elevations
- Reinforcing steel lists and bar mass
- All material quantities required, such as:
    - Concrete, nearest 0.1 of a m^3 is more than sufficient
    - Earth quantities (excavation and backfill), approximately
    - Pile quantities
    - Structural steel mass

The Inspector should review material requirements with the Contractor to ensure quality and quantity of material.

Any discrepancies noted, or clarification required of details shown on the Drawings must be discussed with the Resident Engineer or Contract Administrator. Familiarization with the Drawings may be time consuming but it is essential for the following reasons:

- The Inspector will become completely knowledgeable with the project.
- The Inspector will become sufficiently familiar with all details on the Drawings to be able to discuss with the Contractor his methods, procedures and schedules.
- The Inspector will be "on top of" or "ahead" of situations that will or may develop and will have time to check with the Resident Engineer or Contract Administrator if necessary before problems arise.
- Quantity items necessary for progress estimates will be calculated.
- The possibility of errors on the Drawings will be reduced.

A.2.4 MATERIALS

The materials required for any project come in two categories and the Inspector should deal with them as follows:

(a) Materials supplied by the Contractor

The Inspector should check that these materials are on the Department's " Approved Products List" and/or meet the requirements of the Contract, Specifications and/or Drawings. The Contractor must follow the Manufacturer's directions for storage, handling, mixing, and placing.

(b) Materials supplied by the Minister

The Contractor is normally given a list of suppliers and the corresponding purchase order number when materials are supplied by the Department. Quantity is the responsibility of the Contractor. In the event of shortage or discrepancy in shipment from plan quantities, the Contractor should be advised to deal directly with the Supplier. When shortage occurs in materials, supplied directly from MIT's storage yards, and is discovered immediately upon delivery, the Contract Administrator and the Materials Technical Officer should be notified. When the shortage occurs some length of time after delivery, then the replacement of missing materials is the responsibility of the Contractor. In case of large errors in quantities, the Materials Technical Officer should be asked for a check of MIT's stock.

The Inspector should check that concrete piles are handled carefully and stored properly. The Inspector should also conduct a visual inspection for damage, cracking, and honeycombing.

The Inspector should also ensure that all the materials are properly stored and handled. Cement and admixtures should be kept dry.

The reinforcing steel, piling, precast, etc. should be kept out of mud and the timber unloaded in the appropriate manner. Reinforcing steel should be unloaded with slings.

A.3 START OF PROJECT

Upon arrival at the project, the Inspector should be familiar with the general conditions at the project site. Notes on location and photographs of dirt mounds etc. would do a great deal to help at the end of the project in deciding whether the Contractor has cleaned up the site properly.

The Inspector should be familiar (even if they did not help with layout) with the locations of all survey pins, bench marks, and other reference points and should make sure that they are properly protected against damage.

Immediately upon arrival at the site, the Inspector should introduce himself/herself to the superintendent and the foremen and obtain their home phone numbers as well as obtain the names of personnel authorized to act on the behalf of the Contractor in the absence of the superintendent or foremen from the project site. Also, the names of firms doing work for the Contractor on the project should be obtained.

A.4 AUTHORITY

A.4.1 GENERAL

The Inspector is usually the only representative of the Department at the site for the entire duration of the project. In recognition of this responsibility, the Inspector has been given certain authority in the General Conditions. This authority includes the right to inspect all aspects of the work done and materials furnished, rejection of defective material, suspension of any work method or procedure not meeting the requirements of the contract documents, Specifications and Drawings, and other authority as may be explicitly given by the Resident Engineer or Contract Administrator.

- Rejection or suspension will usually be met with strong disagreement from the Contractor, but must be done when necessary, after consultation with the Resident Engineer or Contract Administrator.
- The Inspector is not authorized to alter or waive the provisions of, or to issue instructions contrary to the contract documents, Specifications or Drawings.
- The Inspector is not authorized to give final acceptance or approval of the Work.
- The Inspector is advised to contact the Resident Engineer or Contract Administrator for help with a problem.
- In general, it is beneficial to ask lots of questions rather than to hope things will work themselves out.

A.4.2 INSTRUCTIONS TO THE CONTRACTOR

The Work specified under the terms of the contract documents, Specifications and Drawings must be complete, uniform, of good quality, and aesthetically pleasing. When sub-standard or unacceptable work is being performed, the Contractor must immediately be instructed in writing to correct the condition.

Before issuing instructions, the Inspector should be confident that his decision is correct and reasonable. **All verbal instructions given to a Contractor must be followed up in writing**. Instructions should be given only to the authorized representatives of the Contractor, usually the superintendent or foreman. Instructions are to be direct and courteous at all times. Copies of all instructions must be given to the Resident Engineer or Contract Administrator.

Instructions concerning work done by a subcontractor should be given through the General Contractor's Superintendent. When the Superintendent is not present, instructions may be given to the subcontractor, if he is the Contractor's representative at the time. **Instructions of any significance should be confirmed in writing to the General Contractor**.

When instructions involve strictly routine matters (i.e. reading drawings), they may be given verbally to a responsible representative of the Contractor. Items such as Extra Work, corrective action for faulty construction, finishing, signing, etc., must always be dealt with in writing.

Arguments should be avoided, and disputes referred promptly to the Resident Engineer or Contract Administrator. Criticism should be in the form of a caution that the work might not be acceptable if the contract document, Specification and/or Drawing requirements are not met.

Actually ordering the Contractor to perform his work in a certain way must be avoided since liability for that portion of construction may then claim to be assigned to the Inspector.

A.4.3 WORK STOPPAGE

The Contract Administrator is to be consulted before shutting down any project, except in an emergency when the Contract Administrator or Resident Engineer must be notified as quickly as possible. The following are some of the valid reasons for shutting down or suspending the work of a Contractor:

- Inadequate protection of the travelling public.
- The failure of the Contractor to carry out the Work in accordance with the Contract, Specifications and Drawings.
- Non-compliance with Workplace Safety and Health Act and Regulations.

A.4.4 RELATIONS WITH CONTRACTOR

The Inspector should carry out inspection in a friendly, business-like and ethical manner and ensure that all dealings with the Contractor are in a professional nature. As seen to be the on-site representative of the Department for the project, the Inspector must behave at all times in a manner satisfactory to the Department. The Inspector should be confident that the best interests of both the Contractor and the Department are being met under the terms of the Contract.

Enforcement of instructions will not be difficult if judgment is fair and impartial and knowledge of the work is thorough. This involves completing a detailed review of the contract documents, Specifications and Drawings.

Disputed instructions must always be referred to the Resident Engineer or Contract Administrator.

The Inspector is cautioned **not** to accept personal favors from the Contractor. By dealing fairly and by recognizing and commending good work, the Inspector can usually secure the friendly cooperation and respect of the workmen, an important asset.

The Inspector should take the attitude that any changes he/she suggests are for the benefit of the work, and not merely to show the authority of the Inspector.

The Inspector must avoid "criticizing" the Contractor's organization or discussing mistakes discovered.

A.4.5 RELATIONS WITH OTHER AGENCIES

A positive relationship shall be established in the early stages with the Regional staff, Provincial and Federal Fisheries officers, utility companies, local municipalities and other agencies affected by the construction operations.

The Inspection shall compile and maintain a list of addresses, telephone and facsimile numbers of contact persons for future reference.

A.4.6 RELATIONS WITH THE PUBLIC

The Inspector's relationship with the public must also be cordial and discreet.

As seen to be the representative of the Department for the project, the Inspector will be subject to public scrutiny. The Inspector is also the representative of the Department that is providing "the new structure" and as such will be subjected to local curiosity.

The Inspector must also consider the travelling public and ensure that the Contractor's operations are not hazardous and cause as little inconvenience to them as possible.

A.5 RECORD KEEPING

A.5.1 GENERAL

The importance of keeping complete, current and accurate records for each project cannot be overstressed.

Accurate records, along with regular progress photographs, not only provide a means of proper completion of required reports, but may prove invaluable in settling disputes concerning delays or improper methods used on the project.

A.5.2 SCHEDULE OF WORK

The Inspector should request from the Superintendent/Foreman at the end of each week a proposed schedule of work for the following week and should pass on this information to the Resident Engineer or Contract Administrator so that he/she may arrange to be at the site when required.

A.5.3 REPORTS

It is very important to have the weekly reports emailed or faxed into the Contract Administrator or Resident Engineer as early in the following week as possible. These reports are often needed for reference and, of course, the most current one is the one that is required.

The Inspector should go through all the forms and make sure that he/she understands them and knows when to use them and how they should be filled out. All correspondence, reports, forms, etc., must be identified with the correct structure site number in the top right hand corner.

When writing these reports, the Inspector should make sure that all the information is both concise and clearly stated. Also the Inspector should make every effort to send in clear and neatly printed or typed not written reports.

The following are examples of forms and reports to be completed by the Inspector during construction of a bridge structure:

- Inspector's Weekly Report

- Pile Driving Report
- Record of Concrete Pour
- Record of Lateral Stressing
- Concrete Cylinder Field Report
- Bi-Weekly Time Sheet - Extra Work
- Daily Gravel Record
- Vehicle Measurements
- Record of Salvaged Materials
- Equipment Rental Agreement

A complete listing and description of all record documents is included in Part B – Contract Administration.

A.6 BENCH MARK PLUGS

Bench Mark plugs shall be installed on all structures.

The location of the Bench Mark plug shall be the top of the North-East corner of the culvert headwall and approximately 4 feet out from the barrel, the top of curb over the North-East pier corner or in the case of single span bridges the top of curb in the North-East abutment.

In cases of a bridge on reinforced concrete foundations but without a concrete deck the benchmark plug should be installed only if it can be easily accessible to a level rod. The North-East orientation and priority for installation in a pier should be followed when possible.

The Inspector should make sure that the bench mark plug is approximately one-eighth (1/8") inch higher than the finished concrete surface.

The Geodetic Elevation of the bench mark plug shall be established at the completion of the project and entered in the Field Book as well as on the "As Built" Drawings.

A.7 BRONZE STRUCTURE MARKERS

The Branch policy is to install bronze structure markers on all structures. The Inspector should therefore arrange with the Contractor for the installation of the bronze structure marker.

Reinforced Concrete Culverts

Secure the Bronze Identification Plaques on the outside face of the North-East headwall, directly below the bench mark plug, approximately four (4) feet out from the barrel and one foot down from the top of the headwall. The marker should be attached to the forms and cast into the headwall. Cadmium Plate Screws should be set through the holes and cast into the concrete to ensure that the marker does not come loose.

Steel and Concrete Bridges

Place Bronze Marker on outside face of North-East wingwall close to the upper front of the abutment. The marker should be attached to the forms and cast in the abutment. Cadmium Plated Screws should be set through the holes and cast into the concrete to ensure the marker does not come loose.

Multi-Plate Structures

Attach to outside of plate at North-East corner (i.e. on the most Northerly or Easterly pipe in case of multiple installation or twin bridges). Punch mark holes to fit marker. Drill through plate using drill in kit which is proper size for No. 10 Robertson Self Threading Screw. End of screw protruding from steel plate could be bent over for security.

A.8 CONCLUSIONS

Inspection is the key to a quality structure, and the attitude of the Inspector should be that prevention is better than cure. If things are being done incorrectly, firmness and positive action directed towards corrective measures by the Contractor is in order. Corrective work can never be considered as equivalency.

With the understanding that their respective authorities and responsibilities should never be compromised, the Contractor/Inspector relationship on a project should be approached as having the common objective of ensuring the Work fully satisfies the requirements of the contract documents.

The Contractor has the obligation to conform to the standards required by the contract documents, Specifications and Drawings. However, as long as these standards are being met, the Contractor is reasonably free to choose his own methods for so doing.

The Inspector will have to observe and learn from others in many cases, but he/she should not hesitate to speak out if he/she thinks things are wrong. It is better to delay a concrete pour for half an hour while seeking advice, decision or guidance from the Contract Administrator or Resident Engineer, than trying to sort out mistakes after subsequent pours have been completed.

The Inspector should not hesitate to take a firm stand on something he/she knows is wrong.

Equipment Checklist

- ❑ Transit
- ❑ Level
- ❑ Rod
- ❑ Picket
- ❑ Slump cone and rod
- ❑ Cylinder moulds
- ❑ Concrete thermometer
- ❑ Chain
- ❑ Chain clamp
- ❑ Tension spring
- ❑ 8 meter tape measure
- ❑ Air Meter
- ❑ Rod level
- ❑ Sample bags
- ❑ Bench Mark Plug
- ❑ Bridge Identification Marker
- ❑ Ribbon
- ❑ Pins
- ❑ Sledge
- ❑ Punch
- ❑ Hard Hat
- ❑ Flashlight
- ❑ Safety Vest
- ❑ Safety Glasses
- ❑ Safety footwear (steel toed boots/shoes)

All equipment should be checked for condition and operation. Any equipment in poor condition should be repaired and/or replaced.

Note: All equipment removed must be signed out to a project and only the equipment required for a particular project should be taken out.

Stationary Checklist

- ❑ Contract Documents
- ❑ Specifications
- ❑ Drawings
- ❑ All the needed forms and reports
- ❑ Field instruction's to the Contractor
- ❑ Envelopes
- ❑ Pens
- ❑ Paper
- ❑ Stapler
- ❑ Calculator
- ❑ Survey Book

SECTION 1 – EXCAVATION

1.1 GENERAL

Excavation is the removal of all material (including ice, water, etc.) required for the construction of foundations or substructures as indicated on the Drawings or as determined by the Contract Administrator or Resident Engineer. Structural excavation may be wet, as in excavations required within or adjacent to stream channels, or they may be dry as in excavation in dry land. Dry excavations may also become wet due to the presence of ground water and surface runoff. Channel excavation is excavation carried out to improve the alignment or carrying capacity of the stream channel and excavation as may be required to allow placing of stone riprap.

- Dry structural excavation is usually done with backhoes.
- Wet structural excavation usually requires the equipment to be located above the excavation, involving backhoes, clamshells or airlift pumps.
- Channel excavation is usually done utilizing excavators or draglines.

The Resident Engineer and the Inspector must make sure that all excavated material not required for backfill is removed from the construction site and out of sight of the right-of-way during excavation. Under no circumstances shall the excavated material be left stockpiled at the construction site during construction of the structure unless this material is required for backfill. Especially during winter construction, excavated material must be disposed of immediately so that the material will not freeze and be difficult to clean up after completion of the job. There may also be instances when the excavated material cannot be stockpiled on river banks or embankment slopes because of slope stability issues.

1.2 FALSEWORK AND COFFERDAMS

The Inspector must make sure that the plans and details for falsework and/or cofferdams to be built are on the project site at all times, or until the temporary structures are dismantled. The Contract Administrator or Resident Engineer will provide the Inspector with the plans and details of these temporary works. All construction must be carried out according to the plans. The Inspector is ***not*** to "*inspect"* the construction of temporary structures, but must observe that such are constructed in accordance with the plans *sealed by a Registered Professional Engineer.* **Any deviations from the plans in the construction of falsework and/or cofferdams are not to be ignored, but should be brought to the attention of the Contract Administrator or Resident Engineer immediately.**

1.3 ENVIRONMENTAL CONSTRAINTS

The Resident Engineer and the Inspector must be aware of the environmental constraints governing the site relating to excavation activities within or adjacent to the stream channel. The Contractor must conform to the following:

- There are only certain time periods that construction activities are allowed within a channel.
- The Contractor is responsible to prepare and submit for review to the Contract Administrator or Resident Engineer an Environmental Site Management Plan prior to the commencement of construction activities.
- The Contractor must accommodate natural drainage of surface water passing through the excavated site or redirect surface water away from the excavated site.

- The Contractor shall obtain approval for his method and location of discharge of water pumped or drained from the excavations. Water pumped out of excavations may be detrimental to the environment and cannot be discharged directly into a waterway. The water must be pumped into a settling pond to remove the suspended materials.

- The Contractor's operations adjacent to the required excavations should not be allowed to affect in any way the existing stream channel or natural stream banks, unless permission has been received from the Contract Administrator or Resident Engineer.

- Careful consideration should be given to the location of access roads down to the river.

- If the Contractor's activities contravene the environmental permit conditions, the Resident Engineer or Inspector shall instruct the Contractor to cease operations immediately.

1.4 SAFETY

Excavations can be dangerous and have been the cause of many fatalities. The Workplace Safety and Health Act and Regulations give safety guidelines and requirements relative to allowable vertical heights of excavated faces, back slopes and safety railings around tops of excavations.

- It is the responsibility of the Contractor to ensure that all safety requirements are met.

- The Resident Engineer and Inspector are responsible to point out any safety violations that he is aware of to the Contractor, and to take necessary action where there is non-compliance in accordance with Department policies contained in Section 19 of this manual.

1.5 INSPECTOR'S RECORD

Prior to the beginning of excavation, for common waste excavations, the Inspector must take a series of levels on the ground surface in the area around the excavation. These form the datum for calculations of excavated quantities and provide information for future reference, settlements of disputes, etc. Photographs of the original ground of the non-excavated site are required to record conditions prior to the beginning of excavation.

- It is the responsibility of the Contractor to investigate whether there are utilities in the area to be excavated and if there are utilities that they are accurately located by the utility company, protected and/or relocated.

- The bore hole logs should be thoroughly reviewed so that the Inspector knows the type of material to be encountered when excavated, and a record kept of actual material type that was excavated.

- The Contract Administrator or Resident Engineer shall be notified if different material types are encountered to review the need for foundation modifications.

- All structures adjacent to the site of the excavation must be reviewed and photographed prior to the beginning of excavation. If damages are claimed later, the photos can be checked to verify whether or not the damage occurred because of the excavation.

- The Inspector shall record elevations of groundwater, stream water levels, and ice levels and the tops of berms, dikes and cofferdams.

- Photographs and records of equipment used for excavation are necessary for resolving disputes and claims.

1.6 SOIL MATERIALS AND GROUND WATER

The Inspector should be aware of the effects of certain conditions and material types on the satisfactory performance of an excavation. High ground water levels make excavations difficult and free water lying at the bottom of an excavation can very rapidly disturb and soften otherwise suitable bearing materials. High ground water tables also provide a source of water in which can lead to frost heaving in cold weather conditions.

- Existing fill materials encountered in excavations are often incompetent and a) may have to be removed and the footing extended downward or b) the material replaced with a more competent bearing material that must be compacted into place.

- Highly plastic clays are subject to swelling and shrinkage with changes in moisture content.

- Fine sand, silts and weak clays are easily disturbed during construction. They are sensitive to flows of ground water when excavations are carried below ground water table and are subject to erosion, frost heave and piping.

- Clay shale in a dry condition appears very competent at the time of excavation, but can be weaken rapidly with exposure to weather and water.

- Variability of soil types within the excavated area may require the over-excavation of softer portions. This should be reviewed with the Contract Administrator or Resident Engineer.

1.6.1 Sulphates

The subsurface investigation may or may not indicate the presence of sulphates in the soil. During excavation the Inspector should examine the material being excavated. If a white powdery or “feathery” substance is noted, it is often an indication of relatively high sulphate content. It may be necessary to analyze a sample of the material at a testing laboratory.

- The Contract Administrator or Resident Engineer should be contacted for a decision as to whether tests for sulphates should be undertaken and if the cement type will have to be changed for concrete in contact with the soil.

- If the cement type is changed, the Contractor will be compensated for the increase cost of the cement, unless it is specified in the contract documents or the cement is supplied by the Department.

1.7 FOUNDATION REQUIREMENTS

- In preparation for casting of concrete footings, all loose material must be removed.

- As shown on the Drawings, a concrete working base is placed to protect the excavated surface and provide a firm, level and flat surface for concrete falsework and formwork.

- Where excavations must be drained or de-watered, ensure that drainage trenches and sumps are located outside of the area in which the concrete working base is to be cast, so that the concrete is not placed with flowing water present.

1.8 DRY STRUCTURAL EXCAVATION

Dry structural excavations are usually quite straightforward. The Inspector must confirm that the bottom of the excavation is at the depth required by the Drawings, and that the material encountered is the same as that anticipated from the test bore holes.

- Spread footings not supported on piling are to be cast “neat” into excavations, unless otherwise specified.

- Neat excavations are dug carefully to a size and shape conforming closely to or slightly larger than the required footing dimension shown on the Drawings.

- Water trying to enter an excavation is to be controlled at a level above the newly poured concrete.

1.8.1 Shoring

Depending on the soil type and depth, excavations may require shoring. The Contractor is required to have all shoring designed by a Registered Professional Engineer and it must meet the requirements of the Workplace Safety and Health Act.

- Shoring Drawings shall be submitted to and reviewed by the Contract Administrator or Resident Engineer, and the shoring will be inspected for conformance to the approved design. Deviations are to be discussed with the Contractor and the Contract Administrator.

- During excavation, the Inspector shall monitor the performance of the shoring and report any inadequacies or movement to the Contract Administrator or Resident Engineer.

1.9 WET STRUCTURAL EXCAVATION

Excavation within or adjacent to the streambed is usually classified as wet excavation. Such excavations are made by one of two methods. An open “hole” method using dikes and berms or by constructing a steel sheet piling cofferdam. The main purpose of either method is to eliminate/minimize water from the excavation.

- Details of cofferdams, dikes or berms must be submitted and approved by the Contract Administrator or Resident Engineer and all work must meet environmental constraints.

- All cofferdams, dikes and berms must be removed as soon as that portion of the substructure is completed and in conformance with the applicable permits.

- After the removal of cofferdams, dikes, berms and work bridges, etc., it is essential that the Contractor restore the channel to its original condition or to such improved condition as is required by the plans and specifications and applicable environmental permit.

1.9.1 Open Hole

In this method of excavation, the area to be excavated is accessed and surrounded by berms or dikes. The hole is de-watered by various methods such as pumping or well points prior to excavation. A sloped, or terraced and sloped excavation is then made down to the footing level.

- Perimeter drainage must be maintained at the bottom of the sloped excavation, above the level of the neat excavation for the footing.

- It is essential that the neat excavation be carried out in the ‘dry’.

- When such excavations are carried out adjacent to the toe of a headslope fill, the Inspector should monitor the fill for possible signs of sliding or instability and immediately report any such occurrences to the Contract Administrator or Resident Engineer.

1.9.2 Cofferdams

Cofferdams are usually constructed by driving interlocking sheet piling through the water bearing formations into shale, sandstone or clay materials to obtain a seal. The cofferdam is usually located about 1 meter or more from the neat lines of the footing to be excavated. This is to allow for sufficient space to intercept perimeter drainage or water that will invariably leak into the cofferdam, and must be kept out of the neat excavation. Dependent upon the depth and head of water, cofferdams and shoring can be subjected to substantial lateral pressures.

- Details for cofferdams and shoring must be stamped and sealed by a Registered Professional Engineer.
- Care should be taken to ensure that the braces do not interfere with the pile locations or concrete components where applicable.
- The Inspector should ensure that the Contractor monitors cofferdam or shoring walls daily for lateral movements and increased leakage through joints.
- Brace connections, wedges, etc. should also be checked regularly by the Contractor to ensure that they remain tight.
- The condition of the ground at foundation level should also be monitored. Any signs of increased water flows or softening of the material should be considered as danger signals and drawn to the Contractor’s attention immediately.
- It is sometimes not possible to de-water a cofferdam. A concrete seal may have to be tremied into the bottom of the excavation. This is a critical operation and requires the approval of the Contract Administrator or Resident Engineer.

1.10 CHANNEL EXCAVATION

Excavation carried out to improve the alignment or carrying capacity of a stream channel or required for placing stone riprap should meet the lines and elevations shown on the Drawings.

- Any special environmental constraints will be noted on the Drawings or in the Special Provisions.
- Note that as a result of excavation, special precaution may have to be taken to prevent fines in suspension from reaching the stream. This should be reviewed with the Contract Administrator or Resident Engineer.
- If the Contractor’s activities contravene the requirements of the environmental permit, the Inspector shall require the Contractor to cease operations and the Inspector shall immediately contact the Contract Administrator or Resident Engineer.

1.11 CULVERT EXCAVATION

Installation of culverts generally involves “short-term” vertical and/or sloped excavations in order to:

- Divert water around the site.
- Remove soft or yielding material at least 600 mm below the culvert invert so as to provide a firm foundation.
- Remove solid rock material 150 mm to 300 mm below the culvert invert so as to provide for the bedding layer. Place the culvert below average streambed elevation.

- Provide enough space for assembly of the culvert and operation of equipment for placement and compaction of the structural fill.

- Place stone riprap at the ends of the culvert.

All excavations below finished gradeline for the installation, removal and/or salvage of culverts, placement of stone riprap, and stream diversions are classified as “channel excavation”. The only exception is when solid beds or masses of rocks or boulders exceeding 0.5 cubic metres are encountered, in which case that portion of the excavation is classified as “rock excavation”.

In general, the excavation for culvert installation should extend 600 mm below the pipe invert for the entire width of the excavation. The width of the excavation is defined as the pipe width plus 3 m at the invert elevation. The sides of the excavation are generally sloped at one horizontal to one vertical but should be adjusted depending on the depth of excavation, soil type and climatic conditions. The Contractor should also consider extending the excavation limits to include the bedding requirements for stone riprap.

The excavation is to be carried out to the design lines as shown on the drawings. Over excavation for any reason will not be paid for unless recognized and proven as necessary by the Contract Administrator or Resident Engineer.

In some cases additional excavation may be required to:

- Provide more space for assembly, large excavation equipment, etc.

- Remove soft or yielding material to the specified depth below the pipe invert and/or the specified distance from the side of pipe.

- Stabilize the sides of the excavation by providing benches.

In general, vertical banks should be avoided in wet conditions. Some soils will stand at considerable depths vertically while most will slough off to a stable angle or slide into the excavation. Sandy soils will tend to slough during excavation while cemented sands, silty clays and clays will stand up to greater depths.

For excavation in wet areas or excavation at the toe of the slope the following should be considered:

- Minimize the time the excavation has to remain open by proceeding immediately with backfill and culvert assembly.

- Unload the top of the slope as much as possible – remove spoil pile, construction material, etc.

- Do not allow construction equipment to park or travel on the top of the slope – the minimum distance from the top edge should be equal to or greater than the depth of the excavation.

- Use appropriate dewatering and/or drainage scheme.

- Prevent surface runoff from entering the work area.

- Consider using appropriate excavation equipment.

- If possible, excavation below the invert should be done in short sections and backfilled immediately.

- In special circumstances, undertake excavation during freezing conditions.

- Use geotextiles and/or perforated pipe to minimize the depth of excavation.

Sloped or vertical excavation, the type of soil and its moisture content will generally dictate the type of excavation equipment required. The common types of excavation equipment are excavator or backhoe.

1.12 MATERIAL DISPOSAL

Excavated material suitable for re-use is usually stored at some location on the site approved by the Contract Administrator or Resident Engineer.

The Contractor should ensure that this stockpiled material is not placed on private property, nor in a manner that will interrupt surface drainage, nor in a location that will interfere with subsequent construction operations. Unsuitable or surplus excavated materials are to be disposed of by the Contractor in a location and manner approved by the Contract Administrator or Resident Engineer.

- When disposing of waste material, the Contractor shall provide the Resident Engineer with a letter of permission from the land owner absolving MIT from all liability for damages prior to the Contractor receiving permission to dispose of his excavated material. If the material consists of wet excavation, the landowner should be advised that this material could take a long time to dry.

- Surplus excavated materials are to be disposed of in an area and manner approved by the Contract Administrator or Resident Engineer.

- Material excavated from the riverbed shall not be disposed of close to river channel, as it will inevitably flow back into the river causing siltation.

1.12.1 Hauling of Waste Material

- When hauling excavated material to a disposal area, often the wet material can leak out or be spilled onto the highway thus creating a slippery and hazardous condition for the travelling public, especially during the cold weather months.

- The Contractor shall have an approved traffic control plan in place for trucks entering and leaving the highway.

- The Contractor shall clean the roadway as required.

- The Contractor shall only be permitted to haul during certain hours of the day, as directed by the Contract Administrator or Resident Engineer.

1.13 CHECKLIST

1.13.1 Inspector's Responsibilities

- ❑ Read and study specifications, contract documents, Drawings and borehole logs.
- ❑ Review arrangements of access routes and disposal area.
- ❑ Confirm suitable stockpiling locations at site with Contract Administrator or Resident Engineer.
- ❑ Ensure Contractor complies with environmental requirements.
- ❑ Observe how excavation and insitu material behaves on exposure to weather and water.
- ❑ Confirm the elevation and dimensions at the bottom of the excavation.
- ❑ Advise the Contract Administrator or Resident Engineer of any water problems during excavation.
- ❑ Keep good records of any excavation extending beyond required depth.
- ❑ Cutting or filling of slopes is not allowed, unless approved by the Contract Administrator or Resident Engineer.

1.13.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Review with the Contractor and the Inspector the terms and conditions of the Environmental requirements as they pertain to the Contractor's work procedures.
- ❑ Ensure that the Contractor's proposals for deep excavations, shoring and cofferdams are stamped and sealed by a Registered Professional Engineer.
- ❑ Prior to any construction commencing on deep excavations, shoring or cofferdams, attend a job safety meeting called by the Contractor that identifies hazards and safety procedures to be followed.
- ❑ Confirm and approve the "neat" excavation for a spread footing prior to the placement of concrete.
- ❑ If over-excavation beyond contract limits is assessed to be beneficial to the project, the Contract Administrator or Resident Engineer should begin processing the Extra Work Order.

Cofferdams

- ❑ Check lines (centerline of roadway and centerline of pier) for position of cofferdam.
- ❑ Confirm toe elevation of sheetpiling as required by the Registered Professional Engineer.
- ❑ Confirm blocking (wooden wedges) of ring are in accordance with the design.
- ❑ If elevation difference between water in channel and water in cofferdam becomes apparent, inform Resident Engineer immediately.
- ❑ Confirm dimensions of ring.
- ❑ Confirm structural size of sections for the sheetpiling, ring, and struts.
- ❑ Verify welding is completed as designed (or bolted connections.)
- ❑ Confirm position of struts (requirement for temporary position during pile driving?)
- ❑ Inspected by Registered Professional Engineer before anyone goes in cofferdam and confirmation in writing has been received.
- ❑ Beware of potential for blowout of bottom from artesian aquifers.
- ❑ Ensure strut and ring are orientated in the right direction.
- ❑ Confirm elevation of streambed.
- ❑ Note all welds or deviations in the rolled metal of the cofferdam steel sheet piling.
- ❑ Measure length of all sheet piling on-site, prior to installation.

SECTION 2 – BACKFILL

2.1 GENERAL

Excavations are made for the purpose of constructing bridge substructure units. Competent backfill material is then placed to fill the excavation after the substructure unit is constructed. The backfill material must be adequately compacted into place to minimize future settlement of the material. Backfill may also be required to build up areas where the existing ground level is lower than that required in the final project or for the construction of river training works.

All backfill material must be properly compacted by mechanical tampers. Some tampers are designed to compact cohesive materials while others are designed for granular materials. The Inspector should check that the tamper being used meets the correct requirements. The Inspector should not allow the use of front-end loaders, bulldozers, etc., as compacting equipment.

In freezing conditions, the Inspector must ensure that the granular backfill is not frozen, the sub-grade it is being placed against is not frozen, and that the Contractor is taking all necessary measures to ensure it is not freezing while being placed and compacted.

2.1.1 Granular Backfill

If paying by the cubic meter, the Inspector must measure the dimensions of the box for every truck hauling granular materials and record the measurements on the Vehicle Measurement form. Each load should be checked individually and deductions for not hauling the calculated volume must be made. The total volume hauled on each load must be recorded on a Daily Gravel Record form.

The Inspector should impress upon the Contractor the fact that sufficient time must be allowed to complete quality assurance testing of the granular backfill. At the start of the project, the name of the Supplier should be obtained, samples taken, and tested as soon as possible (See Procedures for Sampling). The origin of the aggregates should be indicated on the sample shipment forms. The above work should be completed at the early stages of the project.

2.2 ENVIRONMENTAL CONSTRAINTS

The Inspector must be aware of the environmental constraints relating to backfilling in and adjacent to the stream channel. The following criteria must be met:

- Normally, there are only certain time periods that construction activities are allowed within a channel.
- Backfill material deposited into fish bearing streams must be clean with very few fines. Fines shall be confined from entering the water body using filter fabric, silt trap/fence/barrier, or settling pond, etc.

2.3 SAFETY

Refer to Manitoba's Workplace Safety and Health Regulation for specific safety requirements.

The Inspector must be aware that there may be situations where excavations can be classified as confined spaces (e.g. when compaction equipment is compacting granular backfill and the appropriate safety measures need to be taken by the Contractor).

2.4 INSPECTOR'S RECORD

It is important that the Inspector keep an accurate record of the following items:

- In situations where the approach embankment fill is deficient and extra fill material is anticipated in order to achieve the final grade line, it is essential to obtain and record before and after cross-sections so that the Contract Administrator or Resident Engineer can inform the appropriate parties.

- The results of density tests need to be accurately recorded to validate n order that rejection or acceptance of a backfill material can be validated.

- All rejected work should be recorded and recompacted to meet density requirements.

- Include the date, any related discussions held with the Contractor, and stated reasons for rejection of any work.

2.5 MATERIALS

Backfill is generally classified into two types: Compacted non-granular (cohesive material) and compacted granular. The location where each type of material is required is noted on the Drawings and in the specifications and contract documents.

2.5.1 Compacted Non-Granular Backfill (Cohesive Material)

Non-granular backfill material (cohesive material) may be used as backfill if it is suitable. In freezing conditions, if excavated material is used as backfill material, the material should be piled such that the frozen outer shell can be removed and discarded leaving access to the unfrozen inner material.

- Material similar to that being used for the roadway embankment is generally acceptable to be used as non-granular backfill material (cohesive material).

- Non-granular backfill must be acceptable to the Contract Administrator or Resident Engineer.

- Material must be free from all topsoil, roots, large lumps and any frozen material.

2.5.2 Compacted Granular Backfill

Compacted granular material is a mixture of free draining sand and gravel complying with the gradation requirements noted in the specification. It must also be free from any frozen lumps.

- Requires sieve analysis.

- Material must meet specified gradation.

- Density tests need to be taken to ensure that specified compaction is achieved.

2.5.2.1 Crushed Granular

Crushed granular material is generally specified in areas where a higher standard of backfilling is required, such as around culverts and culvert beds. The specified gradation and density must be achieved.

- Requires sieve analysis.

- Material must meet specified gradation.

- Density tests need to be taken to ensure that specified compaction is achieved.

2.6 PLACING

The sequence of placing and compacting backfill can be important depending on the structural element being backfilled. For example, backfilling only one side of a pier can cause significant lateral forces, which could displace or cause an element to fail.

- No backfill should be placed against abutment wingwalls or backwalls or culverts until permission is granted from the Contract Administrator or Resident Engineer.
- Ensure that all patching is properly carried out and cured before backfilling against any concrete element.
- The backfilling should progress at the same rate, in lifts of approximately 150 mm, on all sides of a concrete element, especially for thin sections.
- Steps or terraces may be required to be excavated when backfilling on a slope so that the newly placed backfill material can be “keyed” into the slope.

2.7 COMPACTION

For backfill material, compaction is required to be 95% Standard Proctor Density with optimum moisture content. Proctor Density is obtained by taking an actual sample of the backfill material and doing **standard** compactions on it at varying moisture contents in the laboratory.

- Field tests may be taken to determine the density of the material as compacted and to compare it to the optimum density as achieved in the Proctor test.
- Testing of the density of the compacted material shall be in accordance with the appropriate specification.
- Compaction equipment can be small hand operated mechanical rollers or tampers, or larger vibratory roller type equipment.
- **ALWAYS** review the requirements for testing backfill at **each** location on site with the Contract Administrator or Resident Engineer.
- Backfilling operations are not allowed to begin until the concrete elements have reached 85% of the 28 day design compressive strength.

2.7.1 Non-Granular Material (Cohesive Material)

- In confined areas adjacent to substructure element, a motorized “jumping jack” tamper or a pneumatically operated tamper may be used to achieve the required density.
- In larger areas, a “sheep foot” type of roller may be more economical and more appropriate.

2.7.2 Granular Material

- Granular materials are usually compacted effectively with a smooth vibratory drum type roller.
- In confined areas, a “jumping jack” tamper or a pneumatically operated tamper may be more effective.

2.8 PROCEDURES FOR SAMPLING AGGREGATES

2.8.1 Sampling from a Stockpile

The entire stockpile from top to bottom should be sampled. Sampling should start at equally spaced points along the bottom of the pile and proceed upwards, at equal intervals over the sides and top. If only part of the pile is to be used for a portion of the job, just the part to be used should be sampled.

Samples should be obtained with a shovel and consist of material from well beneath the surface. By holding a short piece of board against the pile just above the point of sampling, the inclusion of unwanted surface material may be avoided.

The sample should be reduced to test sample by quartering as follows.

The sample is placed on a hard, clean surface where there will be neither loss of material nor accidental addition of foreign matter. The sample is mixed thoroughly by turning the entire lot over three times with a shovel. This can best be accomplished by two men, one on each side of the sample, beginning at one end and taking alternate shovels of the material as they advance the length of the pile. With the third or last turning, the entire sample is shovelled into a conical pile by depositing each shovelful on top of the proceeding one. The conical pile is carefully flattened to a uniform thickness and diameter so that the material will not be transposed from one quarter to another. The flattened mass is then marked into quarters by two lines that intersect at right angles at the centre of the pile. Two diagonally opposite quarters are removed and the cleared spaces brushed clean. The remaining material is mixed and quartered successively until the sample is reduced to required size.

2.9 CHECKLIST

2.9.1 Inspector's Responsibilities

- ❑ Review specifications, contract documents and study Drawings.
- ❑ Report on Contractor's compliance with the project environmental requirements.
- ❑ Ensure Contract Administrator or Resident Engineer approves the backfill material.
- ❑ Check backfill material frequently to see that it is free from topsoil and roots, large lumps and frozen material.
- ❑ Be aware as to where granular and non-granular types are required.
- ❑ When backfilling thin elements, check that backfill material is being placed to the same elevation on both sides.
- ❑ Check that backfill material is being placed and compacted in maximum 150mm lifts, with appropriate equipment.
- ❑ Obtain density tests as required.

2.9.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Review environmental requirements with the Inspector and Contractor.
- ❑ Discuss anticipated problem areas, solutions and construction methods with the Inspector and Contractor.
- ❑ Discuss and approve backfill material, density tests and sieve analysis if required.
- ❑ Discuss with the Inspector possible "extra cost" claim items.
- ❑ Promptly refer or report contractual issues or matters to Contract Administrator or Resident Engineer.

SECTION 3 – BEARING PILES

3.1 GENERAL

Piles are slender underground columns, generally placed in a group and sometimes with the top portion projecting as an unsupported column to a pier cap. They are designed to support their loads through bearing at the tip, friction along the sides, adhesion to the soil, or a combination of these means.

- Piles are used when other foundation types are impractical.
- Piles are classified as either end bearing or friction piles, or both.
- Piles can penetrate weak soils and transmit their loads to underground strata that have higher bearing capacities.
- Piles can also distribute loads over a sufficiently large vertical area of weaker soil to enable them to carry the designed loads safely.

3.2 ENVIRONMENTAL CONSTRAINTS

Be aware of the environmental constraints when installing piles that encroach on the stream channel.

- The Resident Engineer and Inspector should be aware of noise generated by the pile driving hammer, and work should not be permitted late at night in or near a populated area.

3.3 SAFETY

Refer to Manitoba's Workplace Safety and Health Regulation.

- All site personnel must wear a hard hat and safety boots when working with, near or around pile driving hammer, as falling objects from the hammer will create a dangerous situation.
- It is advisable to wear ear protection to minimize the noise generated from the pile driving hammer.
- Ensure that proper fall protection is in place when climbing pile driver leads.
- Personnel should not stand in the vicinity of a pile during the pile set-up operation, as the pile may fall if the cable holding the pile fails.
- A timber pile may fail without warning during driving; resulting in many pieces of timber "splintering" out from the pile, creating a very dangerous situation.
- Ensure that the pile driving procedures do not interfere with any utility lines.

3.4 INSPECTOR'S RECORD

The Inspector must observe and record the results of all pile driving operations and must ensure that all conditions of the Contract are met.

- If site conditions vary from that shown on the Drawings, pile requirements may have to be modified by the Contract Administrator or Resident Engineer.
- General comments pertaining to the performance and specific details of the hammer must be recorded.

- A careful record of pile length driven must be recorded.

- In case of bearing piles, ensure that the Contractor knows the expected final set. The penetration as shown on the plans should be obtained whenever possible without overdriving of the piles. The Contract Administrator or Resident Engineer must be consulted in this regard.

- Whenever a pile shows any sign of damage/splitting during the pile driving operations, pile driving must be stopped immediately. The pile must then be accessed for the extent of damage and the Contract Administrator or Resident Engineer should be contacted immediately.

- Payment for driving piles is made at the unit price bid for the metres of piling acceptably driven and used in the completed structure.

- The length of pile is the actual length from tip to cut-off.

- It is essential that the Inspector monitor the entire driving operation so he can confirm that the length of driven piling to be paid for is correct.

- The number and location of splices must be recorded.

- Any pile "set" values or negative friction should be recorded.

- Survey check of the installed pile alignment and elevations should be recorded.

3.5 SOIL

Pile driving usually affects the properties of the soil through which the pile is being driven. When piles are driven in the ground, they displace soil. The soil can be pushed down, up, or sideways or a combination of these.

- The information provided by the soil log and the test pile data should assist in anticipating the degree of driving difficulties and the penetration of the piles.

- Be aware that approach fills may include soils with large boulders, stones, broken concrete slabs or old asphalt pavement, which will create difficulty in the pile driving operation.

- Vibrations from the driving effort tend to consolidate granular soils and unsaturated clays.

- Displacement of the soil by piling, such as steel pipe, steel "H" or timber piles can also increase compaction of the surrounding granular materials.

- In some over consolidated materials and saturated clays, soil displacement may cause heaving of the surrounding soil, which can lift previously driven piles and push them out of alignment.

3.5.1 Pile "Set"

Some weaker clays or silty soils offer relatively little resistance to penetration of a pile while it is being driven, but "tighten up" and grip the pile securely after the driving disturbance ceases. This is called pile "set" and can be a concern if driving is stopped for any length of time before the pile has reached the required penetration. It is sometimes difficult to get the pile moving again once pile "set" has occurred.

- The weight of the added fill material may cause underlying strata to consolidate. As the soil consolidates downward, upper layers that have gripped the pile will tend to "hang-up" on the pile and transfer their weight to the piles as additional loading.

- Where piles are driven through fills which are expected to settle or consolidate in the future, they may be installed in holes pre-bored through the fill layer or coated with a bond breaking material which will reduce or eliminate the gripping effect on the pile of the upper layers.

3.6 EQUIPMENT

- The installation of a pile involves a variety of choices of equipment.
- Selecting the most suitable equipment for each pile application is very important.

3.6.1 Drop Hammer

A gravity or drop hammer pile driver consists of a weight, guides or leads, a supporting framework and a means for raising and dropping the weight, usually a crane. The weight is raised along the leads to a desired height above the pile top, then released and allowed to drop onto the pile.

- The specifications require the Contractor to provide of the mass of the hammer being used.
- The Inspector must obtain an accurate weight of the hammer as well as the follower. The foreman's word will not suffice; the Inspector must obtain a weight ticket for the hammer or some other proof of weight. When in doubt, insist on the weighing of the hammer and follower in the presence of the Inspector. The Inspector should look into this matter at the early stages of operations and should not wait to obtain the information until after the hammer is in the leads.
- The available impact energy delivered per blow by a drop hammer is calculated by multiplying the weight of the hammer times its effective height of fall.
- The maximum allowable height of fall is limited to 2.0 metres to avoid damage to the pile.
- The leads should be marked in a manner that allows the easy determination of the distance that the hammer falls.
- The pile cap should contain a cushion block to serve as a "shock" absorber.
- Drop hammers are generally more time consuming than other types of hammers, however they can provide a fast driving rate in soft soils where high drops can be used.
- In hard soil formations, where the drop has to be reduced to avoid overstressing the pile, driving can be slow. One of the greatest risks in using a drop hammer is overstressing and damaging the pile.
- A gravity hammer could be utilized for setting up piles, i.e. to drive the first section of a pile or driving timber piles in a soil that has a minimal amount of resistance.
- Generally, a drop hammer should not have a drop of more than six (6) feet. The Contract Administrator or Resident Engineer must be consulted in this regard since the desired drop will vary depending on resistance to driving and the weight of the hammer being used.

3.6.2 Diesel Hammer

A diesel hammer can be a single or double acting hammer. The diesel hammer is a precision pile hammer and has a high-energy rating. The diesel hammer is efficient and compact as it carries its own fuel from which it generates its power internally.

- Diesel hammers use rapid combustion of fuel to directly drive the pile down and the ram up. The unit contains a fuel-injection system, ram, anvil, and vertical cylinder.

- To start the hammer, a cable lifts the ram and a trip drops it. As it falls, it actuates a fuel pump to inject fuel between the ram and the anvil. The compression on impact ignites the fuel, and the explosion drives the pile down and the ram up for another blow.

- In the case of double acting diesel hammers fuel is injected at the top of the ram travel and the resulting explosion also drives the ram downward giving additional energy to the ram weight as it falls. A lighter ram weight is used, but more blows per minute are achieved.

3.6.2.1 Efficiency Factor

Energy determination is important with diesel hammers. The number of blows the hammer produces per minute must be recorded so the hammer can be properly rated. For some hammers, the operator can vary the fuel supply, which directly affects the energy output. The Inspector must be aware of the operating characteristics and rated energy output of the specific hammer as provided in the Manufacturer’s manual supplied by the Contractor.

- Length of stroke varies with pile resistance.

- The performance of a specific hammer is evaluated, realizing that the relationship between the number of blows per minute and the efficiency of the hammer is not a linear relationship.

- Pile-driving leads facilitate proper pile positioning.

3.6.3 Vibratory Pile Driver/Extractor

The vibratory pile driver drives a pile by being rigidly connected to the pile usually by clamps, and advances the pile through the soil by vibration. Vibratory pile drivers are effective for advancing piles in granular soil conditions and especially in sandy material.

- Vibratory drivers are not rated by ram (eccentric) weights or by impact energies delivered per blow. Vibratory pile drivers are classified as the driving force delivered to the pile.

- The driving force of a vibratory driver is the product of the eccentric moment of the eccentrics in the machine and the steady-state frequency at which the eccentrics can be rotated when loaded with an oscillating pile.

- The operation, maintenance and repair of vibratory pile drivers are more complex than other pile installation equipment.

- Vibratory pile drivers are efficient for driving sheet piles for cofferdams.

- Vibratory pile drivers can also be used to extract piles.

- At the site, care must be taken when swinging the vibratory hammer, clamping it properly to the pile and inspecting the connecting electric cable or hydraulic hose bundles.

3.7 PILING

Essentially, piles to be installed fall into two major categories: bearing piles and retaining piles. The bearing pile category can be subdivided into end bearing and friction bearing pile. The retaining pile category can be subdivided into permanent and temporary piles.

- Commonly used piles in bridge construction include steel H-piles, concrete piles or steel pipe piles.

- Bearing piles are slender columns, and as such they rely on the lateral support from the soil through which they are driven to prevent buckling. When piles are driven through water or in extremely weak soils special precautions to prevent buckling may be required.

- When foundations are subjected to significant lateral forces, piles may be driven battered (i.e. at an angle to the vertical) to provide a horizontal component to the load carrying capacity.

- Pile tops must be cut squarely, to accommodate a driving cap or follower which is provided to hold the pile in line with the hammer.

- To prevent damage to the pile from the impact of the hammer, a plywood or hardwood shock block is used as a cushioning material in the driving cap or follower.

- Pre-boring may be required to assist pile alignment where the ground is frozen or alleviate "down drag" forces on piles driven through newly placed embankments. Approval from the Contract Administrator or Resident Engineer must be obtained before pre-boring.

- The pre-bored hole could be over/under sized depending on whether side friction is a critical factor or not.

- All piles must be marked at a minimum of 1.0 meter intervals prior to their being put in the leads.

3.7.1 Timber Piles

Timber piles have been used in foundations for a long time; however, they are not normally used anymore. If the piles are installed such that they will be permanently below water level, the material will not decay and untreated timber may be used. Where piles may be subject to decay, they are pressure-treated.

- Piles that are curved, cracked or contain large knots must be rejected.

- Timber piles are susceptible to damage and must be handled and driven carefully. Treated piles must not be handled with tools such as hooks, tongs, dogs and pike-poles, which will break the surface. If cuts or breaks in the surface do occur, the surface is to be appropriately repaired.

- Driving operations tend to split and "broom" the tops of timber piles. The top of the pile must be protected with a collar, multiple banding, or some other approved device. Pile caps or followers used with the hammer must be such that the driving impact is distributed to the full end surface of the pile. Limitations on the weight and height of fall for drop hammers, and the energy supplied by diesel hammers must be controlled to avoid pile damage.

- Splicing of timber piles is allowed, but the connection must be approved by the Contractor Administrator or Resident Engineer.

- Occasionally, metal shoes may be used when driving into hard soil conditions.

- Ensure that the required elevation is maintained after any "broom", splintered or damaged material is cut off.

3.7.2 Steel Sheet Piles

Steel sheet piles are generally utilized for cofferdam construction. As with treated timber piles, steel sheet piles cannot withstand hard driving. A vibratory hammer is most effective for driving and extracting sheet piles, especially when driving in granular material.

- It is imperative that the “starter” pile to be properly aligned and subsequent piles be properly “threaded” in order to maintain the desired alignment. At the corners of a cofferdam, appropriate “corner piles” should be employed.

- All sheet piles should be “threaded” and set-up before driving commences.

- The first sheet pile should be minimally advanced with subsequent piles advanced the same amount, rotating equally from sheet pile to sheet pile.

- Spliced sheet piles should not be used, as the “splice” in the pile will cause problems in the “threading” process and the final alignment.

3.7.3 Steel “H” Piles

Steel H-piles are usually rolled wide flange sections. H-piles are strong and durable and can be driven into relatively difficult ground conditions. They have a small cross section, so ground displacement and heaving are minimized.

- The specifications and/or contract documents state limitations on pile driving requirements.

- The specifications require that the pile head to be cut squarely and a suitable follower provided to ensure the driving force is delivered to the pile uniformly over the full cross section.

- When splicing during adverse weather conditions, the welding area must be sheltered from the wind and preheated. Splicing details are given on the Drawings.

- Under difficult driving conditions, a pile “shoe” or “pile tip” may be required.

- The Contractor must use the standard “Pile Tip Detail” when welding on a pile tip to a steel H-pile.

3.7.4 Steel Pipe Piles

Steel pipe piles may be driven with open or closed ends. All steel pipe piles should be checked for roundness and it is essential that the pile cap on the follower fit the pipe piles properly. Care should be taken so that pipe piles are not over driven to cause buckling or folding at the tip. One indication of folding is when high blow counts suddenly drop and the information provided in the soil log does not account for this sudden change.

- Steel pipe piles with closed bottom ends displace a relatively large amount of soil.

- Care must be taken during driving to ensure that pipe piles are not damaged from buckling of the pipe walls. The interior of pipe pile should be inspected by either lowering a light bulb or using a mirror to ensure that the pile is not buckled or split and allowing water seepage.

- During hard driving some local buckling of the pipe wall at the driving follower may occur requiring removal of the damaged portion.

- When splicing in cold weather, the welding area must be sheltered and the splice location pre-heated. When pile splices are required, the Contractor shall bevel the end of the pile for welding and use backup rings when making the weld.

- The method of “drive and drill” may be necessary to advance open-ended piles. When this method is used, casing will be required if the sides of the holes are unstable and begin to cave. If a water seal cannot be maintained at the designed elevation, the casing will have to be further advanced to ensure a proper seal.

- The Inspector must discuss with the Contract Administrator or Resident Engineer all special requirements such as cleaning out the pipe pile after driving, socketing the pile base, concreting and reinforcement.

- Tremie concrete may be employed to pour the pipe pile, if approved by the Contract Administrator or Resident Engineer.

- A mix design for tremie concrete must be approved by the Contract Administrator or Resident Engineer.

- Steel pipe piles extending above the ground or water surface are susceptible to corrosion and must be protected either by painting, galvanizing, or metallizing. Sandblasting is required to properly prepare the steel surface before field painting.

- Open steel pipe piles must be securely covered until they are filled with concrete or otherwise back filled.

3.7.5 Drilled Piles

Selection for the pile type to be incorporated into a structure is primarily dictated from economics and soil conditions. The full advantage of a drilled pile may be utilized in situations where the bed rock outcrop is close to the surface. Due to the high friction value of a drilled pile, it is advantageous in certain soil conditions to use a shorter drilled pile rather than driving a long steel H-pile.

- Ensure that the piles are installed as the correct locations.

- Ensure that the angle of the batter is correct. The batter angle may be checked measuring the angle of the “kelly-bar”.

- Ensure that the sides of the drilled hole have not collapsed and that free water is not in the bottom of the hole before concreting.

- Ensure that the hole is filled with concrete as soon as the hole is satisfactory drilled.

- Ensure that the hole is drilled to the correct elevation and record it for concrete quantity calculation.

Additional Information

1. Thorough documentation is essential.

2. Easy driving - soft soils or too heavy hammer, or both.
   - Reduce energy by reducing height of fall or adjusting the throttle.
   - Restrike 2-3 piles to assess set-up. In restriking document each blow.

3. Hard driving - hard soils or not enough energy of the hammer.
   A termination criterion depends on soil type, pile and hammer.

   - With *adequate* hammer the driving should be stopped when 300 mm is driven into the hard soils as follows:
     - Concrete Piles

a) 305 mm, 5-7 blows/25 mm
b) 355 mm, 6-8 blows/25 mm
c) 405 mm, 9-12 blows/25 mm

- Steel H-Piles -10-12 blows/25 mm

- Long and heavy piles are harder to drive.
- ***Stop driving when piles become damaged*** (spalling, brooming, etc.)

4. Easy driving after hard driving.

- Broken through hard layer into soft layer.
  - o Broken pile.
    - Timber - could be split, sheared or broomed.
    - Concrete – sheared
    - Steel - deformed or deflected

Note: ***If any of these problems exist, stop work immediately and consult the Resident Engineer.***

5. Reasonable variations in depth of refusal are normal because soils are never uniform. Large variations - *Trouble*, *call the Contract Administrator or Resident Engineer.*

6. Diesel hammers are hard to assess in real energy delivered. Manufacturer's specifications apply to new machines and ideal conditions. In practice ideal conditions never exist, and hammers, are subject to aging.

- For example, at Brandon Eastern Access Bridge, the Linkbelt 520 was rated to deliver only 25% of specified energy instead of customary 50-70%. Reasons:
  - Old equipment.
  - Poor cushion material and fitting.
  - Loose and/or poorly aligned leads or followers

Note: Watch for all these indications and try to correct the last two.

7. Consult the Contract Administrator or Resident Engineer when something differs from the Drawings and/or specifications.

3.8 CHECKLIST

3.8.1 Inspector's Responsibilities

- [ ] Read the specifications, contract documents and study the Drawings.
- [ ] Discuss the pile driving criteria with the Contract Administrator or Resident Engineer (see "Pile Driving Guidelines" at the end of Section 3).
- [ ] Confirm that driving equipment has been approved by the Contract Administrator or Resident Engineer.
- [ ] Ensure that the Contractor has proper equipment for unloading and has extra piles and extra splice plates. This is especially important in remote areas.
- [ ] Check pile layout and ground elevations prior to driving. Ensure that allowances are made for the batter piles and the ground elevation when verifying pile locations.
- [ ] Check Drawings to see if pre-boring is required or permitted.
- [ ] Confirm required blow count with the Contract Administrator or Resident Engineer.
- [ ] Carefully measure and record pile lengths for payment purposes and "As Constructed" Drawings.
- [ ] Check that pile tops are square before driving.
- [ ] If a pile follower is used, ensure the follower is vertical.
- [ ] Observe the driving operations from the beginning. After the first one or two piles have been driven, report the results of the driving to the Contract Administrator or Resident Engineer.
- [ ] A pile should be driven at each end of the substructure unit, if possible, to serve as "test" piles and confirm bore hole log information.
- [ ] Check the blows per minute of the diesel hammer and compare with the Manufacturer's specifications.
- [ ] During driving, record the blow count per inch for every meter of driving and the blow count per inch at refusal.
- [ ] Check that the pile has been driven to the required depth, or that it has the required capacity as measured by the blow counts.
- [ ] Check that pile has been driven to refusal and has not "set" because driving was stopped.
- [ ] Check the elevation at the top of the piles to see whether they are heaving and have them re-driven if necessary.
- [ ] Check pile splices for splice plates, back-up rings and proper welding.
- [ ] Ensure special precautions are taken when splicing piles in cold weather.
- [ ] Reject defective timber piles that have checks, knots or bowing.

- ❑ Ensure timber piles are properly handled and that all surface breaks and cut tops are treated.
- ❑ Ensure timber pile tops are banded before driving.
- ❑ Check cut-off elevation for pile tops.
- ❑ Check the pipe pile to ensure the pile is not split or buckled at any point and de-watered before concreting.
- ❑ Chain for distance between substructure units.
- ❑ Check quality of cushion before driving each pile.
- ❑ Check batter of pile prior to pile driving.
- ❑ Ensure hammer is hitting pile at 90 degrees square and leads are parallel to the pile.
- ❑ Ensure leads are stable (ie. Resting on a work platform).
- ❑ Check for spalling / cracking of piles during driving.
- ❑ Follower
  - (a) Ensure proper alignment.
  - (b) Ensure proper cushion.
  - (c) Follower to cap should be metal to metal. (ie. No cushion)
  - (d) To be supported for the full length of driving unless in the ground where supported.
- ❑ If driving through water in a cofferdam, leads should be long enough to sit on bottom of excavation, support a follower as described above, or drive longer piles from a working platform with the leads resting on this platform.
- ❑ Ensure template is strong enough to keep the piles from moving during driving operations.

3.8.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Discuss site soil conditions with the Inspector, anticipate possible problems and provide possible solutions for anticipated problems.
- ❑ Discuss with the Inspector all operating aspects and potential problems pertaining to hammer efficiency, acceptable pile penetration and/or pile driving refusal criteria.
- ❑ Discuss with the Inspector what action should be taken if the following conditions occur: a) "set" condition of the soil, and b) a negative friction force acting on the piles.
- ❑ Discuss with the geotechnical design engineer, the acceptable blow counts for the first one or two piles to determine the final acceptable pile penetration and/or the pile driving refusal criteria (i.e. blow count per inch).

SECTION 4 – CAST-IN-PLACE CONCRETE

4.1 GENERAL

Concrete is a combination of a paste, or binder, and mineral aggregate filler. The paste is a mixture of cement, water and air. The water is required to hydrate the cement and provide a lubricating effect that makes the resulting mix workable. Properly proportioned, handled and cured concrete will result in a strong and durable building material.

- The aggregates and mixing water are usually readily available resulting in a relatively economical construction material.
- Plants producing concrete are numerous and generally distributed throughout the populated part of the province.
- At bridge sites, outside the range of established concrete plants, temporary batching facilities can be set up to supply concrete.
- Durable concrete requires rigid quality control.

4.1.1 Aggregates and Water for Concrete

The Inspector should impress upon the Contractor the fact that sufficient lead time is required for approval of concrete mix designs. (See Specifications) If ready-mixed concrete is used then the name of the supplier should be obtained, aggregate samples taken and tested for quality assurance purposes. In the event that concrete is batched on site, then samples should be obtained at the site only, after a sufficient quantity of aggregates has been delivered. Then the samples are to be taken and tested for quality assurance purposes.(See Procedures for Sampling – Section 4.8). All aggregates should be identified on the sample shipment forms. The necessity of doing the above work at the early stages of a project cannot be over-emphasized.

Water samples should be obtained in all cases where the supply is not coming from a tested, potable source (i.e. not town water).

4.1.2 Ready-mixed Concrete

Under no circumstance is the Inspector to instruct anyone to add more water to concrete in a Ready-Mixed truck. In the event that a concrete load is too stiff, the Inspector shall advise the Contractor that the slump of the concrete is too low. If the Ready-Mixed truck operator decides to add water, this may be permitted providing that the drum is given at least 25 revolutions prior to discharging of the concrete and the load is not beyond the time allowed for in the specifications.

Under no circumstances is water to be added to a Ready-Mixed Truck partially through the discharge of the load. In the event that too much water was added and the slump becomes too high, the load shall be rejected.

4.2 ENVIRONMENTAL CONSTRAINTS

Be aware of the following environmental constraints:

- Do not pump or unload any concrete into the water channel.
- Do not throw debris or forming residue materials into the water channel.

- The concrete truck and pump should be cleaned in a suitable area away from the stream channel.

4.3 SAFETY

Refer to the Manitoba's Workplace Safety and Health Act and Regulations for specific safety requirements. In addition:

- Be aware that joints in the line of the concrete pump could burst open during difficult pumping causing a hazardous situation.
- A concrete pump is operating under high pressure and this pressure could vary causing the end of the hose to "whip" thus creating a potentially dangerous situation.
- Concrete pump should be cleaned away from the worksite.
- Be aware of the swing and uncontrolled movement of the concrete bucket when concrete is being placed using a crane and bucket.
- Be vigilant for unsecured lumber during formwork inspections.

4.4 INSPECTOR'S RECORD

On any structure project, concrete plays a very important part in construction. Many costly contract disputes involve the concrete item because concrete is a costly item to rectify if mistakes are made. Therefore, it is important for a Inspector to keep an accurate and detailed record of the following in order to minimize any potential extra claims.

- All survey information such as: location measurements, elevations and cambers, haunch heights, etc.
- Dates of concrete placement, and weather for each pour.
- All quality control and quality assurance test results.
- Location of each tested batch.
- Condition of facilities where cylinders are stored (i.e. maximum/minimum temperatures).
- Dates and core locations, if required.
- All aggregate sieve analysis results.

4.5 PROPERTY OF CONCRETE

Following are the principal properties of hardened concrete:

- It should attain the required design 28 day strength, be homogeneous, watertight and resistant to weather, wear and other destructive agents to which it may be exposed.
- The concrete may or may not contain one or more admixtures, that are used to modify the properties of the fresh or hardened concrete.

4.5.1 Air Content

The minute air voids trapped in concrete serve to enhance the workability and improve resistance to freeze and thaw. The quantity of air “trapped” in concrete can be controlled by the introduction of an air-entraining admixture. Consolidated concrete without any air-entraining added, usually contains less than 2% of air void by volume (i.e. entrapped air). This entrapped air content generally increases if the proportion of cement or other fines in the concrete mix are reduced.

- The entrained air voids in the concrete provides a more workable mixture and imparts added “body” and cohesiveness to the paste.
- Entrained air, produced by an air-entraining agent, is essential for a high degree of freeze/thaw resistance, which is desirable if the concrete is to be exposed to freezing temperatures.
- An excessive amount of air voids is detrimental to concrete as it reduces the strength and durability.
- Air-entrained concrete has the following benefits:
- Increases the workability and cohesiveness,
- Increases the resistance to freezing and thawing,
- Increases the resistance to sulfate attack, and
- Decreases segregation and “bleeding”.

4.5.2 Settlement and Bleeding

In undisturbed newly placed concrete, the solids will slowly settle through the cement paste, usually leaving a layer of water at the surface. This process, resulting in visible water, is known as “bleeding”. As a result of this settlement, the solids at the bottom become more closely packed and the upper part of the concrete becomes less compact than the lower part.

- Settlement or bleeding is greatly influenced by friction against the forms, temperature, and by the composition and consistency of the mix. Well-proportioned concrete mixes will experience minimal settlement and bleeding.

4.5.3 Composition of the Paste

Since the paste surrounds and separates the individual aggregate particles of good quality, the strength of the concrete is due almost entirely to the strength of the paste and the strength of the bond developed between the paste and aggregate.

- It is desirable that the paste be strong and dense, especially where the concrete has prolonged contact with corrosive agents (e.g. chlorides).
- The strength and density of the paste depend primarily on the original amount of water filled space surrounding the cement grains and on the extent the cement becomes hydrated.
- The permissible amount of water filled space is specified in terms of the water-cement ratio. Therefore, it is important that the amount of water added to concrete, with an allowance for moisture in the aggregates, not exceed the specified water-cement ratio.

4.5.4 Hardening Process

As the cement paste sets and hardens, the principal reaction product is a gel, formed from water and the dissolved constituents of the cement grains. However, if the paste is kept moist, this process continues until the supply of cement is exhausted or until all the space in the paste becomes filled with hydration products. In commonly used concrete mixes, the supply of cement is the limiting factor.

- If the paste is not kept moist, hydration of the cement may cease when the evaporable water escapes from the paste; hence the importance of “moist” or “wet” curing.
- The time required for complete hydration of cement varies with the richness of the mix, the type and quantity of cement, the ambient temperature, and the accessibility of an external water supply.
- Under field conditions, the concrete usually becomes partially dry within a few days.
- The hydration of cement may continue for many years.
- The gain in strength is generally due to an increase in the degree of cement hydration. Premature drying is detrimental to the development of strength.
- Increasing the ambient temperature increases the rate of hydration. However, very high temperatures will lower the ultimate strength of the concrete. Therefore, temperature control is critical for the first seven days.

4.5.5 Curing

The period of curing specified is intended to assure attainment of the specified strength and to minimize formation of shrinkage cracks due to loss of water. Cement in slabs in contact with dry earth and in beams and columns may effectively cease hydration soon after termination of controlled curing.

- To assure hydration at the maximum possible rate, the cement paste should be kept saturated. Water must be supplied not only to compensate for evaporation from surface but also to replenish the water removed from the pores by the chemical process.
- Moist curing or wet curing involves covering the concrete surface with wet filter fabric after the concrete surface is sufficiently hard. The filter fabric is kept in a moist condition for the duration of the specified curing period.
- When placing concrete in cold weather, special curing procedures such as hoarding and heating are necessary.

4.5.6 Durability

The ability of concrete to resist the disintegrating action of freezing and thawing increases if the concrete has 4 to 6% of air entrainment introduced into the concrete mix using an air-entraining agent. The entrained air disperses throughout the concrete in the form of minute disconnected bubbles. It provides spaces where forces that would cause disintegration can be dissipated.

- A controlled quantity of air entrainment in concrete will increase the concrete durability.
- Low water-cement ratios increase concrete durability.
- Proper vibration will increase concrete durability. An excessive amount of vibration will cause segregation, thus reducing concrete durability.
- An air content in excess of 8% will reduce concrete durability and strength.

4.5.7 Shrinkage and Swelling

When concrete is kept continuously damp, the volume of the concrete remains relatively constant. However, if concrete is not kept continuously damp, it is subject to water loss and shrinkage.

- The average concrete will shrink approximately 0.06% from a saturated to a dry state.
- The more porous the hardened paste, the greater its shrinkage.
- Higher cement content will cause greater shrinkage.
- Higher water content will also cause greater shrinkage.
- Unequal drying will cause shrinkage cracks.
- Unequal drying will cause thin slabs to warp or curl.

4.5.8 Workability

Workability is the ease with which the concrete can be handled, transported and placed with minimum loss of homogeneity. Good workability is required for proper placement and consolidation of concrete into the forms and around the reinforcing.

- A concrete mixture should be sufficiently workable for proper handling and placement, but still as “dry” as possible to obtain maximum strength and durability.
- Fluidity of the concrete mix is an important component of workability and can be measured with the slump test. For a given concrete mix design, variation in slump is a good indicator of changes in the water/cement ratio.

4.5.9 Creep

When concrete is subjected to a sustained load, the deformation produced by the load may be divided into two parts: elastic deformation, which occurs immediately, and creep, which develops gradually. In most concrete structures, dead loads, which act continuously, constitute a large part of the total load; thus, both immediate strain and gradual yielding contribute to the total final deformation.

- In prestressed beams and girders, the prestressing forces transmitted from the prestressing strand to the concrete will induce a net upward loading resulting in upward creep deflections (i.e. measured as “camber”).
- Under sustained load, the creep of concrete continues in the direction of loading for an indefinite time but at a steadily diminishing rate.
- Creep increases with increasing water-cement ratio and is approximately proportional to load intensity. Factors that increase the strength of the concrete will reduce creep.
- Creep is also reduced with increasing age of concrete at the time of loading. Therefore, it is important to maintain a minimum length of time before stripping and removing falsework regardless of the strength gain of the concrete.

4.6 INSPECTION OF CONCRETE

Concrete is one of the most important components in a structure. The service life of a structure depends largely on the concrete quality.

- The Inspector must be especially thorough and diligent in fulfilling his responsibilities in inspecting all aspects relating to this phase of the work.

- It is imperative for the Inspector to ensure that all quality assurance tests are properly performed.

4.6.1 Formwork

Most plastic concrete will be contained and formed into the desired shape by formwork. Exceptions to this are for some footings where concrete can be cast into neatly trimmed excavations. Formwork may be built from a number of materials including steel, aluminum and fibreglass, however the most common formwork material is plywood sheathing supported by a system of wood studs, walers, joists, stringers, posts, etc.

- The Contractor is responsible for the design, construction and performance of the formwork, containing and shaping the concrete, and the falsework supporting the weight of the concrete along with temporary construction loads.

- The contract documents require the Contractor to submit formwork and falsework drawings designed and sealed by a Registered Professional Engineer. The formwork and falsework drawings must be reviewed by the Resident Engineer prior to the start of any concreting.

- The Inspector must check the dimensions of the spaces being formed to ensure that the resulting concrete will be of the required size and shape.

- The formwork must be rigid enough to prevent bulges and be adequately braced either internally with form ties or externally.

- All construction debris such as sawdust, bits of wood and wire etc., shall be cleaned out, possibly by blowing with an air compressor through a cleanout hole or by other means.

- The condition of the formwork is vital to the appearance of the finished concrete.

- Plywood panels must be properly aligned to eliminate visible joints. The joints between panels must be mortar tight and the form surface should be smooth, free from splinters, gouges and damaged edges. Forms being re-used must be cleaned of all concrete mortar.

- Fillets and chamfers are required at exposed corners and must be neatly done. These fillets and chamfers prevent damage to the concrete surface. Blockouts, where required, must be accurately located and neatly built.

- The form surface should have a parting agent (i.e. form oil) applied to facilitate form removal.

- The Inspector must ensure that the Contractor has accommodated any required camber in the forms, and that his screed procedure for the top surface will also reflect this camber.

- In setting cambers, allowance for settlement of the forms must be made. Adjusting mechanisms must be installed in the forming system to allow for adjustments if required.

4.6.2 Reinforcement

Concrete is strong in compression but weak in tension. Reinforcement is used to provide the tensile capacity.

- Reinforcement must be cleaned of all mud, oil, concrete, mortar and other substances, which tend to reduce or prevent the necessary bond between concrete and reinforcement. Mud and loose concrete can be removed by wire brushing, while oils can be removed using solvents or high-pressure washing.

- When the Contractor applies form release agent or cleans forms with compressed air, he must ensure that no oil gets on the reinforcement.

4.6.3 Quality Control / Quality Assurance

Concrete plays a major role in any structure, and it is imperative to ensure that rigid quality control and quality assurance is carried out at the site.

- The responsibility for quality control of the concrete produced for the project lies with the Contractor, as it is the Contractor who “controls” the means of achieving the required quality.
- The Resident Engineer and/or Inspector are responsible for quality assurance.
- Concrete quality control and quality assurance tests are empirical and rely on strict conformance to procedure in order to produce reliable and consistent results.
- During cold weather, the Contractor must provide a thermostatically controlled storage facility on site for concrete test cylinders.
- Test cylinder records must be completed in full detail on the appropriate forms.
- The concrete sample must be collected by intercepting the entire discharge stream to ensure that the sample is representative.
- Concrete cylinders must be properly marked and a sketch is required to show where the sample batch is deposited.

4.6.4 Rejection

If concrete being supplied to the project fails to meet the specified requirements it should be rejected by the Contractor. If the Contractor does not reject the load, the Inspector or Resident Engineer should put the Contractor on notice that the concrete element may be rejected once the test results are known. The Inspector must be confident to what aspect of the concrete does not meet the specifications. If a batch appears questionable, the Contractor should stop placing the load until slump and air tests are completed to determine whether or not the concrete is acceptable.

- Low slump may be increased by the addition of water, provided the design water/cement ratio is not exceeded. A superplasticizer (high range water reducer) may be added, if approved by the Contract Administrator or Resident Engineer.
- Low air content may be corrected by adding air entrainment at the site.
- If the 7-day strength results indicate the possibility of low strength at 28 days, the Contractor should be notified immediately as he has certain recourse under the Contract.
- Coring is not permitted until approval is obtained from the Contract Administrator or Resident Engineer. When approved cores must be handled, cured and tested in accordance with CSA Standards A23.2-14C, “Obtaining and Testing Drilled Cores for Compressive Strength Testing”, by a certified independent testing laboratory.

4.6.5 Mixing and Handling

All concrete shall be mixed thoroughly until it is uniform in appearance, with all ingredients uniformly distributed.

- The mixer must not be loaded above its rated capacity, and the mixer must be maintained in good working condition. The inner surface of the mixer must be kept free of hardened concrete and mortar and all bent or worn down fins must be replaced.
- The mixer must not be operated at a speed above that recommended by the Manufacturer.
- Diluted air entraining agents or admixtures should be introduced into the mixer after the initial water is in the mixer drum.

4.6.6 Placing

The Inspector should discuss with the Contractor, the proposed methods of handling, placing and consolidating the concrete. The Inspector shall check that the forms are rigid, clean, the reinforcement is adequately tied into its proper locations, and inserts are properly located.

- The concrete may be placed by discharging directly from the truck into the forms, conveyors or chutes, crane and bucket or by pumping.
- The concrete must not be allowed to segregate, or cause displacement of the reinforcement.
- If concrete is to be dropped more than 2 meters, it should be deposited through an approved chute, elephant trunk or by a concrete pump. The end of the discharge pipe should be buried in the newly placed concrete.
- The method of placing must not be allowed to impart vibrations to any previously placed concrete, which has set but is less than 48 hours old.
- Concrete should be placed in such a way so that an entire element is completed, or in large elements, placing will occur from one pre-planned construction joint to another.
- These construction joints must be located only where shown on the Drawings, or in the pouring schedule, unless approved otherwise by the Contract Administrator or Resident Engineer.
- If the concrete placing must be stopped, the unfinished face of the concrete is to be prepared or treated according to standard construction joint details.
- Once placed in the forms, the concrete must be thoroughly compacted, usually by internal vibrators. Concrete vibrators must be held vertical while vibrating concrete.
- All laitance, mud, oil and sawdust etc. must be thoroughly removed and the hardened substrate concrete surface must be thoroughly wet using a cement slurry prior to casting the new concrete.

4.6.7 Finishing Plastic Concrete

Finishing the unformed surfaces of concrete elements vary from simple to difficult.

Leveling a narrow exposed width of concrete at the top of a wall is simple. Achieving smooth, dense, durable and uniform surface of a finished slab or deck, which will be driven on for many years, is major and critical effort expended.

- Finishing effort should be **the minimum required** to achieve the specified surface, since overworking tends to draw fines to the surface and can result in later scaling or dusting of the surface.

- Finishing should begin immediately after placing and before any bleed water appears on the surface.

- Concrete finishing is accomplished by screeding the surface of the concrete to the required elevation.

- Screeding often produces open voids on the surface. These voids must be closed with a hand float or with a “bull float” constructed of wood or magnesium.

- Finishing with a steel trowel is generally not permitted since it results in a closed shiny surface, which can prevent the escape of bleed water.

- Overworking the concrete during finishing operations leads to water and fines at the surface and often results in hairline cracking of the surface.

- Cracking can also be caused by untimely finishing and by excessive drying or cooling.

- No concrete finishing operation shall be performed while there is excess moisture or bleed water on the surface.

4.6.8 Shrinkage Cracks

Plastic shrinkage cracking sometimes occurs in slabs and decks, especially on warm, dry, windy days. This is cracking of the surface of the concrete after placing and while it is still in a plastic condition.

- The cracks are usually discontinuous, roughly parallel to each other, up to 3 mm wide and 50 to 100 mm deep.

- At initial stages of finishing, the concrete may be reworked to close the cracks, but prevention is a better solution.

- A rapid drop in the temperature of the concrete surface may result in thermal cracking.

- The complete surface must be protected against cold air, and the temperature of the curing water should be within 10°C of the concrete surface.

- The following precautions by the Contractor help to minimize plastic shrinkage:
  - Dampening the subgrade and formwork (no free standing water).
  - Supplying concrete within the allowable slump range.
  - Erecting hoarding, windbreaks or sunshades to reduce evaporation rates. Alternatively, do the work during evening or night.
  - Reducing time between placing and start of curing by improved placing and finishing procedures.
  - If a delay between placing and finishing is unavoidable, placing white polyethylene sheets over the unfinished concrete to help keep it cool and moist.
  - Lowering the temperature of the concrete mix using cold water or ice.
  - Utilize a fog mist upwind of the concrete to humidify the air passing over the finished concrete. Do not allow this procedure to cause free water on the surface while still finishing.

4.6.9 Curing and Removal of Forms

Inspection does not end with the actual casting of concrete.

- Concrete should be protected from damage.
- Observation of the finished parts of the work should be continued throughout the construction period.

Curing concrete means keeping it moist and, if necessary, warm so that hydration of the cement can continue.

- Proper curing significantly improves the surface condition and the quality of concrete.
- The more moisture retained within the concrete, the more the curing effectiveness.
- Bridge decks, must be moist cured for a minimum of 7 days*.*
- Other exposed concrete surfaces may be cured with 2 coats of a curing compound. Where premature drying is expected or experienced, moist curing is to be used on these elements as well.
- A sealing or curing compound will retard evaporation of the mixing water.
- The surface to be sealed should still be moist when the coating is applied.
- If bleeding occurs under the film, it may split open in many directions and require resealing as soon as the excess water disappears.
- The preferred method of curing is by use of continuous sprays, ponded water, or continuously saturated coverings of filter fabric*.*
- Water should be applied on unformed surfaces soon after concrete is placed but only when the water will not wash out the cement or damage the finish.
- Wood forms, kept wet, will provide some protection against the loss of moisture.

4.6.9.1 Removal of Forms

Concrete supports should be allowed to remain undisturbed until the concrete can safely bear its own weight plus any construction live loads. Supports and forms should only be removed in conformance with the specifications*.*

- At normal temperatures, vertical forms can be removed 24 hours after concrete is cast.
- Forms directly supporting the weight of the concrete must be left in place until the concrete reaches 80% of the 28 day design strength. This is dependent on such factors as the type and size of the member, the hardening characteristics of the concrete, the concrete mix design, the temperature and the expected loads.
- Supports should be removed in such a manner as to permit the concrete to take its share of the load gradually and uniformly.
- Early removal of vertical forms is desirable to complete surface repairs and to apply surface treatments that bond better to the “green” concrete. Curing of the surface is also easier.

- In warm, dry weather, it is preferable to remove vertical formwork and establish the specified curing procedure at the earliest possible time after the concrete has been placed.

- While forms remain in place, exposed portions of the concrete should be kept wet.

- Concrete test results from field-cured specimens will provide an indication as to when forms may be removed.

- Horizontal spanning elements such as beams and slabs should remain supported for as long as practicable in order to increase the maturity of the concrete at the time of loading. Increased maturity has one of the larger effects in reducing creep deflections.

- In cold weather, vertical forms should not be removed while the concrete is still warm, since rapid cooling of the surface may cause checking and thermal cracks.

4.6.9.2 Finishing Hardened Concrete

The type of finish required for hardened concrete depends upon the exposure of the surface in the completed structure and will be clearly detailed on the Drawings and in the specifications. Finishing includes removal of projections, minor surface repairs, and treatment to both improve tightness of the surface and result in a uniform pleasing appearance.

- All fins and irregular projections are to be removed by chipping or grinding. “Honeycomb” areas should be inspected with the Contract Administrator or Resident Engineer to determine whether the structural capacity has been impaired. Minor honeycomb areas may be chipped down to sound concrete and patched. Major honeycomb areas shall be repaired in accordance with the instructions of the Contract Administrator or Resident Engineer.

- Finishing should be done at an early stage of concrete maturity to assure bonding of applied materials to the concrete. The concrete surface at locations requiring repairs must be thoroughly wetted before and after treatment to ensure sufficient moisture for complete curing.

4.7 SPECIAL CONSIDERATIONS

The foregoing dealt with situations, which will likely be encountered on every project. The following are situations, which may arise only occasionally but are situations sufficiently common that the Inspector should be prepared for them.

4.7.1 Depositing Underwater Concrete (Tremie)

Depositing concrete under water, called tremie concrete, is sometimes beneficial during construction of footings in rivers where it has not been possible to de-water the footing excavations. Approval by the Contract Administrator or Resident Engineer must be obtained and the proposed procedures should be thoroughly discussed with the Contractor. Tremie concrete requires a special concrete mix design.

- Tremie concrete is deposited through a pipe into a compact mass of concrete. The upper end of the tremie pipe terminates in a hopper into which the concrete is discharged. The lower end is equipped with a closing device or seal such as a ball bladder that will prevent the entry of water into the tremie pipe at the start of this work.

- Tremie concrete may be placed using a concrete pump, but special precautions should be taken to ensure that the discharge end is constantly embedded in the freshly placed concrete and the discharge pipe is filled with concrete **at all times**. At no time should the line be allowed to empty because this will force air into the concrete mass and damage the concrete.

- **It is essential** to keep the lower end of the tremie discharge below the surface of the freshly placed concrete to ensure that a seal is maintained.

- Tremie concrete is **not** vibrated.

- The top surface of tremie concrete is rough with laitance, and must be thoroughly cleaned and chipped down to sound concrete.

4.7.2 Cold Weather Concrete

Construction of structures during winter months is common. Special precautions are required when concreting in cold weather to prevent damage to the “green” concrete.

- Heating methods must be discussed with the Contract Administrator or Resident Engineer and the Contractor.

- Both aggregate and water will have to be heated to produce sufficiently warm concrete.

- Heated aggregate will affect air content and slump, and requires diligent quality control.

- Forms and reinforcing shall be heated and hoarded and remain at a temperature of 20°C for 12 hours prior to concrete placement.

- The forms and reinforcing must be carefully inspected to ensure that they are free of snow and ice.

- If concrete is being placed on grade, the grade must be at a temperature of 5°C or greater.

- Hoarding must be constructed to enable warm air circulation completely around the element.

- Heaters must not be allowed to discharge warm air directly on any concrete, and intense local heating is prohibited.

- Moist cure is required whenever concrete is subjected to artificial heat.

- Concrete which has been cured using artificial heat for a period of no less than 7 days should be brought to ambient temperatures at a rate not exceeding 5°C per day for concrete up to 300 mm thick, and 4°C per day for thicker concrete.

4.7.3 Hot Weather Concrete

Problems encountered during hot weather may include premature setting, rapid drying and insufficient moisture for curing.

- The temperature of the concrete mix should be kept at the low end of the allowable range using cold mixing water or ice.

- Placing procedures should be “streamlined” so that finishing can be accomplished quickly and efficiently.
- Concrete pours should not be allowed to commence on a hot and windy day.

- Moist curing should be started as soon as the concrete surface hardens.

4.7.4 Shear Keys on Precast Concrete Girders

Shear keys on precast girders are very small in section, requiring a small volume of concrete. However, shear keys are an important integral part of the bridge deck and must be cast and cured with as much care and attention as deck concrete.

- The keyways should be thoroughly cleaned and wetted before concreting.
- A bonding agent should be applied immediately in advance of fresh concrete, and the fresh concrete should be carefully placed and consolidated.
- All keyways shall be moist cured.
- Concrete for shear keys should be batched in smaller loads.
- Sufficient concrete finishers must be available to ensure that proper concrete finishing keeps up with the concrete placement.

4.8 PROCEDURES FOR STANDARD TESTS

4.8.1 Sampling from Ready-Mixed Plant

When sampling aggregates at a Ready-Mixed Plant, the Inspector should not sample from stockpiles if at all possible, but should attempt to sample directly from a conveyer belt or the discharge opening of bins. If these are inaccessible then the Inspector should request that ¼ yard of each material be dropped into a dump truck. Each aggregate should be re-mixed and a sample taken. Not less than 75 pounds of stone and 50 pounds of sand are needed to run the required tests. The Inspector should note whether more than one size of stone or sand is being used and should sample accordingly.

4.8.2 Procedure for Concrete Testing

I. Procedure for Concrete Testing

Preparation for Field Tests of Concrete

Certain preparation must be made beforehand so that all facilities and equipment are in readiness for any tests that are to be undertaken. The Contractor's obligations with regards to aiding the Inspector are generally outlined in the Specifications. The following gives an outline which should be followed before a concrete pour is started to avoid unnecessary rush and confusion.

a) Have the Contractor prepare a level and stable surface (plywood platform) on which the tests and taking of cylinders will be done. During cold weather, the Contractor should erect some type of shelter around the platform not only for comforts sake but to avoid freezing of concrete and equipment. If the shelter is heated with propane, any tanks must be kept outside, because of Labour Board Regulations.

b) The Contractor must supply a wheelbarrow in which the concrete sample is taken and a shovel to mix the concrete. A small coal shovel is about the best tool for filling the cylinder molds and slump cone. Have a pail of water handy for the washing of equipment after the tests are taken.

II. Slump Test

After being discharged from the mixer or ready-mixed truck, into a wheelbarrow or clean pail, the sample obtained shall be transferred to the place of molding of the specimen, and to counteract segregation the concrete shall be mixed with a shovel until it is uniform in appearance.

III. Air Meter Operating Instructions

1. Place concrete to be tested in container in three equal layers rodding each layer 25 times. Rodding is similar to that during slump test and during taking of test cylinders. After each layer tap the container 10 to 15 times with a rubber mallet to allow any excess trapped air to escape. After final layer has been rodded, remove excess concrete by sliding a straight edge across the top flange using a sawing motion until the container is level full.

2. Wipe lid of container clean of all sand and mortar.

3. Close the air valve situated on the air pump and open both petcocks on top of lid.

4. Place lid on material container and close the four toggle clamps.

5. Pour water using the syringe provided into one of the petcocks until water appears out of the other. Alternate this procedure from one petcock to the other until no air bubbles appear. Close off both petcocks.

6. Open air pump and gently pump air into receiver until the gauge hand goes slightly past the initial pressure mark. Each air meter is calibrated so that the initial pressure mark is known for each individual meter. If the initial pressure mark is not known, the Inspector must calibrate the air meter before any tests are undertaken.

7. After waiting a few seconds for the air to cool, with one hand gently tap the gauge and with the other open the bleeder valve slightly until the needle is on the initial pressure mark. The bleeder valve is then closed.

8. Depress the air valve, rapidly. After the gauge needle has stabilized the percent of air entrained in the concrete is read directly on the dial. The information is recorded.

9. Open all valves and remove lid and clean air meter thoroughly.

NOTES:

i) To assure trouble free operation, keep meter clean and dry after each test. Meter may be cleaned effectively by flushing with a stream of water or by washing in water with a brush. DO NOT SUBMERGE THE GAUGE.

ii) Remove sand and grit from underside of material container lip and toggle clamps before assembling to avoid damage to lip and clamps.

iii) When meter is not in use leave the valves and petcocks open. DO NOT STORE WITH LID CLAMPED TO MATERIAL CONTAINER.

iv) The air meter should be taken to the testing lab for general servicing and recalibration after it is no longer required on a project. Although laboratory calibration is mandatory, the Inspector can obtain a reasonable indication of the accuracy of the instrument by filling the air meter with water in the manner described by steps 3 to 8 under Air Meter Operating Instructions. When the valve is depressed the gauge needle should stabilize at the zero (0) mark on the dial.

IV. Test Cylinders

Unless otherwise instructed by the Contract Administrator or Resident Engineer, one set of cylinders shall be taken for every fifteen (15) cubic meters of concrete with a minimum of one set per pour.

A set of cylinders shall consist of:

(a) In cold weather conditions, a minimum of 5 cylinders, one as job cured, one for seven day break, one for fourteen day break, and two for twenty-eight day break. The job cured cylinder is to be broken at the conclusion of heating operations or as instructed by the Contract Administrator or Resident Engineer.

(b) In summer, a minimum of 4 cylinders, one for seven day break, one for fourteen day break, and two for twenty-eight day break.

The cylinders shall be taken or shipped to a Certified Testing Laboratory accompanied by the Concrete Cylinder Field Report. If shipping from out of town they should be properly boxed. All cylinders should be identified by means of a marking pen.

The cylinders must be protected from freezing as well as excessive heat. In winter, the job cured cylinders must be placed in the hoarding immediately after casting in an area where they are not subject to direct heat or damage from the Contractor's operations. The remaining cylinders must be taken into the field office and positioned off the floor and away from the wall. Proper arrangements must be made for protection from direct sunlight or high temperatures.

The number, handling and curing of concrete cylinders is explained elsewhere. The method for taking the cylinders is identical to the method for obtaining the slump. That is, three layers rodding and leveling. It is important to obtain a smooth level surface on the cylinders to facilitate proper capping and testing in the Lab.

4.9 CHECKLIST

4.9.1 Inspector's Responsibilities

- ❑ Understand the Specifications, contract documents and Drawings.
- ❑ Check aggregate gradations and mix designs are approved by the Contract Administrator or Resident Engineer.
- ❑ Inspect batching plant and mixer trucks and provisions for quality control.
- ❑ In advance of concrete placement, check forms for:
  - Dimensions
  - Location and alignment
  - Provision for settlement
  - Stability
  - Tightness of ties and form joints
  - Surface preparation and form oil
  - Fillets, chamfers and blockouts
  - Cleanout holes and cleanliness
  - Cambers, etc.
- ❑ Check reinforcing.
- ❑ Check anchor bolts and inserts.
- ❑ Check cleaning and wetting of concrete contact surfaces.
- ❑ Check concrete placing to ensure no segregation occurs.
- ❑ Check that vibration of concrete is thorough and uniform.
- ❑ Check location and preparation of construction joints.
- ❑ Ensure concrete cylinder storage box is adequate and in proper working order.
- ❑ Check finishing to ensure concrete surface is not overworked.
- ❑ Check curing to ensure that exposed surfaces are continuously moist.
- ❑ Ensure concrete is protected from any possible damage.
- ❑ Check formwork removal meets criteria as stated in specifications.
- ❑ Check finishing of formed surfaces for:
  - Removal of fins
  - Repair of defects (such as "honeycomb")
  - No surface drying
  - Surface finish requirements
- ❑ Check depositing concrete under water for:
  - Approval by the Contract Administrator or Resident Engineer
  - Lower end of tremie pipe or pump hose to be kept below fresh concrete surface.

- ❑ Check cold weather concreting for:
    - Forms and rebar free of ice and snow
    - Concrete placed on grade that is above 5°C
    - Heated mixing water and aggregate
    - Record temperature of each batch placed
    - Heating and hoarding
    - Protection from drying (i.e. wet curing)
    - Protection from too rapid cooling

- ❑ Check hot weather concreting for:
    - Concrete temperature (record temperature of each batch placed)
    - Protection from drying
    - Moist curing

- ❑ Check shear keys on precast concrete girders for:
    - Keyways cleaned and wetted
    - Bonding agent applied
    - Placing and consolidating concrete
    - Surface properly finished
    - Moist curing

- ❑ Calculate quantities for payment.

- ❑ Check that sandblasting if required results in a uniform surface.

- ❑ Check that grit and dust from sandblasting is cleaned up and moving parts of bearings and expansion assemblies are free from grit.

4.9.2 Contract Administrator / Resident Engineer's Responsibilities

The following items must be discussed with the Contractor and the Inspector:

- ❑ The pour procedure and schedule.

- ❑ Anticipated problems and possible solutions.

- ❑ The formwork design.

- ❑ The concrete mix design.

- ❑ The quality control and quality assurance procedures and the facilities provided by Contractor.

- ❑ Reduced payment or rejection of substandard concrete where applicable.

- ❑ Final pay quantities

GENERAL

- ☐ If working inside a hoarding, ensure all patching is completed prior to shutting the heat off and has sufficient time to gain strength.

- ☐ Discuss restrictions with Contract Administrator or Resident Engineer on pile driving and pouring concrete on site at the same time.

- ☐ **Do Not** add water to a concrete truck once the load has started to unload (always at the beginning - never into the load.)

- ☐ Ensure concrete truck spins 70 - 100 revolutions after water has been added (see CSA A23.1 "Production of Concrete" 18.3.4.3.)

CONCRETE POUR

Prior to Pour

- ❑ Confirm correct location (ex. Centerline of roadway, centerline of substructure unit, inside face of abutment backwall, etc.)
- ❑ Confirm proper dimensions – length, width and height
- ❑ Safe access and fall protection – walkways, platforms with railings and ladders
- ❑ Formwork
  - Good condition
  - Tight
  - Formwork liner installed on exposed, vertical faces is tight and extends beyond bottom of form
  - Confirm cantilevered formwork will not deflect under weight of concrete
  - Confirm height of chamfer strips
  - Construction joint formwork is in correct location and done correctly
  - Clean immediately prior to pour
  - Piers and high walls – forms are plumb
- ❑ Reinforcement
  - Grade
  - Diameter
  - Location (i.e. proper spacing)
  - Cover
  - Proper chairing and tieing
  - Clean
- ❑ Embedments (ex. Anchor bolts for bearings, plagues, benchmark plugs, etc.)
  - Correct location
  - Properly anchored
  - Correct elevation
  - Does not interfere with reinforcement
- ❑ Electrical ducts and junction boxes
  - Correct location
  - Cover
  - Sufficient clearance with reinforcement to allow cement paste around reinforcement
  - Joint in ducts at expansion joint locations allows for horizontal and some vertical movement
  - Sealed tight so concrete cannot enter
  - Fish wire is installed

- ❑ Piers - ice breakers installed properly in correct location
- ❑ If casting against "old" concrete, confirm if galvanic anodes are required and installed properly
- ❑ Confirm necessary surface preparation of construction joints is completed prior to subsequent pour
- ❑ Hoarding
  - Good condition
  - Watertight
  - If temperatures are going to fall below -15 C, confirm with contractor that hatches can be opened during the pour
- ❑ Heating (if applicable)
  - Heaters are vented to the outside
  - Fans may be installed to circulate the air inside the hoarding
  - Max/min thermometers are installed strategically within hoarding
  - Hoarding can be maintained at temperatures between 10 C and 20 C for a minimum of 24 hours before the pour
  - Substrate temperature is above 5 C
- ❑ Preparation 1 Day Prior to Pour
  - Water for saturating substrate is at same temperature as concrete to be delivered
  - Extra vibrators on site
  - Substrate is clean
  - Thermacouples are installed for monitoring internal concrete temperatures
  - Grout slurry materials and application are confirmed with contractor (if applicable)
  - Confirm optimal slump for placement with contractor
  - Confirm pigmented curing compound is on site

<u>During Concrete Pour</u>

- ❑ Concrete
  - Temperature
  - Air
  - Slump
  - Cylinders
    - o confirm number of sets to be taken
    - o confirm if field (job) cylinders are to be taken
  - Confirm results between back of truck and end of pump are consistent during pours
- ❑ At Pour Location
  - Concrete is placed transversely across the component as much as possible
  - Properly vibrated

- Concrete is not being dropped a long distance and segregating
- Surface finishing is appropriate
- Forms are stable under the weight of the freshly placed concrete
- Culverts
  - If casting walls and top slab in the same pour, reinforcement and top slab formwork are cleaned before the top slab pour begins
  - If casting walls and top slab in the same pour, allow min. 2 hours between wall and top slab for initial set and settlement of wall concrete

After Concrete Pour

- ❑ Curing compound is placed on the surface
- ❑ Vents for heating are not aimed directly at the freshly placed concrete surface
- ❑ Monitor the thermocouples to document the internal temperatures for at least 4 days following the pour
- ❑ Monitor the max./min. temperatures within the winter hoarding (if applicable) and reduction in temperature is following specification
- ❑ Supporting falsework is not to be removed until cylinder breaks confirm the strength of the concrete
- ❑ Heavy loads are not to be placed on component until cylinder breaks confirm the strength of the concrete
- ❑ Do not allow removal of a winter hoarding until cylinder breaks confirm the strength of the concrete from the last pour and all patching of snap tie holes has cured
- ❑ Preparation of joints

EXPANSION JOINT POUR CHECKLIST

In order to ensure sound concrete at the expansion joints, the following are items to be checked and maintained during concrete placement. The Inspector should:

- ❑ Review the Drawings and concrete pour checklist to ensure the expansion joint is placed properly.

- ❑ Ensure that the epoxy adhesive has been applied to all surfaces of the expansion dam metal that come into contact with the concrete. Check the pot life of the epoxy. The epoxy must be applied to the metal surfaces sufficiently far in advance of concrete placement to allow the epoxy to develop a "tacky" surface, but <u>not</u> so far ahead of the concrete that the epoxy starts to harden.

- ❑ The slump of the concrete placed in this area is not to exceed 50 mm (2"), and the air content shall not exceed 4% ± 1%.

- ❑ Ensure the Contractor pays special attention to the vibrating of the concrete in order to remove any entrapped air under the horizontal leg of the expansion dam.

- ❑ During placement of the concrete, in addition to the normal concrete vibration, the Contractor shall remove any remaining air pockets from under the horizontal leg of the expansion dam. This shall be accomplished by tamping the top surface with a rubber mallet (not a carpenter's hammer) at regular intervals (not exceeding 100 mm o/c). A carpenter's hammer may damage the galvanizing on the expansion dam.

- ❑ The Contractor is to place the concrete full height from one side of the bridge to the other, and maintain a 45° angle on the leading edge of the concrete. This method will allow the Inspector to visually inspect the concrete as it is being placed under the horizontal leg of the expansion dam.

The final elevation of the concrete placed at the expansion dams should be 6 mm (1/4'') higher than the final elevation of the structural steel expansion dam.

SECTION 5 – CONCRETE REINFORCEMENT

5.1 GENERAL

Concrete is a material, which is relatively strong in compressive strength but is weak in tension. Reinforcing is used to provide the tensile capacity required in the tensile action.

- The required reinforcing is detailed on the Drawings.
- It is essential that the reinforcing be thoroughly checked and approved by the Inspector before the Contractor is allowed to begin placing concrete. Once the concrete has been cast around the reinforcing, it will be virtually impossible to check or confirm that the correct size and number of bars have been placed in the required locations.
- The Contractor must handle and store the reinforcing in a manner, which does not damage it and keeps it clean and accessible. Reinforcing anticipated to be stored at the site for lengthy periods must be protected from the elements.
- Reinforcing must be clean to ensure a good bond. All loose rust, mill scale, paint, oil, grease, mud and weak dried mortar must be removed.
- Reinforcing steel should be checked promptly when requested by the Contractor. No concrete placement will be allowed while reinforcing is still being placed.

5.2 PLACEMENT AND SUPPORT

Reinforcing must be installed accurately in the position shown on the Drawings and securely held in place until the concrete has been placed around it. The means of securing the reinforcing must withstand all forces caused by placement of the concrete and being walked on by workers.

- Bars are required to be tied at all intersections, except if the spacing is less than 250 mm in each direction, then it needs to be tied at alternate intersections only.
- The Contractor must take all measures necessary to ensure that the required clearances are obtained and maintained during placing of the concrete.
- Spacers used to maintain clearance are to be precast concrete, plastic or galvanized steel chairs whose shape and dimension have been approved by the Contract Administrator or Resident Engineer.
- Inspection must be done thoroughly and diligently and the checking process should commence as soon as the Contractor starts placing the reinforcing. Check quantities, sizes, spacing and clearance to the forms and to the top of the unformed surface as detailed.
- Unless the Drawings indicate otherwise, the minimum clear distance between parallel bars is 40 mm. This allows concrete to flow around the bars during placement.

5.3 SPLICING

Where possible, splices are to be staggered to avoid congestion and to distribute stresses over a larger zone.

- Where bars are to be lapped, unless shown otherwise on the Drawings, the lap is to be at least 35 bar diameters for horizontal bars at the bottom of slabs, beams and girders, and bars in walls, columns and haunches.

- When bars are lapped they are to be wired together in contact and oriented such that the minimum clearance of 40 mm to other bars is maintained.

5.4 CHECKLIST

5.4.1 Inspector's Responsibilities

- ❑ Read specifications, contract documents and study Drawings.
- ❑ Check delivered reinforcement for correct bar sizes, quantity and grade.
- ❑ Check that all bar surfaces are free from objectionable material.
- ❑ Check that reinforcement has been accurately placed and securely held with tie wire and sufficient chairs of suitable design.
- ❑ Any field bending must be approved by the Contract Administrator or Resident Engineer.
- ❑ Check that lap lengths are adequate.
- ❑ Check clearances between formwork and reinforcement.
- ❑ No concrete is to be placed until the reinforcement has been checked and approved.
- ❑ Record mass of reinforcement acceptably placed for payment.

5.4.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Discuss with the Contractor, the Inspector and the Design Engineer possible additional splice locations, especially in high columns or pier shafts.
- ❑ Discuss with the Contractor and the Inspector acceptable deck chairs.

SECTION 6 – PRECAST CONCRETE FABRICATION & ERECTION

6.1 FABRICATION OF PRESTRESSED CONCRETE MEMBERS

6.1.1 Stressing Operations

- Each reel of stressing strand shall be inspected for:
  - Proper identification: tag no. & Modulus of Elasticity. This shall be compared with the approved calculations and data.
  - Condition: surface rust should be cleaned, but, if the strand is pitted under the rust, the affected sections should be rejected.

- For the first member to be stressed, the preload (500-1000 lb.) shall be applied to all the strands before any of the strands are stressed to the final load. For the subsequent members, the preload and then the final load may be applied in immediate succession on each strand in the approved stressing sequence.

- The Contractor is required to keep a log of elongations, anchorage losses, chuck slippage, and jack pressures. The Inspector should observe and if necessary keep an independent record of the actual elongations and chuck slippage or jack return measurements. If the actual net elongations are consistently greater or less than the required net elongation, the actual losses encountered shall be used to modify the gross elongation required.

In the event of discrepancies between measured elongations and actual pressure gauge readings, the following limits shall be observed:

- The actual net elongation of a strand shall not vary from the required net elongation by more than 3 mm.
- The actual jack pressure shall not vary from the calculated pressure required to obtain the gross elongation by more than 5%.

When variances occur within the above limits, the required net elongations shall be the governing criteria.

When variances exceed the above limits, the stressing operations should be stopped until the problem(s) can be determined and corrective measures can be implemented.

- When stressing draped strands in the draped position, the stressing shall be done from both ends unless the correct elongation can be obtained from one end without exceeding the maximum allowable jack pressure. The strands shall be held in their draped position by means of low friction pins or rollers at all support and hold-down points.

- **No heating or steam** shall be applied to the member until the concrete has obtained its initial set approximately 4 hours after finishing operations are complete.

6.1.2 Destressing Operations

- No destressing shall occur until the concrete has obtained strength equal to or greater than identified on the Drawings.

- The “Approved” destressing sequence must be followed. It is important that the method of destressing also be approved by the Contract Administrator or Resident Engineer.

- If heat-cutting detensions the strands, each strand must be cut simultaneously at both ends of the member to minimize sliding. For members with draped strands, unless the hold-downs are released initially, it is necessary to cut strands simultaneously at all spaces between members to reduce sliding.

- In general, if the sum of hold-down forces is not more than half the weight of the member, it is safe to release hold-downs prior to the release of anchorage stresses. The effect of vertical forces resulting from initial release of hold-downs can be minimized by weights or vertical restraint applied over the hold-down points.

PRECAST CONCRETE PLANT CHECKLIST

Forms

- ❑ Form dimensions (length, width, and depth)
- ❑ Level (prior to first pour)
- ❑ Cleanliness
- ❑ Oiled

Stressing Cables

- ❑ E-value @ rolls of strand. (Corresponds to value on stressing calculations)
- ❑ Not damaged
- ❑ Correct Diameter
- ❑ Location of Hold-downs
- ❑ Strand layout @ endblocks (prior to first pour)
- ❑ No conflict with other strands, rebar, inserts, etc.
- ❑ Check jacking length of strand (matches length on stressing calculations)

Reinforcing Steel

- ❑ Bar size, bending details, and overall dimensions
- ❑ Correct number, spacing, and position
- ❑ Appropriate cover
- ❑ Cleanliness
- ❑ Proper Tieing and chairing (concrete chairs not plastic chairs)
- ❑ No conflicts with stressing strand/rebar/inserts

Embedded Hardware

- ❑ Ensure hardware dimensions, etc. match Drawings
- ❑ Check number, spacing, and position
- ❑ Cleanliness
- ❑ Securely fastened
- ❑ Check Galvanizing

Pre-Stressing

- ❑ Appropriate pre-load and final load
- ❑ Sequence of stressing (mark on stressing block)
- ❑ Jacking forces and elongation are as per stressing calculations (have plant mark final and initial pressure on gauge)
- ❑ Document stressing jack being used
- ❑ 10% of cables are checked for jack return and jack check loss (match what is on stressing calculations)
- ❑ Copy of report stressing with Inspector’s Report

Concrete Pour

- ❑ Mix design (batched according to mix design)
- ❑ Air, slump and temperature of concrete
- ❑ Number of cylinders being made
- ❑ Poured within 1 hour of batching
- ❑ Vibrating (non-metallic heads for FRP reinforcing)
- ❑ Placed in uniform lifts (not to exceed 500 mm)
- ❑ Continuous operation (for box girders, keep time between bottom lift and walls to a minimum)
- ❑ Top is finished properly (i.e. broomed, squares pockets @ lifting devices)

Curing

- ❑ Check graph next day to ensure concrete temperature never exceeded the requirements for the accelerated curing cycle for the precast concrete as specified for moisture category damp in CSA A23.4-00, Table 2 – Accelerated Curing Cycle (Maximum temperature of 60°C and with increases of 20°C/hour and decrease of 15°C/hour).

Destressing

- ❑ Follow sequence
- ❑ Check camber (@ destressing and 24 hours)

Concrete Strength

- ❑ Required strength for distressing
- ❑ Required strength for yarding (28 Day Strength)

Finishing

- ❑ Open all holes and patch bug-holes, honeycombing, and voids
- ❑ Look for cracking
- ❑ Grout, waterproof or bend stressing strands @ ends of beams per Contract requirements
- ❑ Mark date cast and girder type on bottom of girders and at ends.
- ❑ Proper curing of finishing (24 hours)

Storing

- ❑ Supported properly in yarding
- ❑ Temperature at time of yarding

6.2 PRECAST CONCRETE GIRDER ERECTION - GENERAL

Erection of precast concrete girders includes transporting the girders to the site, handling and temporary storage, installing anchor bolts and bearings, erecting the girders, placing and grouting connectors, post-tensioning, grouting the anchor bolts and placing grout pads.

- A major concern with girder erection is the security and stability of the superstructure during all phases of erection with respect to construction conditions, wind loads and construction loads.
- Delivery of precast concrete girders to the site cannot always be scheduled such that the units are lifted directly from the trucks and erected on the sub-structure.
- If girders are to be temporarily stored at site, the Inspector must check that the Contractor places the units on adequate timber blocking to keep them properly supported, clean and adequately drained.
- Girders must be stored upright, braced to prevent tipping and supported at the bearing points only.
- Units must be lifted only at the lifting holes or hooks provided near the ends of the girders and must be kept vertical at all times, in order to prevent damage.
- Erection of the precast concrete girders must be done accurately and carefully, as shown on the Drawings and in a manner that will prevent damaging the girders.

6.2.1 Environmental Constraints

Be aware of the environmental constraints as outlined in the Special Provisions, Drawings and permits, and note the following:

- Before final acceptance, the Contractor is required to remove all temporary works.
- All earthwork, temporary pilings and falsework are to be removed and acceptably disposed.
- The Contractor is required to leave the bridge site, roads, stream channel and adjacent property in a neat and satisfactory condition.
- If adjacent property outside the right-of-way has been affected, the Contractor is required to provide to the Contract Administrator written evidence that his cleanup is satisfactory to the property owners.
- All disturbed riverbanks are to be acceptably restored, and borrow pits satisfactorily reclaimed.

6.2.2 Safety

It is ESSENTIAL to have a pre-girder erection meeting with the Contractor to discuss all the safety issues. Refer to Manitoba's Workplace Safety and Health Regulation.

6.2.3 Precast Concrete Girder Erection Proposal

The erection proposal is to be submitted for review and approval by the Contract Administrator or Resident Engineer. The Inspector must not allow any erection work to begin until approval of the erection scheme has been granted. This approval does not relieve the Contractor of his responsibility for safety and for ensuring that the work is done in accordance with the Specifications, contract documents and Drawings.

The erection procedure should address the following in full detail:

- Traffic accommodation plan, as necessary.
- Survey of substructure.
- Access to work, earth berms, work bridges, and ice bridges.
- Sequence of operations.
- Size and position of cranes.
- Lifting devices and lifting points.
- Falsework details (Registered Professional Engineer’s stamp required).
- Method for securing the girders prior to grouting.
- Grouting procedures.
- Falsework release.
- Temporary access removal.

The Inspector must ensure that the following steps are diligently carried out to ensure all erection requirements are satisfactorily achieved.

- Review and understand the erection procedure.
- Review falsework and traffic accommodation plan.
- Survey of the completed substructure prior to beginning of erection.
- The survey is to be done independently of the Contractor.
- Check that centrelines of bearings for piers and abutments, and bridge roadway centrelines are in the correct location.
- Check the locations of anchor bolts or pockets, elevations of pier and abutment seats and elevations of bearing pads.
- Where girders are erected onto bearings, ensure that the Contractor is required to take special precautions with the bearing areas on the piers and the abutments.
- The concrete surface to receive the bearings is to be finished to a smooth, true, uniform surface to ensure full contact.
- Minor grinding, chipping or filling may be required to ensure proper contact of the bearings.

- Bearings to be grouted are generally set on stacks of thin galvanized steel shim plates.
- Contractor must clean the bearing surfaces and the surfaces to be in permanent contact before the members are assembled.
- Check the elevations, camber, and girder alignment.
- Check the elevations of the bearings and review the shims requirements to ensure that they will be stable under load, and are distributed such that the bearings will not be damaged by high local stresses.
- Ensure that anchor bolts are fully grouted with an approved flowable grout.
- The grout must be kept sufficiently warm and wet to ensure proper curing.

6.2.4 Inspector's Record

The following items must be included in the Inspector's record:

- Ensure agreements are in place between Contractor and private landowner pertaining to borrow and disposal areas.
- Record traffic disruptions or minor traffic mishaps.
- Record all "as-built" survey information and camber corrections.
- Record all shim elevations.
- Record temperature and bearing settings.
- Record final girder elevations.

6.2.5 Precast Concrete Channel or Box Girder Erection

- Take profiles of the girder tops so that camber adjustments may be determined with particular emphasis on the differential camber between adjacent girders.
- If post-tensioning of the girders is required, discuss the procedures and all aspects of the inspection required with the Contract Administrator or Resident Engineer.
- When grouting post-tensioning tendons, ensure that there are a sufficient number of "breather holes" and ALWAYS commence grouting from the LOW end towards the HIGH end.

6.2.6 Ice Bridge

In some instances, it may be advantageous to schedule girder erection over a river during the cold weather months, to take full advantage of the river ice to support all the equipment necessary to complete the erection.

- The river ice thickness must be adequate to support the erection equipment and may require flooding.

- Normally, **1.5 m of BLUE ice** is required to support the erection equipment and concrete girders. However thicker ice may be required for extra heavy loads.
- In preparation for building ice, the snow should be piled around the perimeter to serve as a berm to contain the flooding water inside this area.
- On cold days, water can be pumped from holes drilled through the ice to flood the work area.
- It is sometimes advisable to do ice building during the night when air temperatures are more conducive.
- It is **ESSENTIAL** that the ice thickness be checked daily as the flowing water in the channel below the ice will have a continuous effect of eroding the ice thickness.
- When heavy loads are anticipated, it may be necessary to drive piles at crane outrigger locations for extra support.
- Falsework towers, if required to support the girders at the splice points, must be founded on piles not on ice.
- The Ice Bridge will tend to move, crack and heave as the temperature conditions change, and it is therefore important that the supporting piles be free of the ice at all times, to prevent the piles from being “pushed-up”.

When the girders are satisfactorily erected and approved, ensure that: a) the lifting devices are cut off, b) all lifting pockets are filled with grout, and c) lifting holes on exterior girders are filled with grout.

Inspect the girders for cracks, chips or other damage, which may have occurred during erection. Report any damaged girders noted to the Contract Administrator or Resident Engineer.

6.3 CHECKLIST

6.3.1 Inspector's Responsibilities

- ❑ Review the applicable Specifications, contract documents and Drawings.
- ❑ Survey substructure prior to erection to check centrelines, bearing locations, and elevations.
- ❑ Check that the erection scheme and falsework details are submitted by the Contractor and approved by the Contract Administrator or Resident Engineer.
- ❑ Study and understand the erection scheme and the post-tensioning procedure.
- ❑ Check access roads and berms for stability, scour and drainage.
- ❑ Check installation of anchor bolts, bearing elevations, shims below bearings, temperature offset of expansion bearings, and grouting of anchor bolts and base plates.
- ❑ Ensure that when girders are stored on site they are on blocking to keep them properly supported, clean and securely braced.
- ❑ Check that all bearings and bearing surfaces of girders are clean before erection.
- ❑ Check security and stability of girders as erection progresses.
- ❑ Check that lifting hooks are cut off and all holes are grouted and metal parts painted.
- ❑ Inspect girders for cracks, chips or other damage.
- ❑ Survey top profile of each girder to record camber data.
- ❑ Ensure that cleanup has been satisfactory done and if private property is involved ensure that owner is satisfied.

6.3.2 Contract Administrator / Resident Engineer's Responsibilities

Discuss the following items with the Contractor and the Inspector:

- ❑ Discuss the "as-built" survey information and decide on corrections and elevations.
- ❑ Discuss the erection procedure.
- ❑ Discuss post-tensioning procedure if required.
- ❑ Discuss access road and berm locations.
- ❑ Discuss the final girder alignment.
- ❑ Discuss proposed methods employed for securing the girders.
- ❑ Discuss the final site cleanup, including restoration of riverbanks, access road; borrow pits and disposal areas

SECTION 7 – STRUCTURAL STEEL FABRICATION AND ERECTION

7.1 FABRICATION

7.1.1 GENERAL – FABRICATION

Structural Steel fabrication includes steel girders, diaphragms, splice plates, cover plates, structural bearings, anchor bolts, dowels, deck drains, deck joint assemblies, bridge railing, etc.

The Fabricator shall provide documentation that their plant is CWB approved

7.1.2 PREFABRICATION MEETING

7.1.2.1 General

Prior to the commencement of fabrication, the Contract Administrator shall be responsible for arranging a meeting between MIT and the Fabricator personnel for the purpose of discussing the fabrication process.

7.1.2.2 Attendees

- Welding Engineer
- Shop Foreman
- Welding Supervisors
- MIT designated representative(s)
- Contract Administrator or Resident Engineer
- Inspector/Plant Inspectors
- Design Engineer

7.1.2.3 Suggested Topics

a) Base Metal
  - Mill certificates
  - Notch toughness
  - Tests for laminations
  - Other requirements

b) Filler Metal and Shields
  - Type
  - Storage facilities

c) Design

  The design engineer shall provide information on the critical areas (including details and welds) of the work.

d) Fabricator
  - Personnel to be used on the work
  - Operator certification
  - Equipment
  - Work period, double shifts, etc.

e) Fabrication
  - Shop Drawings
  - Welding processes
  - Special provisions
  - Welding procedures

- Assembly and welding sequence
- Weld quality
- Tolerances

f) Inspection
- Processes
- Access to the work
- Acceptance standards

g) Storage of Completed Components

h) Transportation of Components

i) Erection

j) Coating

k) Payment

7.1.2.4 Report

Minutes of the meeting shall be prepared by the Contract Administrator and distributed to all in attendance.

7.1.3 PRELIMINARY WORK

Fabrication shall not commence prior to the approval of the Shop Drawings. The Shop Drawings shall be prepared by the Fabricator and submitted to the Contract Administrator for approval prior to fabrication. Allow ten (10) working days for the approval of Shop Drawings. The approval of the Shop Drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions.

- Prior to commencement of fabrication, the Contractor shall present for approval an outline of the fabrication sequence that clearly describes the order of make-up and assembly of all the component parts, as well as shop assembly, inspection station, and surface preparation.
- Mill certificates shall be provided for all material before fabrication commences.
- The Contractor shall provide a separate, carefully compiled list of steel sections to be fabricated, using identification of parts in accordance with the Drawings and Specifications and identifying each part with the appropriate heat number and governing Specification.
- The Contractor shall provide and keep current a complete fabrication schedule in a form satisfactory to the Contract Administrator.
- The Contractor shall supply to the Contract Administrator certified copies of Charpy V-Notch test results for the steel in main girders flanges and webs and welded truss components prior to commencement of fabrication.
- Structural material, either plain or fabricated, shall be stored at the Fabricator's shop or elsewhere above the ground upon platforms, skips or other suitable support and shall be kept free from dirt and other foreign matter.
- Structural material, either plain or fabricated, shall be protected as far as practicable from corrosion. Long members shall be so supported as to prevent deflection and distortion.
- Fabrication shall be performed in an enclosed area that is adequately heated.

7.1.4 SHOP ASSEMBLY

7.1.4.1 Plate Girders

Shop assembly of plate girders shall be by the progressive assembly method according to AASHTO. The detailed method of assembly, including points of support, dimensional checks, method of trimming to length, drilling and marking of splices, shall be to the procedure submitted and approved by the Contract Administrator. Each individual girder section shall meet the camber requirements for that particular length, with the splices between these sections falling on the theoretical camber line for the entire span. The required camber for plate girders shall be produced within the tolerances as set out in AWS D1.1. Correction for variation in flange thickness must be considered. When the camber of the girder fails to meet the required tolerance, the Contractor shall submit a proposed method of repair for approval by the Contract Administrator. No flame cambering will be allowed without prior approval and supervision of the Contract Administrator.

7.1.4.2 Box Girders

The camber of box girders shall be measured on the top of the top flange, and each top flange of a box shall individually meet the required camber. Girder sections assembled for splicing shall be supported within 2 meters of the end of each section. Girder sections shall be supported in such a manner as to provide the correct angular relationship at the splice between girder section while the splices are being reamed or drilled. Shop Drawings shall clearly indicate the expected dead load deflection of each section and the elevations of the sections while supported for the drilling or reaming of each splice.

7.1.4.3 Drilling

All splices shall be drilled from solid material while assembled or shall be sub-punched or sub-drilled and then reamed to full size while in the shop assembly position. No reaming shall take place until approval of the assembly has been obtained from the Contract Administrator.

7.1.4.4 Splice Plates

After shop assembly, splice plates and girders shall be clearly match marked to assure proper orientation and location of splice material for erection. All holes shall align with holes in the attached member. Splice plates shall then be removed, de-burred, solvent cleaned to remove all oil and sandblasted to remove all mill scale in order to provide a suitable faying surface. These plates shall then be securely ship-bolted to the girders. The match marking system shall be shown on the Shop Drawings.

7.1.4.5 Bolt Holes

Clause 11.4.8 in Division II of AASHTO shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or sub-punched and reamed to full size. All holes in girder splices shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.

7.1.4.6 Dimensional Tolerances

All matching holes for bolts shall register with each other so that a gauge 2 mm less in diameter than the hole shall pass freely through the assembled member in a direction at right angles to such member. Finished holes shall be not more than 2 mm in diameter larger than the diameter of the bolt passing through them unless otherwise specified by the Design Engineer. The centre-to-centre distance between any two holes of a group of holes shall not vary by more than 1 mm from the dimensioned distance between such holes.

7.1.5 WELDER AND WELDING OPERATOR QUALIFICATION

Welder and welding operators shall be qualified in accordance with the requirements of AWS D1.1 and CSA W59. Qualification tests for tack welders shall also conform to the requirements of the above mentioned standards. The making and testing of specimens for qualification tests shall be witnessed by the Inspector if requested by the Contract Administrator or Resident Engineer.

- The reports of the results of the qualification tests shall bear the welder’s or welding operator’s name, the identification mark he will use, all pertinent data of the tests. These tests shall be certified by the Inspector and approved by the Contract Administrator or Resident Engineer.

- The Inspector may accept previous qualification of the welder or welding operator if verification is submitted to the Inspector and approved by the Contract Administrator or Resident Engineer.

7.1.6 WELDING PROCEDURES

The Contractor shall, prior to the start of fabrication, submit detailed procedures of all welding to the Inspector. Items to be considered and reported shall include welding process, plate thickness, grade of steel, weld position, details of groove, type and size of electrode, type of flux or gas, if used, number and location of passes, welding sequence, back gouging, current and voltage per pass, heat input, preheat and maximum interpass temperature.

Welding procedures which conform in all respects tot the approved procedures of AWS D1.1 and CSA W59 shall be deemed as prequalified and are exempt from tests or qualifications.

Welding procedures which do not conform to approved procedures of AWS.D1.1 and CSA W59 shall be qualified by tests carried out in accordance with WS D1.1. The Inspector may accept previous qualifications of the welding procedure if verification is submitted to the Inspector and approved by the Contract Administrator.

7.1.7 SURFACE PREPARATION

7.1.7.1 Blast Cleaning

Unless otherwise noted, all steel components shall be blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) No. SP6. Essentially this is a surface from which all oil, grease, dirt, rust, scale and foreign matter have been completely removed, and all rust, mill scale and old paint have been removed except for slight shadows, streaks or discolorations caused by rust stain or mill scale oxide binder.

7.1.8 GALVANIZING

Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.

7.1.9 TESTING AND INSPECTION

- Attend the pre-fabrication meetings with MIT and the fabricator.
- Check Material mill reports as well as plant’s certification and welder’s qualification.
- The Contractor shall provide full facilities for the inspection of material and workmanship. Free access shall be allowed to the Inspector to all parts of the works. When required by the Inspector, the Contractor shall provide needed for assistance in checking layout and performing inspection duties.
- Check to ensure welding is being performed in accordance with approved procedures.
- The visual, radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Inspector or by a qualified testing agency under the direction of the inspector.
- The following are the Minimum Quality Control/Assurance test required (Quality control testing shall be by the Fabricator and reviewed by the Contract Administrator / Inspector) :
    - Non-destructive Methods of Examination

- Radiography
- Ultrasonic
- Magnetic Particle
- Dye-Penetrant
- Hardness test

○ Radiographic Inspection Schedule
○ Magnetic Particle Inspection Schedule
○ Dye Penetrant Inspection
○ Hardness Test
○ Testing Stud Shear Connectors
○ Certify and accept radiographic film interpretation
○ Perform daily fabrication inspection, check dimensions and visually inspect all welds.
○ Witness critical welds and set up prior to commencing next stage of fabrication.
○ Submit weekly inspection reports. This shall include radiographic films and all nondestructive inspection reports interpreted by NDT technicians.
○ Perform final inspection of each girder section.
○ Any issues or questions arising in the shop that the Inspector is not able to answer shall be referred to the Contract Administrator or Resident Engineer.
○ Items which require major repairs must be referred to the Contract Administrator for consideration prior to the commencement of the repairs.

- Inspection made necessary by the repair of faulty work and additional unspecified material splices shall be paid for by the Contractor. Any test records made by the fabricating shop in the course of normal quality control shall be open to the Inspector for inspection.

7.1.10 FINAL INSPECTION REPORT CONTENT

- summary of fabrication
- pre-job meeting minutes
- weekly construction reports
- production schedules, progress charts, inspection checklist
- approved repair procedures (if any)
- mill certificates
- plate cutting diagrams with heat numbers
- weld procedures and Charpy Impact test on weld metal (if any)
- welder tickets
- hardness test records
- radiography test reports
- ultrasonic test reports
- MPI test reports
- dye penetrant test records (if any)
- heat treatment records (if any)
- camper records
- weekly summaries of inspection hours
- photographs

7.1.11 CHECKLIST

7.1.11.1 Inspector's Responsibilities - fabrication

- ☐ Attend the pre-fabrication meeting.
- ☐ Coordinate all other inspections, including Non-Destructive Testing (NDT) as required. Assume responsibility for the work of the individuals performing such inspections/testing as well as the second shift visual inspector, if one is required.
- ☐ Check material mill reports as well as plant's certification and welder's qualification.
- ☐ Perform hardness testing of flange plates.
- ☐ Check to ensure welding is being performed in accordance with approved procedures.
- ☐ Certify and accept radiographic film interpretation.
- ☐ Perform daily fabrication inspection, check dimensions and visually inspect all welds.
- ☐ Perform minor amount of NDT such as dye penetrant.
- ☐ Witness critical welds and set up prior to commencing next stage of fabrication.
- ☐ Submit weekly inspection reports. This shall include radiographic films and all nondestructive inspection reports interpreted by NDT technicians.
- ☐ Perform final inspection of each girder section.
- ☐ Coating Inspection
  - Ensure the Contractor's coating system is in compliance with the contract specifications.
  - Review details of the proposed containment structure and scaffolding
  - Monitor abrasive blasting spoil recovery and disposal
  - Approve surface preparation and check anchor pattern prior to application of coating
  - Inspect coating application to ensure conformance to all contract requirements
  - Ensure temporary attachments are not injurious to the structure
  - Approve cleaning of structure to ensure it is free of chlorides and other contaminants
  - Inspect penetrant and caulking application
  - Check for quality as well as runs and sags

7.1.11.2 Contract Administrator's Responsibilities

- ☐ Discuss with Contractor and Inspector fabrication procedures.
- ☐ Any issues or questions arising in the shop that the Inspector is not able to answer.
- ☐ Items which require major repairs must be referred to MIT's Construction Engineer for consideration prior to the commencement of the repairs.

7.2 ERECTION - GENERAL

Structural steel erection includes delivery of the steel to the site, handling, temporary storage, falsework, lifting assembly, completion of all connections and plumbing and aligning.

- The method and techniques used to erect structural steel depends on the type of structure, length of span, site conditions, and equipment available.
- The erection procedure should take into consideration the stability of the structure under **all** conditions of partial erection to withstand construction loading and wind loading encountered during erection.
- The girders must be erected in such a manner that they will perform as the design intended, and not be subjected to overstressing.
- Very large and/or unusual bridges require specialized erection techniques and scheduling.
- Continuous girder bridges generally require field splices. Longer spans require temporary intermediate supports or falsework to support the steel until adjacent members are connected.

7.2.1 ENVIRONMENTAL CONSTRAINTS

Be aware of the environmental constraints and note the following:

- Before final acceptance, the Contractor is required to remove all temporary works.
- All access roads, temporary pilings, and falsework are to be acceptably removed.
- The Contractor is required to leave the bridge site, haul roads, stream channel and adjacent property in a neat and satisfactory condition.
- If adjacent property outside the right-of-way has been affected, the Contractor must provide written evidence that his cleanup is satisfactory to the property owner(s).
- All disturbed riverbanks are to be acceptably restored, and borrow pits satisfactorily reclaimed.

7.2.2 SAFETY

It is ESSENTIAL to have a pre-girder erection meeting with the Contractor to discuss all the safety issues. Refer to Manitoba's Workplace Safety and Health Act and Regulations.

7.2.3 INSPECTOR'S RECORD

The following items must be included in the Inspector's record:

- Ensure agreements are in place between Contractor and private landowner(s) pertaining to borrow and disposal areas.
- Record traffic disruptions or minor traffic mishaps.
- Record all "as-built" survey information and camber corrections.
- Record all shim elevations.
- Record temperature, bearing settings, and distances between girders and backwalls
- Record final girder elevations.

7.2.4 PRELIMINARY WORK

The erection proposal is to be submitted by a Professional Engineer for review and approval by the Contract Administrator. The Inspector must not allow any erection work to begin until approval of the erection scheme has been granted. This approval does not relieve the Contractor of his responsibility for safety and for ensuring that the work is done in accordance with the Specifications, contract documents and Drawings.

The erection procedure should address the following:

- Traffic accommodation plan as necessary.

- Survey of substructure.
- Access to work, access roads, work bridges, and ice bridges.
- Sequence of operations.
- Size and position of cranes.
- Lifting devices and lifting points.
- Falsework details (Registered Professional Engineer's stamp required).
- Bolt torque sequence and method.
- Method for securing structure once erected.
- Grouting procedures, if required.
- Falsework release.
- Temporary access removal.

The Inspector must ensure that the following steps are diligently carried out to ensure all erection requirements are satisfactorily achieved.

- Review and understand the erection procedure.
- Review falsework details.
- Review traffic accommodation plan.
- Survey the completed substructure prior to erection.
- The survey is to be done independently of the Contractor.
- Check that centerline of bearings for piers and abutments, and roadway centerline is in the correct location.
- Check the locations of anchor bolts or pockets (clearances to the backwalls), elevations of pier and abutment seats and elevations of bearing pads.
- Where girders are erected onto bearings, ensure that the Contractor is required to take special precautions with the bearing areas on the piers and the abutments.
- The concrete surface to receive the bearings is to be finished to a smooth, true, uniform surface to ensure full contact.
- Minor grinding, chipping or filling may be required to ensure proper contact of the bearings.
- Bearings to be grouted are generally set on stacks of thin galvanized steel shim plates.
- Check the elevations of the bearings and review the shims requirements to ensure that they will be stable under load, and are distributed such that the bearings will not be damaged by high local stresses.
- Ensure that anchor bolts holding the bearings are fully grouted with an approved non shrink, non metallic, non acrylic flowable grout.
- The grout must be kept sufficiently warm and wet to ensure proper curing.

7.2.5 ICE BRIDGE

In some instances, it may be advantageous to schedule girder erection over a river during the cold weather months, to take full advantage of the river ice to support all the equipment necessary to complete the erection.

- The river ice thickness must be adequate to support the erection equipment and may require flooding.
- Normally, 1.5 meters of **BLUE** ice is required to support the erection equipment and steel girders. However thicker ice may be required for extra heavy loads.
- In preparation for building ice, the snow should be piled around the perimeter to serve as a berm to contain the flooding water inside this area.
- On cold days, water can be pumped from holes drilled through the ice to flood the work area.
- It is sometimes advisable to do ice making during the night when air temperatures are more conducive.
- It is **ESSENTIAL** that the ice thickness be checked daily as the flowing water in the channel below the ice will have a continuous effect of eroding the ice thickness.

- When heavy loads are anticipated, it may be necessary to drive piles at crane outrigger locations for extra support.
- Falsework towers, if required to support the girders at the splice points, must be founded on piles not on ice.
- The ice bridge will tend to move, crack and heave as the temperature conditions change, and it is therefore important that the supporting piles be free of the ice at all times, to prevent the piles from being “pushed-up”.

7.2.6 ERECTION AND ASSEMBLY

Assembly of the structural steel members is to be done accurately as shown on the Drawings, and in a manner that will prevent bending or other damage to the steel.

- The Inspector should check that the elevations of girders bearing seats are correct.
- Splices and field connections are to have 25% of the holes filled with bolts and 25% of the holes filled with erection pins before final bolting commences.
- Serious misfits are to be reported to the Contract Administrator or Resident Engineer and an approved method of correction obtained.
- When the entire superstructure is erected, take elevations at the piers, abutments, splice points and mid-spans to determine whether corrections are required.
- After the steel girders are erected and all connecting splice points are bolted and impacted, all shims, wedges or jacks used to support the steel on the falsework are to be removed or lowered such that the steel girders are carrying their own dead load.
- The Contractor shall not commence torquing until all the girders are erected and elevations approved
- Ensure that expansion assemblies and bearings are offset with the corresponding temperatures as shown on the Drawings.
- The structural steel in all areas is to be left clean and free from mud, dust, oil, etc.
- Ensure that falsework, temporary pilings, and access roads are removed prior to spring breakup or other high water runoff periods.

7.2.7 HIGH STRENGTH BOLTED CONNECTIONS

High tensile strength bolts are used in bolted connections and tightened to a very high tension, which clamps the joined pieces between the head and the nut of the bolt. This clamping action enables the load to be transferred from one plate to the other by friction with no slip, thus producing a rigid joint.

- Under no circumstances shall ordinary bolts be substituted for high tensile strength bolts. The connections will not function as designed and could lead to failure.
- The clamping action created by the high tensile strength bolts enable the working loads to be transferred by friction and the bolts are not subjected to bearing or shear stresses. The frictional resistance is effective beyond the hole area, so the load is transferred over a relatively large area, reducing local stresses on the net section at the holes. In addition, the high initial tension prevents the nuts from loosening.
- Frictional resistance depends on the amount of initial tension in the bolt, therefore it is essential that proper tightening of the nut on the bolt develop adequate clamping forces. Special attention must be given to installing and tightening high strength bolts.
- The Inspector must check the torque of 100% of the bolts at splice locations and ensure the bolts are the same size, grade and condition as those used in the calibration device. The Contractor is required to provide safe and adequate access for inspection.
- The Contractor must tighten the bolts to produce the minimum tensions required. Tightening of the high strength bolts may be done either by using properly calibrated wrenches, or by the “turn-of- nut” method.

- The Contractor is required to provide on site, a calibrated device capable of indicating tension in bolts of the size being tightened. Beveled washers are required where the surface of the connected part slopes more than 1:20 (5%).
- High strength bolts must not be "re-used".
- The contact surfaces must be cleaned and free of all dirt, oil, loose scale, burrs, pits, paint or lacquer, etc.
- At a splice location, bolts are to be tightened from the centre outward. Each bolt should be tightened to a tension of at least 5% but not more than 10% greater than the specified minimum tension.
- High strength A449 or A490 bolts may be tightened by turning either the nut or the head of the bolt providing a washer is used at the tightening end. All A325 high strength bolts shall be tightened by applying the required torque to achieve the minimum tension applicable to each diameter of bolt. Each bolt shall utilize a washer at both ends orientated correctly such that the washers remain flat and sealed to the joint they are clamping.

7.2.7.1 Tightening by Calibrated Wrench

Tightening by calibrated wrench can be done using an impact wrench (powered by air pressure) which stalls or "cuts out" when the torque reaches a set value, or by using a manual torque wrench with an indicator that shows when a set torque value has been reached. The indicator on the manual torque wrench must be read while the nut is in motion rotating in the tightening direction.

- Where there are several bolts in a single joint, there may have minor separation between the joined parts when the first bolt was torqued.
- Separation will close up with torquing of subsequent bolts leaving the tension in the first bolts less than required.
- The Contractor is required to re-use the calibrated wrench to re-torque previously tightened bolts.
- The Contractor is required to calibrate the wrenches at least once a day on site, and the Inspector should witness this calibration.
- In calibrating the torque wrench, three bolts are to be tested and the average torque from the three tested bolts will be the "job inspecting torque" to be used. All torque wrenches must be released each night to allow the mechanical spring to be "let off" and "relax" each night.
- No torque wrenches will be allowed to be used the following day if it is found that the spring has not been "relaxed" overnight.

7.2.7.2 Tightening by the "Turn-of-Nut"

The turn-of-nut" method of tightening assures proper tension by imposing a set amount of strain (lengthening) in the bolt. The bolts are tightening snugly to ensure full contact of jointed parts, and the nut (or bolt head) is then turned a further specified amount. The nut moving along the pitch of the thread forces the bolt to stretch, thus developing the required tension in the bolt. The amount of rotation required depends on the length of the bolt and the "flatness" of the surface beneath the nut and head of the bolt, and is tabulated in the Specifications.

- Snug tight is defined as the tightness reached with a few impacts of an impact wrench, or when tightened with the full effort of a man using an ordinary spud wrench.
- In using the "Turn-of-Nut" method, the Contractor must snugly tighten enough bolts to ensure that the parts of the joint are brought into full contact.
- Bolts are to be placed in all remaining holes in the connection and brought to snug tightness.
- All bolts are to be tightened to the minimum bolt tension by rotating the turned part through the required portion of a turn, working systematically from the most rigid part of the joint to its free edges.
- During tightening, there must be no rotation ("wheeling") of the head or nut not turned by the wrench.

- The Inspector must observe procedures to be assured that the joints are being properly snugged, and that the required rotations are being achieved.
- The Inspector should mark the bolts after they are snugged to indicate that the required rotations have been obtained.
- If any nut or bolt head is turned by the "job inspecting torque", the Contractor is required to test the torque of 100% of the bolts in the connection, and properly tighten all bolts.

7.2.7.3 High Strength Bolting

The following torque (ft. lbs.) values for high strength bolting are provided for information purposes only as a check in determining whether the values obtained by field calibration are within reason.

Note: Check with the Contract Administrator or Resident Engineer prior to torquing to determine the exact value to be used.

BOLT SIZE (INCHES)	TORQUE (FT. LBS.)
½	110
5/8	220
¾	390
7/8	580
1	870
1 1/8	1170
1 ¼	1650
1 3/8	2160
1 ½	2870

The torque wrenches used to check these values are mechanical and must be calibrated before use to obtain their deviation at a required torque. The values given above are within 15% (-10% to +5%).

Note: foot-pound x 1.3558180 = Newton-meters
foot-pound x 1.35582 = Joules

7.2.8 CHECKLIST

7.2.8.1 Inspector's Responsibilities

☐ Review the Specifications, contract documents and Drawings.

☐ Survey the substructure independently of the Contractor prior to erection, checking centrelines, bearing and anchor locations and elevations. Compare with Contractor's layout. Notify the Contract Administrator or Resident Engineer of discrepancies.

☐ Check that the erection scheme and the falsework details submitted have been approved by the Contract Administrator.

☐ Report any departures from the erection proposal to the Contract Administrator or Resident Engineer.

☐ Check that the falsework is constructed in accordance with the approved details and that it is monitored daily by the Contractor for tightness of bolts, wedges and cables.

☐ Check the access roads and sitework roads for stability, scour and drainage. Ensure conformity with the environmental requirements.

☐ Check bearings for the following:
- Bearing elevation is correct.
- Shims are stable and adequately distributed.
- Anchors are set accurately as detailed.
- Expansion bearings are offset for ambient air temperature.

☐ Check that the crane wheel or the outrigger loads will not induce excessive pressure to substructure, e.g. wingwall, backwall.

☐ Check that the structural steel stored at site is:
- Off ground on blocking.
- Tilted for drainage.
- Has beams, girders braced upright.
- Has slender members supported frequently, not under other heavier members.

☐ Check the elevation of the temporary supports and the falsework relative to the required cambers.

☐ During erection check that:
- Splices and field connections have half the holes filled with bolts and erection pins.
- Problems with misfit are reported to the Contract Administrator or Resident Engineer.
- Method of correction of misfit approved by the Contract Administrator or Resident Engineer.
- Approved correction of misfit observed by Inspector.
- All bracing and diaphragms fully connected and properly fitted.
- Contractor gives full regard for security and stability of all erected pieces.

☐ Survey the continuous girders when the falsework is removed but prior to torquing of the bolts.
- Report discrepancies to the Contract Administrator or Resident Engineer **BEFORE** any torquing is allowed.

☐ For High Strength Bolted Connections check that:
- All fraying surfaces seat solidly and are free from dirt, oil, paint, loose scale, burrs, and pits.
- Beveled washers are used where required.
- Contractor's wrenches are calibrated daily in the presence of the Inspector.
- In connections with several bolts, that the first bolts torqued are re-torqued after all bolts are tightened.

- All bolts are "snug tight" before using "turn-of-nut" method
- The "inspection wrench" is kept properly calibrated and loosened each night.
- 100% of bolts checked for proper tightness.
- Check bolt tightness as soon as possible when Contractor is ready.

☐ For grouting check that:
- Flowable grout has been approved by Contract Administrator or Resident Engineer.
- Flowable grout is mixed in required proportions.
- Flowable grout is being placed fully under masonry plates and in anchor bolt holes.

☐ After the completion of erection check that:
- Temporary piles, berms and falsework are removed.
- The site, including stream channels and banks, is left in a neat and satisfactory condition.
- The owner is satisfied with the cleanup if private property has been affected.
- The steel is left clean, free from mud, dust, and oil.
- Do the post-erection survey on the girders recording elevations of the top flanges at 1/10 points for each span.

7.2.8.2 Contract Administrator / Resident Engineer's Responsibilities

Discuss the following items with the Contractor and the Inspector:

☐ "As-built" survey information and decide on corrections and elevations.

☐ Erection procedure.

☐ Access road locations.

☐ Temporary bent locations, if required.

☐ Final girder alignment including setting of bearings.

☐ Proposed methods employed for securing the structure.

☐ Final site cleanup, including restoration of riverbanks, access road, borrow pits and disposal areas.

☐ Initiate payment upon acceptable completion.

SECTION 8 – CONCRETE SLOPE PROTECTION

8.1 GENERAL

Concrete slope protection is normally provided on the head slopes of approach for a grade separation, or on slopes of river training works. The concrete slope protection resists erosion by wind and water and provides an aesthetically pleasing surface with little maintenance required.

- Slopes to be protected require trimming to approximately the lines and grades shown on the Drawings.
- The Contractor is required to do trimming to a surface 200 mm below the final concrete surface, and to place 100 mm of compacted granular fill and 100 mm of reinforced concrete.
- The Inspector must take elevations of the slope to determine if there are any discrepancies and should submit the results to the Contract Administrator or Resident Engineer for review.
- The final grades of the slope protection may be adjusted to minimize or eliminate any Extra Work required, however the toe elevation is usually critical.
- The elevations for the top and bottom cut off walls are often specified and should not be altered unless approval is obtained from the Contract Administrator or Resident Engineer.
- If the grade of the slope has discrepancies in its surface that final trimming requires excavation greater than 250 mm or more than 150 mm of fill, and the discrepancies were constructed by others, the excess quantities will be considered as Extra Work.
- If the discrepancies are the result of the Contractor's activities, there will be no entitlement to extra compensation.

8.2 ENVIRONMENTAL CONSTRAINTS

Be aware of the following requirements:

- Deposition of concrete or other debris in the stream channel is not permitted.
- Concrete truck or pump should be cleaned in a suitable area away from the worksite and the water channel.
- Before final acceptance of the concrete slope protection, the Contractor is required to remove and dispose of all earthworks, such as berms and access roads.
- The Contractor is required to leave the bridge site, roads, stream channel and adjacent property in a neat and satisfactory condition.
- If adjacent property outside the right-of-way has been affected, the Contractor must provide written evidence that cleanup is satisfactory to the property owners.
- All disturbed riverbanks and/or borrow pits are to be satisfactory restored/reclaimed.

8.3 SAFETY

Refer to Manitoba's Workplace Safety and Health Regulation for specific safety requirements.

8.4 INSPECTOR'S RECORD

The Inspector should keep an accurate record of the following information:

- Headslope survey information.
- Weather conditions on pour days.
- All quality control and quality assurance test results.
- Location of each tested batch.
- Maximum and minimum temperature inside the hoarding during winter concreting.
- Measured total area of concrete slope protection placed.

8.5 MATERIAL

Materials required in the construction of concrete slope protection include granular backfill, appropriate formwork, wire mesh reinforcement and concrete.

- The granular fill underneath the concrete and in the top or the toe of the cut-off walls is to conform to the applicable Specification requirements.
- The concrete shall meet the requirements as defined in the Special Provisions or on the Drawings.
- Wire mesh reinforcing shall be 152 x 152 MW25.8 x MW25.8 flat welded wire mesh, and is to be supplied by the Contractor. The first set of two digits refer to the wire spacing in mm in each direction, and the second set of digits refer to the wire size (gauge) in each direction.
- Thickness of the granular fill and the concrete are to be measured perpendicular to the slope.

8.6 PLACING

It is important that granular backfill, welded wire mesh and concrete are carefully placed for concrete slope protection.

8.6.1 Granular Backfill

Granular backfill serves as a base for the concrete slope protection.

- The granular fill is to be placed and compacted to a uniform thickness.

8.6.2 Welded Wire Mesh

The welded wire mesh serves as reinforcement for the concrete slope protection and must be properly installed to be effective.

- The welded wire mesh must be supported adequately in order to ensure that it remains at the mid-depth of the concrete.
- Formwork should be constructed in two pieces, one below and one above the mesh to provide support at the edges.

8.6.3 Concrete

Extra attention is required in placing concrete on a steep slope and precautions must be taken to ensure that the concrete does not freeze when placed during the cold weather months.

- The Contractor should do a layout of the slope protection prior to forming, so that horizontal or vertical strips of equal width will result.
- Slump control is vital to pouring concrete slope protection. Too low a slump will make finishing of the surface very difficult, whereas too high a slump will result in concrete tending to flow down the slope.
- Concrete may be placed in horizontal or vertical strips with one strip being allowed to cure before the adjacent strip is placed. Pouring alternate strips helps to reduce shrinkage and control thermal cracking.
- Horizontal or vertical joints between adjacent sections are to be cold joints with no filler. Joints are to be formed or grooved to provide regular locations for shrinkage and thermal contraction to occur. All joints are to be finished to a rounded edge with proper edging tools and must be at least half the depth of the concrete to the mesh. These joints must be carefully done to ensure that they are continuous and straight.
- The concrete must be consolidated as it is placed, but too much effort with the vibrator will result in concrete flowing down to the lower edge of the slope. A small amount of vibration, along with “spading” by the workers is essential to get the required consolidation.
- The surface is to be given a broomed texture finish. The concrete is cast in a relatively thin section and it is very susceptible to rapid drying or cooling. Moisture may have to be added after initial set for curing before a sprayed membrane is applied.
- In cold weather, the Contractor may have to preheat the ground before placing concrete, and also provide hoarding and heating as required for curing.

8.7 CHECKLIST

8.7.1 Inspector's Responsibilities

- ❑ Review the applicable Specifications, contract documents and the Drawings.
- ❑ Survey the slopes to determine whether they have been placed to within specified tolerance, particularly the top and bottom elevations.
- ❑ If there are discrepancies in the required slope surface, provide the profile to the Contract Administrator or Resident Engineer for consideration of modifications.
- ❑ If Extra Work by the Contractor is required in trimming the slope, record the quantities of material for which "Extra Work" will be paid.
- ❑ Check to ensure that the top, side and toe cut off walls are constructed as required.
- ❑ Check the granular fill material for gradation, thickness and compaction.
- ❑ Ensure that the forms are straight.
- ❑ Check that the size and type of reinforcement is as specified.
- ❑ Ensure that the reinforcement is flat and adequately supported at mid depth of slab, and remains at mid depth during placing operations.
- ❑ Test the concrete for air, slump and strength.
- ❑ Ensure that the concrete is being properly and neatly edged in straight continuous line, which results in an esthetically pleasing appearance.
- ❑ Ensure that the Contractor takes proper measures to protect concrete during curing.

8.7.2 Contract Administrator / Resident Engineer's Responsibilities

Discuss the following items with the Contractor and the Inspector:

- ❑ The pour procedure and schedule.
- ❑ The access road and berm locations.
- ❑ The hoarding and heating requirements, if required.
- ❑ The final site cleanup, including restoration of riverbanks, access road, borrow pits and disposal areas, etc.
- ❑ Measure and calculate the quantities for payment.

SECTION 9 – STONE RIPRAP

9.1 GENERAL

Stone Riprap is a protective layer of material used to protect earth slopes and channels from the effects of erosion by runoff or scour by stream flow. Stone riprap is a specific depth of large boulders or rocks necessary to prevent scour or erosion in streams with higher flow velocities.

- Stone riprap relies on an angular irregular shape and mass to resist being rolled away by the force of flowing water.
- Stone riprap must be placed uniformly and carefully to eliminate any weak area where erosion can begin.
- The Contractor may be required to obtain a permit, agreement or authorization to obtain stone riprap.
- The Inspector should review with the Contractor that all requirements have been satisfactorily met prior to loading and hauling any stone riprap.

9.2 ENVIRONMENTAL CONSTRAINTS

Be aware of the environmental constraints governing the site. Note the following requirements:

- Environmental requirements are met.
- The time frame permitted for any instream activity.
- Ensure equipment is clean when working in or adjacent to the stream.
- Cleanup all oil leaks and spills.
- Prevent loose material from washing into the stream.
- Removal and disposal of all earthworks, such as berms and access before final acceptance of the stone riprap slope protection.
- Cleanup of the bridge site, roads, stream channel and adjacent property is acceptably completed.
- Receipt of written evidence that cleanup is satisfactory to the property owner if adjacent property outside the right-of-way has been affected.
- Restoration of all disturbed stream banks and/or borrow pits satisfactorily reclaimed.

9.3 SAFETY

Refer to the Manitoba’s Workplace Safety and Health Regulation for specific safety requirements.

9.4 INSPECTOR’S RECORD

The Inspector should keep an accurate record of the following information:

- All survey information to ensure that the pay quantities can be calculated.

- All discussions and agreements between Contractor and private landowner pertaining to disposal areas.

9.5 MATERIALS

The stone riprap shall be hard, durable and angular in shape, resistant to weathering and water action.

- The rock source should be selected well in advance as the Contractor may be required to submit a sample for testing and approval.

- The material should be free of overburden, spoil, shale or organic material and must meet the gradation requirements for the class specified.

- Stone riprap must have a gradation conforming to the class specified.

9.6 PLACING

Stone riprap must be placed accurately in the locations shown on the Drawings and in the size and thickness of layers specified to be effective. Stone riprap must meet the gradation requirements for the classes specified.

Stone riprap is placed by dumping directly from trucks, by pushing with bulldozers or loaders or by placing boulders by backhoe.

- The required cross-section will be shown on the Drawings.

- The finished surface must be reasonably uniform without large cavities, and without individual stones protruding above the surface.

- Control of the gradation of stone riprap is to be done by visual inspection. The Contractor is required to arrange two samples, one near the site and one at the source, with the individual pieces weighed and marked with the weight.

- The Inspector can do his inspection by comparing the rock being placed with the displayed sample.

- The Contractor's staff loading the material can refer to the source sample to ensure that a proper gradation is loaded.

- The Contractor is required to provide all assistance necessary to confirm that the stone riprap being placed conforms to the Specifications.

9.7 CHECKLIST

9.7.1 Inspector's Responsibilities

- ❑ Review the applicable Specifications, contract documents and Drawings.
- ❑ Ensure that the Contractor obtains any necessary permits, agreements or authorizations necessary for stone riprap.
- ❑ Check the excavations and elevations of the prepared areas.
- ❑ Check that the proposed rock meets the specifications and are approved before use.
- ❑ Check that the stone riprap has an angular shape and is clean, free from spoil, overburden, organic, and meets gradation requirements.
- ❑ Check that the stone riprap is placed in trench or as shown on the Drawings.
- ❑ Compare the stone riprap material being placed to the sample set out by the Contractor.
- ❑ Survey as required to measure the stone riprap if paid by volume.
- ❑ Measure and calculate the quantities for payment.
- ❑ If stone riprap is paid by mass, ensure that the scale is approved and calibrated. Record the weight of all loads.

9.7.2 Contract Administrator / Resident Engineer's Responsibilities

Discuss the following items with the Contractor and the Inspector:

- ❑ The final grade of the headslope.
- ❑ The acceptability of the stone riprap pertaining to the quality and the gradation.
- ❑ The required final elevation.
- ❑ The final cleanup requirement.

SECTION 10 – SERVICE DUCTS AND VOIDS

10.1 GENERAL

Service ducts/conduits are normally detailed for installation in the curb /barriers /sidewalk sections.

- Service ducts/conduits are required in bridges to carry services such as telecommunication and electrical power through the bridge.
- When detailed, electrical conduit is installed to provide electrical service to lighting on the bridge.

10.2 MATERIALS

Material for service ducts and electrical conduit are generally described on the Drawings and supplied by the Contractor or utility companies. These materials must be approved by the Contract Administrator or Resident Engineer.

- Service ducts are usually rigid plastics or fiber reinforced plastic and specially made for the purpose, complete with fittings for joints, bends and end caps. The Contractor should have the material approved by the Contract Administrator or Resident Inspector prior to delivery to the site.
- The electrical conduit is usually rigid plastic of the diameter noted on the Drawings. Special expansion devices are required at the bridge expansion joints to allow movement while maintaining a weather tight seal. The Contractor may be required to provide junction boxes in the conduit to give access for making electrical connections as shown on Drawings.

10.3 INSTALLATION

The Inspector shall ensure that the Contractor installs ducts and conduits in a manner such that they are securely tied down and that the joints will be completely leak proof during casting of concrete.

- During placing of concrete the ducts will be buoyant and will tend to “float up” in the concrete. The Contractor shall securely tie them down, with approved methods.
- Any mortar leaking into a joint can negate the benefit of the void or plug the conduit and make it impossible to subsequently pull wires through.
- The Contractor is required to supply and install a pull wire inside the duct or conduit, which will be utilized during service installation.
- Any blockages encountered must be cleared to the satisfaction of the Contract Administrator or Resident Engineer.

10.4 CHECKLIST

10.4.1 Inspector's Responsibilities

- ❑ Review applicable Specifications, contract documents and Drawings.
- ❑ Ensure that Contractor's material to be used has been approved by the Contract Administrator or Resident Engineer.
- ❑ Check that electrical conduit expansion joints are provided and that the conduit is continuous.
- ❑ Check to be satisfied no mortar will leak into joints.
- ❑ Check that ducts are securely tied down to avoid buoyancy.
- ❑ Check that lamp standard anchorage assemblies are in correct position and adequately secured.
- ❑ Observe the Contractor when installing pull wire to ensure there are no blockages in ducts or conduits.
- ❑ Ensure that ducts have specified earth cover at bridge ends.
- ❑ Locate the buried ends of all ducts and note the measurements on the "As-Constructed Drawings".

SECTION 11 – BRIDGERAIL

11.1 GENERAL

Bridgerail is a critical safety item on all bridges. To provide the degree of safety required, it must be installed securely in accordance with the specifications, contract documents and Drawings. Bridgerail is the most prominent part of a bridge. The installation must be accurately done to produce true alignment and elevation*.*

11.2 INSTALLATION

Bridgerail installation includes casting in the anchor bolt assemblies and erecting/aligning of the rail. Unless otherwise specified, the posts are to be installed vertically.

- Bridgerail anchor bolts must be set very accurately as later adjustment to their height or location is virtually impossible. They must be securely held in position to prevent displacement by concrete placing operations. The Inspector must check the layout of the anchors for correct location, and should sight along the line of anchors to be satisfied that the overall alignment is acceptable.

- The bridgerail must be erected and aligned true to the required lines. The Inspector must check the alignment and the profile to ensure that the rail does not follow any unevenness in the superstructure. Expansion joints in the bridgerail must be installed as detailed on the Drawings.

11.3 CHECKLIST

11.3.1 Inspector's Responsibilities

- ☐ Review applicable Specifications, contract documents and Drawings.

- ☐ Check anchor bolts for:
  - Location and elevation
  - Overall alignment
  - Adequate attachment to forms
  - Type

- ☐ Check bridgerail installation for:
  - Secure attachment
  - Smooth and pleasing alignment both horizontally and vertically.
  - Location and gap of expansion joints.

- ☐ Check rail thoroughly to ensure any damage to galvanized surface is repaired by metalizing.

SECTION 12 – BRIDGE DECK WATERPROOFING

12.1 GENERAL

A hot poured rubberized waterproofing membrane complete with protection board is applied to the deck concrete prior to installation of the bituminous pavement wearing surface. This system is intended to stop the ingress of salt into the substrate concrete of the deck, thereby preventing concrete delamination and corrosion of reinforcing steel.

- It is **IMPERATIVE** that the waterproofing be applied in accordance with the Specifications, contract documents and Drawings.
- The Inspector shall ensure that all phases of work relating to the application of the waterproofing system are performed properly and completely for each subsequent operation.

12.2 ENVIRONMENTAL CONSTRAINTS

Be aware of the environmental constraints. Note the following requirements:

- All over sprayed tack oil shall be satisfactorily removed and cleaned.
- Waterproofing material should not enter into a stream or adjacent embankments.
- Deck sandblast spoil shall not be blown into the stream.

12.3 SAFETY

The bridge deck waterproofing procedures requires the use of “hot” material and proper protective equipment must be worn.

Site meetings between the Contract Administrator, Resident Engineer, the Inspector and the waterproofing contractor should address all safety concerns.

- The Inspector must monitor the safety practices of the waterproofing Contractor.
- Issue “STOP WORK” order to Contractor, if necessary.
- Be aware of the public traffic.

Traffic control usually only applies to the restoration of an old structure, since a new structure is normally closed to traffic.

- Traffic control may be adjusted to suit specific traffic conditions.

12.4 WEATHER

If weather factors are detrimental to the acceptable placement of waterproofing, the work should be suspended until suitable conditions exist.

12.5 SURFACE PREPARATION

To be effective, it is **ESSENTIAL** that the bridge deck be properly prepared before applying the waterproofing. The existing surface of the concrete is completely sandblasted or shot blasted to expose sound, laitance free concrete. It is imperative that the Inspector approves the surface preparation before the Contractor applies the tack coat.

12.6 APPLICATION OF WATERPROOFING

When applying the deck waterproofing, the requirements of the Specifications must be followed.

12.6.1 Tack Coating Deck Surface and Curbs with Primer

The clean, dry, dust free concrete deck surface and portion of front face of curbs must be treated with a primer prior to the application of the waterproofing.

- The primer will turn brownish in color when cured.
- The primer should be applied to the vertical curb face for the full height of the bituminous pavement.
- The primer may be applied by brushing or spraying but brush application is preferable for curb face.

12.6.2 Applying Butyl Rubber Membrane

- In addition to the hot asphalt membrane, a butyl rubber membrane material is applied to all cold joints, grout keys and up on the curb face or other areas as determined by the Contract Administrator or Resident Engineer.

12.6.3 Applying Hot Waterproofing Membrane

The asphalt membrane is manufactured by an approved manufacturer and supplied in cakes to the job site for re-melting. The asphalt membrane should be melted in an approved mechanically agitated heating and mixing unit*,* capable of maintaining the material at the manufacturers recommended temperature.

- Ensure the re-melted membrane in the mixer is at the required temperature prior to application.
- Ensure the re-melted membrane in the mixer is uniform and free of lumps.
- Apply waterproofing over the entire deck area including the rubber membrane strips and up the curb face to the required grade of the bituminous pavement.
- Ensure that the waterproofing covers the underside and the surrounding areas of the deck drains and the vertical face of any deck joints.

12.6.4 Applying Protection Board

The function of the protection board is to prevent the paving equipment and the coarse aggregate in the hot mix from damaging the pliable membrane. Care must be taken to ensure the spreading of the hot waterproofing membrane does not get too far ahead of the protection board placement, as the membrane will lose its tack upon cooling. Protection boards are to be used in conjunction with the asphalt membrane only.

- The boards are laid into the waterproofing membrane before it loses its initial tack, with the length of the board running transverse on the deck.
- Subsequent rows of protection boards are placed with the longitudinal joints staggered and all joints overlapped according to specifications.
- The boards overlap ___ mm.

- The boards must be cut to fit within 6 mm of the curb barriers and deck drains.
- Bituminous pavement must be installed as soon as possible following the waterproofing application to prevent the corners of the protection boards from curling up and damage from water ponding along the curbs / barriers.

12.7 CHECKLIST

12.7.1 Inspector's Responsibilities

- ❑ Review Specifications, contract documents and Drawings.
- ❑ Inspect the dryness and cleanliness of the deck surface prior to proceeding with the waterproofing application.
- ❑ Monitor the uniform application of primer and adequate curing.
- ❑ Calculate the application rate for primer and hot asphalt membrane outlined in the Specifications.
- ❑ Check the membrane thickness frequently.
- ❑ Sample the hot asphalt membrane as required.
- ❑ Check that the kettle temperature is maintained within the recommended application range.
- ❑ Check to ensure that the protection boards are not damaged and are overlapped sufficiently during installation.
- ❑ Monitor the uniform application of SS-1 emulsion over the protection boards and that there is sufficient curing prior to paving.

SECTION 13 – BITUMINOUS PAVEMENT

13.1 GENERAL

Bituminous pavement consists of well-graded crushed coarse aggregate, fine aggregate and asphalt cement. When these components are properly mixed in an asphalt plant, a hot asphalt mixture is produced. This hot asphalt concrete, when properly placed and compacted on the bridge deck, provides a smooth riding surface.

- Bituminous pavement normally consists of two nominal 40mm compacted lifts.
- An SS1 Emulsion Tack Coat must be applied to the surface being paved and the subsequent course, at a rate of 500 ml/m^2.
- Aggregates used must be sound, hard, durable and free of deleterious materials.
- Requirements of the bituminous pavement wearing surface should be as specified.

13.2 ENVIRONMENTAL CONSTRAINTS

Be aware of the environmental constraints. Note the following requirements:

- Before final acceptance of the bituminous pavement on a structure, the Contractor is required to remove all excess material, clean up and restore site to its original state.
- All over sprayed tack oil shall be satisfactorily removed and cleaned.
- Asphalt materials should not be wasted into stream or adjacent embankments.

13.3 SAFETY

It is important to have a pre-job meeting with the paving and sub-contractor as well as the general contractor to discuss all the safety issues.

- Be aware of the public traffic.
- Issue “STOP WORK” order to Contractor, if necessary.

13.4 MATERIALS & EQUIPMENT

In order to achieve the desired product, the material and equipment for asphalt concrete pavement must meet the requirements of the Specifications. Following are major points pertaining to the material and equipment that should be noted.

13.4.1 Materials

It is important that the material and the approved mix design used are strictly controlled. The mix design must comply with the contract specifications and requires the approval of the Contract Administrator or Resident Engineer.

- There are two types of mix designs, Class A and Class B, depending on the road system where the bridge is located. Class B is typically specified.

13.4.2 Equipment

The equipment and method used for this work should be adequate to produce and place the material as specified, and should be subject to the approval of the Contract Administrator or Resident Engineer.

- The paving plant must be calibrated to produce the designated mix gradation and asphalt content, to ensure mix uniformity and consistency.
- Tanks for storage of asphalt cement should be equipped with suitable devices capable of heating the material effectively and able to control the temperature.
- Equipment for spreading should be a self-propelled mechanical paver, equipped with an automatic screed or strike-off assembly to provide the desired cross-section and profile.
- Compaction equipment should equal or exceed the placing rate of the spreading equipment and should be capable of obtaining the required density before the temperature of the mixture is too low.
- Vibratory rollers shall not be used on structures.

13.5 SPREADING AND COMPACTION

During the spreading and the compaction operation, ensure that:

- Asphalt mix is not wasted over the sides or onto adjacent mats.
- Damage is not done to the waterproofing, curb, drains or barriers.
- Damage is not done to bridgerails, guardrails, signs, and utility conduits.
- Each lift of asphalt has a nominal 40mm compacted thickness.
- All longitudinal and transverse joints are vertical butt joints and are staggered.
- Vibratory rollers are not used on the bridge deck.
- Compaction is continued until all roller marks are eliminated and the specified density is reached.
- The designed grade of the bridge is achieved ensuring that there are no local low spots on the deck.
- For short pavement transitions to tie in bridge decks and existing pavement surface, use a string line and straight edge to check the surface profile.

13.6 CHECKLIST

13.6.1 Inspector's Responsibilities

- ❑ Review Specifications, contract documents and Drawings.
- ❑ Check survey and proposed grade-line for bituminous pavement as proposed by Contractor.
- ❑ Check to ensure the tack coat is sufficiently cured.
- ❑ Record the equipment and manpower of the Contractor.
- ❑ Take the asphalt temperatures and samples during paving operation.
- ❑ Check the longitudinal smoothness of the surface.
- ❑ Monitor the surface texture, e.g. segregation, roughness and porous areas.
- ❑ Check cross fall for drainage.
- ❑ Inspect the site cleanup.
- ❑ Inspect the longitudinal sawcut and excess removal of bituminous pavement where required.

13.6.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Discuss with the Inspector and the Contractor regarding the paving methods and procedures.
- ❑ Discuss with the Inspector and the Contractor regarding the environmental and safety concerns.
- ❑ Discuss with the Inspector and the Contractor regarding the site cleanup and disposal of waste material.

SECTION 14 – PARTIAL DEPTH DECK REPLACEMENT

14.1 GENERAL

This section covers the work required to repair and partially replace existing bridge decks. This work is usually carried out on one half of the deck at a time, while traffic is maintained on the other half. This section describes the materials, equipment and construction methodologies required to place an acceptable new concrete deck.

14.2 ENVIRONMENTAL CONSTRAINTS

Be aware of any environmental constraints.

- Concrete must not enter into the water channel.
- Debris must not be thrown into the water channel.
- Ensure milling and hydrodemolition sandblasting operations meet all requirements.
- Ensure that the bridge site and the concrete batch site (if applicable) are satisfactorily cleaned up.

14.3 SAFETY

Refer to the Manitoba's Safety and Health Act and Regualtions.

14.4 INSPECTOR'S RECORD

The Inspector should keep an accurate record of the following information:

- Discussions with the Contractor regarding traffic control, and other potential issues.
- Profile elevations at 3 meter intervals of original riding surface and milled surface along centreline and gutter lines.
- Plotted elevations of hydro-demolished surface and new final grade line.
- Deck joint elevations and gap settings, where applicable
- Areas of full depth repairs
- Screed-rail elevations as compared to the proposed grade line
- Dry-run thickness (i.e. screed heights)
- Quantity calculations
- Quality control and quality assurance data
- Any rejected concrete
- Weather conditions

14.5 DECK SURFACE PREPARATION

The following steps should be taken to ensure that the deck to be cast over is properly prepared:

- Remove all bituminous pavement and water proofing membrane
- Remove concrete as specified on Drawings.
- Remove all areas of deteriorated concrete.
- Hydro-demolish the area to be overlayed including any exposed reinforcing steel.

14.6 SURFACE REMOVAL AND DISPOSAL

All bituminous pavement, waterproofing membrane, tack coat, and 5 mm of the underlying deck concrete is to be removed by milling. On bridges not having deck joints, a saw cut shall be made, through the full depth and width of the asphalt at both ends of the bridge should be made prior to milling.

- Thickness of the bituminous pavement will vary and care should be taken not to remove more than 10 mm of concrete from the deck surface. The reinforcing steel in the existing deck shall not be damaged by the milling procedures.
- The Inspector should check to ensure roto-milling is carried out as close as possible to all curbs, paving lips, drains and deck joints without causing damage. Manual chipping equipment will be required for use in these areas.
- All debris should be disposed of in an approved area.

14.6.1 Removal of Existing Concrete

Concrete should be removed in such a manner as to prevent damage to adjacent concrete, and other components and utilities that are to remain in place. This includes reinforcing steel, pre-stressing tendons, shear connectors, structural steel and expansion assemblies that remain in the structure.

- Concrete removal shall extend below the top layer of reinforcing.
- Concrete removal should not take place within 1 meter of newly placed concrete for a minimum period of 48 hours.
- Corroded reinforcing shall be replaced if the section loss is 20% or greater.
- Only small chipping hammers are to be used for removal of concrete around reinforcing bars specified to remain.
- Only chipping and/or jack hammers should be used for concrete removal in locations within 100 mm from concrete to remain in place, for the removal of concrete adjacent to the deck joints and for the removal of the concrete above the steel girders which are integral with the deck.
- Air hammers should not contact reinforcing steel in a manner that will cause de-bonding of the reinforcing steel in the adjacent concrete areas that are not being removed.
- All unsound concrete should be removed as specified to provide a sound surface on which to bond the new concrete.

- Partially exposed rebar should be entirely exposed by removal of the concrete to a depth of 20 mm below the rebar.
- All exposed rebar surfaces to remain should be sandblasted to a white metal finish immediately prior to casting the new concrete.
- It should be noted that flash rust can occur on the sandblasted reinforcing when the concrete is pre-wetted to saturated surface dry (SSD) condition prior to the pour.
- It is recommended, for long decks, to sandblast the concrete and reinforcing steel to 95% completion and brush blast prior to wetting down the deck the night before the pour date.
- Removed deck concrete should be replaced monolithically with the deck concrete.

14.6.2 Full Depth Removal and Patching

Where the deck deterioration extends completely through, as possibly evidenced by areas of dark or white alkali staining on the underside of the deck, all unsound concrete should be removed as specified and replaced with concrete, monolithic with the placement of the new concrete. Full depth patching exceeding 2 m^2 should be carried out prior to casting of the new concrete to avoid dislodging the formwork by screed action.

- The Inspector shall mark out those areas to be removed for the full-depth by visual inspection, sounding and/or chain dragging.
- The perimeter of all patches should be as square as possible to eliminate broken and feathered edges.
- All exposed rebar should allow for new concrete completely around reinforcing.
- All exposed surfaces are to be sandblasted and blown clean immediately prior to casting.
- The underside of the deck should be formed to neatly restore the original lines of the concrete.
- Before placing a concrete patch, the surface of the adjoining concrete should be saturated with water for a period of no less than 30 minutes and coated with a bonding agent immediately ahead of the fresh concrete.
- Consideration should be given to include galvanic anodes at the perimeter of the patch.
- The concrete must be adequately vibrated, and trowelled smooth and flush to the existing concrete.
- Pre-soaked filler-fabric must be placed on the concrete patch immediately after trowelling and kept continuously wet for the 7 days or until the new concrete is placed.

14.9 INSPECTION AND TESTING

Tests for air content, slump, temperature and compressive strength should be taken as follows:

14.9.1 Air Content

This test should be made for each batch prior to placing and will be sampled and tested in accordance with CAN/CSA A23.2-4C.

- The required air content considering the retention requirement is 5 – 8%.
- Adjustments in the field should be made for concrete not meeting the air content requirement.
- If additional air entrainment is required, it should be compatible with other admixtures.
- Concrete loads not meeting the specified air content should be rejected.

14.9.2 Slump

A slump test should be made for each batch prior to placing and will be sampled and tested in accordance with CAN/CSA A23.2-5C.

- The required slump should be determined by the Contractor based on placeability and finishability.
- Adjustments to the mix in the field should be made for concrete not meeting the slump requirement.
- If additional superplasticizer is required, it should be compatible with other admixtures.

14.9.3 Temperature

Temperature of the concrete should not be less than 10°C, nor more than 18°C, at the time of placing and should be maintained below this maximum temperature with the inclusion of ice to the mix as approved by the Contract Administrator or Resident Engineer.

- Care should be taken to maintain the design water-cement ratio.
- The temperature should be taken for each batch.

14.9.4 Compressive Strengths

Making and curing test cylinders shall be carried out in accordance with CAN/CSA A23.2-3C.

- Suitable all weather storage for test cylinders as per Section 5.3.2.1 of CAN/CSA A23.2-4C, for a period of up to 48 hours until removed from the site, should be available.
- One "Strength Test" consisting of one cylinder for 7 days and three cylinders for 28 days testing is required for approximately each 10 m^3 of concrete poured.
- Additional cylinders may be cast for strength testing at other ages.

14.10 HANDLING AND PLACING CONCRETE

In general, adequate arrangement should be made to ensure disruption of the pour would not happen due to equipment failure.

- The equipment should be suitable for the job and clean and free of coatings of hardened concrete, which would interfere with its proper function.

14.10.1 Finishing Machine

Acceptable finishing machines are Gomaco Model CA450, Bidwell Model RF200 or Model 364, which should be provided in good working condition and with proper alignment

- The length of the screed should be sufficient to extend at least 150 mm beyond the line of the saw cut.

14.10.2 Screed Guide Rail

Rails should be installed to suit the profile of the required surface and to ensure a smooth and continuous surface from end to end of the bridge.

- Guide rail must be located outside finished surface of the pour, and should be installed so that a whole day's pour may be made without resetting rails.
- Rails should be installed with supports at 350 mm, maximum spacing.
- The support should be fully adjustable by screw mechanism. No shims are to be used.
- No deflection of rails between supports shall be tolerated.

14.10.3 Work Bridges

Two work-bridges are required of adequate length and sufficient strength to support two workers to completely span the width of the pour.

- The work bridges should be supported parallel to the concrete surface and at least 250 mm above it.
- One work bridge is used to accommodate the concrete finishers and the Inspector for straightedge checking and it should have a minimum width of 800 mm.
- The second work bridge will enable placing of the curing blankets and initial sprinkling with water.
- The work bridges should be rigid enough that dynamic deflections are not noticeable.

14.10.4 Dry Run

The screed rails should be properly set to ensure longitudinal and transverse drainage from the deck without pond areas or "bird baths".

- Sufficient screed guide rails for the entire pour should be set out, adjusted for height by the Contractor and then independently checked by the Inspector and the Contract Engineer/Resident Engineer the day prior to the pour.
- The system for anchorage of the supporting rails should provide horizontal and vertical stability.
- Hold-down devices shot into the concrete should not be used.
- The minimum thickness of partial depth replacement will normally be 100 mm, or as determined by the Contract Administrator or Resident Engineer.

14.10.5 Cement Slurry Grout

The grout for bonding the new concrete to the existing deck consists of equal parts by weight of 50% type 10 Portland Cement and 50% sand of maximum 2.5 mm size mixed with sufficient water to form a slurry.

- Prior to the slurry grout application and after all deck preparations are complete, the entire deck should be continuously soaked with clean water for a minimum of 3 hours or more depending upon the porosity of the substrate concrete.

- Immediately preceding the concrete placing operation the deck should be blown free of all surface water.

- The slurry grout should be applied immediately prior to placing the new concrete, and in no case should the grout be permitted to dry before the placing of the concrete.

- The consistency of the slurry should be such that it can be applied with a stiff brush or broom to the existing concrete surface in a thin even coating that will not run or puddle in low spots.

- For sealing vertical joints between adjacent lanes and at curbs, the grout should be thinned to paint consistency.

- Mixed grout not yet deposited, should be re-agitated at frequent intervals to prevent segregation.

- Any grout that has not been placed within 45 minutes must be rejected.

14.10.6 Concrete Placement

It is important that every precaution necessary be taken to produce quality concrete with a smooth riding bridge deck that is within the tolerances indicated in the Specifications and contract documents.

- Concrete should not be placed when the air temperature is below +5 °C or above +25 °C, nor in the event of rain or excessive wind or dust, nor when other conditions as judged by the Contract Administrator or Resident Engineer are considered detrimental to the concrete pour.

- Night pours need to have proper lighting.

- Placement of the concrete should be a continuous operation throughout the pour.

- Concrete should be placed so as to avoid segregation of materials.

- Sufficient vibration should be provided to properly compact the mix. Excessive vibration may cause segregation.

- No more than 30 minutes should elapse between discharge truck mixers. If the delay in placing exceeds 30 minutes, the exposed edge of the concrete should immediately be covered with wet burlap. If the cement slurry grout is allowed to dry, it should be removed by sandblasting.

- In the event that due to equipment breakdown, concrete placement is stopped or delayed for a period of 90 minutes or more, further placement should be discontinued and may be resumed only after a period of not less than 12 hours.

- The fill-in section should be placed after a period of not less than 12 hours.

- The edge of any discontinued pour should be sawcut and sandblasted before placing further concrete.

- Concrete should not be placed adjacent to a surface course less than 72 hours old. This restriction does not apply to continuation of placement in a lane or strip beyond a joint in the same lane or strip.

- The width of initial deck sections placed should extend at least 150 mm beyond the longitudinal joint.

- Prior to placing subsequent sections, the surface course previously placed is to be saw-cut along the longitudinal joint, excess overlay concrete removed, and the edge and the area sandblasted.

14.10.7 Screeding Concrete

The finishing machine should be moved slowly and at a uniform rate and screeding should be completed in no more than two passes.

- The newly placed concrete may require “re-screeding” if the desired grade line is not obtained.

- The screeded surface should not be walked on or otherwise damaged.

- Hand finishing will be required in areas adjacent to curbs/barriers, which are inaccessible to the screed.

- Concrete adjacent to deck drains should be hand finished to provide proper drainage.

14.10.8 Bull Floating

The concrete surface produced behind the finishing machine should be magnesium floated the minimum amount necessary to ensure that the surface is free from open texturing, plucked aggregate and local projections or depressions.

14.10.9 Straight Edge Checking

After bull floating and prior to texturing, the Contractor should check the grade and tolerance of the surface of the concrete with a minimum 3 meter long straight edge. This is to be done if the finishing machine is not producing an acceptable finished profile.

- The entire surface should be checked, and any areas not meeting the requirements of the Specifications should be corrected.

- Care should be taken to preserve the crown and cross-section of the roadway.

- Special attention will be required to ensure that there is a smooth transition between the newly placed concrete and deck joints.

14.10.10 Sealing Joints

The vertical joint with the first half (or any transverse joints) should be sealed by “painting” with grout.

14.10.11 Surface Texture

After the concrete has been bull-floated, it should be given a suitable texture with an approved texture tool having a single row of tines with rounded leading edges.

- The desired texture is transverse grooving which may vary from 1.5 mm width at 10 mm centres to 5 mm width at 20 mm centres, and the groove depth should be 3 mm to 5 mm.

- Texturing shall be done at such a time and in such a manner, that the desired texture can be achieved while minimizing the displacement of the larger aggregate particles or fibres.

- It is essential that the concrete surface not be “torn” during this operation.
- Achieving a satisfactory texture on a fibre reinforced concrete is difficult requiring a worker competent in this work.
- Several types of wire brooms, rakes and combs should be available on site so that the one giving the best result can be selected.
- Following the surface texturing, 300 mm of the overlay along the curb should be trowelled smooth and the surface left closed so that a gutter is formed.
- In the event the texture is not satisfactory, sawcut grooves may require to be cut in the concrete surface after initial curing.

14.10.12 End of Deck at Abutments

The deck concrete should be placed to match the deck joints, or as determined by the Contract Administrator or Resident Engineer.

14.10.13 Surface Defects and Tolerances

The finished surface of the deck should conform to the grades and contours required.

- The surface should be free from open texturing, plucked aggregate or fibres, and local projections.
- Except across the crown, the surface should be such that when tested with a 3 meter long straight edge placed anywhere in any direction on the surface, there should not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the deck.
- Areas that do not meet the required surface tolerance should be clearly marked out, removed and replaced.
- If the surface is damaged in any way by construction operations, or if the deck shows signs of distress or scaling prior to final completion, it should be cut out and replaced.

14.11 WET CURING

Following sealing the joints with grout, and surface texturing, the concrete should be covered promptly with a single layer of clean, filter fabric.

- The curing material should be applied as soon as the surface will not excessively be marred by so doing, normally within 30 minutes after the concrete has been deposited on the deck or as determined by the Inspector.
- The curing blankets should be overlapped by 150 mm.
- The curing blankets should be wet but not dripping water before being used for curing.
- Moist curing should be maintained for 7 days.
- Once the concrete has set, the curing blankets should be kept continuously wet by means of an automatic sprinkling system or other approved method.

14.12 CONCRETE SEALER

Concrete sealer such as silane (Type 1c, 100% silane) may be applied only to dry concrete, which has cured a minimum of 14 days and air-dried for a day. Silane sealer will not penetrate a wet concrete surface.

- In order to ensure uniform and sufficient coverage rates, the sealer should be applied to the concrete surface in measured volumes of sealing compound to dimensional areas using a minimum of 2 coats, at the application approved rate.

- After sealing, traffic should not be allowed on the overlay until the sealer has dried.

- The sealer should be protected from rain or splash until it has sufficiently cured.

14.13 CHECKLIST

14.13.1 Inspector's Responsibilities

- ❑ Ensure proper traffic control and safety to the public, are in place.
- ❑ Ensure proper saw cutting prior to milling.
- ❑ Check depth of milling to prevent over milling.
- ❑ Ensure milling is carried out next to curbs, paving lips, drains and deck joints without causing damage.
- ❑ Check depth of hydro-demolition to prevent excessive removal.
- ❑ Mark out unsound concrete areas for full depth removal.
- ❑ Advise on disposal of debris.
- ❑ Set the deck profile and advise on the minimum thickness of new concrete and be present at the "Dry Run" to ensure all operations have been completed.
- ❑ Ensure testing by Contractor of the mix concrete for the following:
  - Air content
  - Slump
  - Temperature
  - Compressive strength cylinders - 4 per 10 m^3 of concrete placed

14.13.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Mix design for concrete to be forwarded for approval.
- ❑ Advise on the conditions when the concrete is to be poured (temperature and need for ice, wind, dust, time of day, etc.).
- ❑ Calculate screed heights.
- ❑ Advise on the course of action if the pour is delayed.
- ❑ Advise on the acceptability of the texturing operation (determine repair option).
- ❑ Advise on the end treatment at the abutments.
- ❑ Approval of the type and duration of the wet curing.
- ❑ Approve the application rate of the concrete sealer.

SECTION 15 – CONSTRUCTION OF CSP AND SPCSP STRUCTURES

15.1 GENERAL

The construction of Corrugated Steel Pipe (CSP) and Structural Plate Corrugated Steel Pipe (SPCSP) includes the supply, fabrication, delivery and installation of all culvert and culvert enhancement materials.

15.2 ENVIRONMENTAL CONSTRAINTS

- Fishery concerns
- Environmental Site Management Plan requirements
- Easement and site access
- Stream flow accommodation – stream diversion
- Siltation prevention measures
- Climatic and ground water conditions
- Seepage control requirements
- Disposal of unsuitable backfill or waste material

15.3 INSPECTOR'S RECORD

It is important for the Inspector to keep an accurate and detailed record, with photographs where possible, to minimize any potential extra claims.

- Record culvert conditions after fabrication, delivery and installation:
  - CSP or SPCSP Fabrication Inspection Report,
  - Culvert Installation Inspection,
  - Culvert Barrel Measurements, etc.
- All survey information:
  - Profiles and cross-sections,
  - Culvert locations or alignments,
  - Elevations and cambers,
  - Span and rise measurements, etc.
- All quality control and quality assurance test results.
- Sieve analysis for all granular backfill material and for concrete aggregates, as specified
- Record details of discussions and/or instructions conveyed to the Contractor:
  - Minutes of site meetings
  - Work schedules and work methods
  - Any site instructions or stop work orders
  - Extra work orders
  - List of deficiencies, rejections and acceptances, etc.

Prior to excavation, the Inspector must take a series of levels of the ground surface in the area of the excavation to confirm the existing ground line is the same as shown on the Drawings. This survey forms the datum for calculations of the excavated quantities and provides information for future reference, settlements of disputes, etc. Photographs of the original ground of the non-excavated site are required to record conditions prior to the beginning of excavation.

- It is the responsibility of the Contractor to ensure that there are no utilities in the area to be excavated or, if there are utilities that they are accurately located, protected and/or relocated by the utility company.
- The Inspector should record the elevations of groundwater, stream water levels and tops of berms and dikes.
- The Inspector should record the material type excavated. The Contract Administrator or Resident Engineer shall be notified if soft and yielding material is encountered to review the need for foundation modifications.
- Photographs and records of equipment used for excavation are necessary for reference purposes.

It is important that the Inspector keep an accurate record of the following backfill items:

- In situations where the backfill is deficient and extra backfill material is anticipated in order to achieve the final gradeline, it is essential to obtain and record before and after cross-sections so that an accurate quantity of the extra backfill material can be calculated for payment purposes.
- The results of density tests need to be accurately recorded in order that rejection or acceptance of a backfill material can be validated.
- All rejected work should be recorded.
- Include the date and any related discussions held with the Contractor, and stated reasons for rejection of any work.

15.4 SUPPLY, FABRICATION AND DELIVERY

Supply and Fabrication of CSP and SPCSP are to be in accordance with CSA Standards G401 with additions and exceptions described in the Standard Construction Specifications.

- Double zinc coating mass on both sides of pipe shall not less than, 1220 g/m^2 when tested by the triple spot test or 1100 g/m^2 when tested by the single spot test.
- Five copies of the shop drawings for any non-standard materials, (elbows, bottomless arch details, SPCSP bevel end details, horizontal ellipses, etc.) are required to be submitted to the Contract Administrator or Resident Engineer for review prior to fabrication.
- SPCSP plate arrangement of the bolts in the valley of each longitudinal seam shall be nearer to the visible edge of the plate than the bolts in the crest.
- One set of the assembly drawings must be supplied with the material to the site.
- All pipe supplied shall be clearly marked with the following information at intervals of not more than 3 metres.
  - Manufacturer's name or trade mark
  - Nominal thickness and type of metal
  - Plate/metal coating for non standard coating
  - Specification designation

- Plant designation code
- Date of manufacture
-

15.4.1 SPCSP Fabrication

- SPCSP material shall be unloaded and stockpiled in a neat and orderly manner, in order to facilitate inspection of inventory.
- SPCSP material is to be stored concave down to reduce the occurrence of strain damage on plates which are not going to be assembled immediately.
- All culvert material shall be handled carefully and in such a manner as to prevent bruising, scaling or breaking of the galvanized coating.

15.5 INSTALLATION

The installation of CSP and SPCSP includes excavation, bed preparation, pipe assembly, backfill and culvert enhancements.

15.5.1 Excavation

Installation of culverts generally involves “short-term” vertical and/or sloped excavations in order to:

- Divert water around the site.
- Remove soft or yielding material at least 600 mm below the culvert invert so as to provide a firm foundation.
- Remove solid rock material 150 mm to 300 mm below the culvert invert so as to provide for the bedding layer. Place the culvert below average streambed elevation.
- Provide enough space for assembly of the culvert and operation of equipment for placement and compaction of the structural fill.
- Place stone riprap at the ends of the culvert.

All excavations below finished gradeline for the installation, removal and/or salvage of culverts, placement of stone riprap, and stream diversions are classified as “channel excavation”. The only exception is when solid beds or masses of rocks or boulders exceeding 0.5 cubic metres are encountered, in which case that portion of the excavation is classified as “rock excavation”.

In general, the excavation for culvert installation should extend 600 mm below the pipe invert for the entire width of the excavation. The width of the excavation is defined as the pipe width plus 3 m at the invert elevation. The sides of the excavation are generally sloped at one horizontal to one vertical but should be adjusted depending on the depth of excavation, soil type and climatic conditions. The Contractor should also consider extending the excavation limits to include the bedding requirements for stone riprap.

The excavation is to be carried out to the design lines as shown on the Drawings. Over excavation for any reason will not be paid for unless recognized and proven as necessary by the Contract Administrator or Resident Engineer.

In some cases additional excavation may be required to:

- Provide more space for assembly, large excavation equipment, etc.

- Remove soft or yielding material to the specified depth below the pipe invert and/or the specified distance from the side of pipe.

- Stabilize the sides of the excavation by providing benches.

In general, vertical banks are not allowed in accordance with Workplace Safety and Health requirements. Some soils will stand at considerable depths vertically while most will slough off to a stable angle or slide into the excavation. Sandy soils will tend to slough during excavation while cemented sands, silty clays and clays will stand up to greater depths.

For excavation in wet areas or excavation at the toe of the slope the following should be considered:

- Minimize the time the excavation has to remain open by proceeding immediately with backfill and culvert assembly.

- Unload the top of the slope as much as possible – remove spoil pile, construction material equipment, etc.

- Do not allow construction equipment to park or travel on the top of the slope – the minimum distance from the top edge should be equal to or greater than the depth of the excavation.

- Use appropriate dewatering and/or drainage scheme.

- Prevent surface runoff from entering the work area.

- Consider using appropriate excavation equipment.

- If possible, excavation below the invert should be done in short sections and backfilled immediately.

- In special circumstances, undertake excavation during freezing conditions.

- Use geotextiles and/or perforated pipe to minimize the depth of excavation.

Sloped or vertical excavation, the type of soil and its moisture content will generally dictate the type of excavation equipment required. The common types of excavation equipment are excavator or backhoe.

15.5.2 Bedding

The bedding is that portion of the structural fill in contact with the bottom of the pipe and consists of the following layers:

- The 150 mm lift of crushed granular material below the pipe invert, placed in a loose uncompacted state.

- 600 mm of granular backfill material compacted to a minimum of 95% of Standard Proctor Density at optimum moisture content in 150 mm lifts.

15.5.3 Culvert Assembly

Placing and assembly of the pipe may proceed only after the excavation, foundation and bottom bedding material and shape have been inspected by the Inspector and approved by the Contract Administrator or Resident Engineer.

SPCSP plates shall be correctly assembled as shown on the drawings provided by the pipe supplier and as outlined below:

- Follow manufacturer's instructions,
- Correct lapping of plates,
- Correct torquing of bolts (200 to 340 Nm),
- Maintain shape within 2% of design shape. The Contractor shall supply and install devices to monitor the shape of pipe.
- Correct contact (nesting) between plates.
- Torch cutting of holes or welding on the pipe is not permitted.

15.5.4 Backfill

CSP and SPCSP are flexible structures. Their integrity depends on the properties of the steel and structural fill, and the details of the construction process.

- Structural backfill consists of granular material except at the ends of the pipe when clay seepage "caps" are specified within a structural fill envelope.
- Embankment fill beyond the structural fill envelope may be approved by the Contract Administrator or Resident Engineer.

Granular material has the following favorable characteristics:

- Compaction is easier to control since it is not too sensitive to moisture content and temperatures.
- Higher shear strength is obtained and is not significantly affected by moisture content.
- Higher bearing capacity.
- Low potential for frost action due to its free draining characteristics and large void ratio.
- Can be placed and compacted at 0°C thus allowing more flexibility for installation.
- Generally non-corrosive when compared to clay material.
- Negligible compressibility under high loads when saturated.
- Excellent workability as a construction material.

15.5.4.1 Compaction

All structural fill, except the 150 mm of granular material immediately below the pipe invert which is placed in a loose uncompacted state, must be compacted to a minimum of 95% Standard Proctor density at optimum moisture content in 150 mm lifts compacted. The structural fill is compacted in order to:

- Increase the soil strength in terms of higher bearing capacity.
- Decrease the compressibility of the soil thereby reducing the settlement.

- Decrease the void ratio which reduces inter-granular movement.

- Increase the passive resistance of the fill and thus reduce horizontal deflections.

- Provide uniform support along the pipe thus enhancing the soil-steel interaction.

- Compaction equipment includes a variety of sizes and shapes of rollers and tampers.

- Method of compaction:
  - Mechanical rollers
  - Hand operated tampers
  - Water jetting

- Field compaction control tests:
  - Nuclear methods

Large diameter SPCSP may require preshaping of the bedding to match the curvature but should terminate 200 mm from the top edge of the bottom plate, to facilitate proper pipe installation in order to:

- Reduce pipe deflection during assembly.
- Minimize rotation during backfill operation.
- Ensure firm contact with bottom surface of the pipe.

Camber is specified when the soil cover is high enough to cause long term differential settlement along the pipe invert. The top surface of the bedding must be constructed on a gradual crest curve with no sudden breaks in the grade. Sharp transitions in the grade will make culvert assembly difficult.

Materials in the haunch areas are considered critical to the integrity of the structure. Ensure that:

- Materials are of high quality and are compacted to 95% of Standard Proctor density at optimum moisture content.

- Material is carefully placed in thin layers and is compacted either using manual labour, manually operated air driven compactors, or water jetting.

- Material fills all corrugations and provides firm contact with the pipe.

15.6 BACKGROUND ON CULVERT ENHANCEMENTS

The following structural enhancements are specially designed additions or special features added to culverts to increase the limits of their structural performance and scope of application:

- End Treatment consists of:
  - Cut-off wall to prevent scouring and undermining of the ends of the culvert.
  - Shoulder or collar continued over the crown of the pipe to provide stiffening and stability and counteract buoyancy or hydraulic uplifts and to provide smooth transition thus decreasing entrance and exit losses with an increase in flow capacity.

- Concrete Headwalls are used for aesthetic reasons or more often as a retaining wall on the upper portion of the culvert to reduce overall longitudinal length.

- Steel Headwalls are used for small culverts where buoyancy and flexibility are not a concern. Since these headwalls are not designed to act as retaining walls for the road embankments, the longitudinal length of the pipe cannot be reduced as much as if concrete headwalls were used.

- Fish baffles consisting of Precast Concrete, Cast-In-Place Concrete, Metal or Natural Rock are used to facilitate the passage of fish. Baffles have several effects in addition to provide resting areas for fish, they increase the invert roughness with a resulting boundary envelope of lower velocity which facilitates fish migration and encourages natural sedimentation of the invert.

- Reinforcement Ribs are commonly used in large elliptical culverts to provide additional bending moment capacity and cross-sectional area for the top arch to withstand the increased dead loads from the high cover.

- Thrust Blocks are continuous longitudinal structural stiffeners attached to the culvert along the junction of the side and top arc seams providing additional stiffness along critical seam. They also aid backfill compaction in this otherwise difficult area with a vertical face.

- Attached Concrete Slabs consist of a composite reinforced concrete slab cast onto the top arc portion of low profile horizontal ellipses and open arch flexible steel culvert.

- In the case when the amount of cover over the pipe does not meet the minimum requirements, Unattached Concrete Slabs are used to transfer most of the live loads to the backfill on the sides of the pipe.

- Releasable Joints are used on large horizontal ellipse or arch pipes to promote positive arching and/or permit relative vertical movement of the top and bottom arcs.

- The joint between two arcs can be left loose to enable their relative movements and eventually be tightened.

15.7 CHECKLIST

15.7.1 Inspector's Responsibilities

- ❑ Review and be familiar with applicable Specifications, Special Provisions and Drawings.
- ❑ Review arrangements of access routes and disposal area.
- ❑ Ensure Contractor complies with environmental permit conditions.
- ❑ Observe how excavation and insitu material behaves on exposure to weather and water.
- ❑ Confirm elevations and dimensions at the bottom of excavation.
- ❑ Report unusual seepage condition or unstable foundation condition to the Contract Administrator or Resident Engineer.
- ❑ Keep good records of any excavation extending beyond the required depth.
- ❑ Ensure Contract Administrator or Resident Engineer approves the backfill material.
- ❑ Check backfill material frequently to see it is free from topsoil and roots, large lumps and frozen material.
- ❑ Be aware as to where granular and non-granular types are required.
- ❑ Check that backfill material is being placed to the same elevation on both sides of the culvert in 150 mm lift compacted.
- ❑ Ensure density tests are completed as required.
- ❑ Ensure concrete tests are completed as required.

15.7.2 Contract Administrator / Resident Engineer's Responsibilities

- ❑ Discuss environmental constraints and anticipated problem areas, traffic accommodation and construction methods with the Contractor and the Inspector.
- ❑ Discuss and approve backfill material, density tests and sieve analysis.
- ❑ Review the required shop drawings and provide comments.
- ❑ Review and determine the need for over excavation, rock excavation, etc.
- ❑ Discuss with the Inspector any possible "extra work" claim items.
- ❑ Process Extra Work, as required.

SECTION 16 – DISMANTLING AND SALVAGING OF BRIDGE STRUCTURES

16.1 GENERAL

Dismantling and salvaging of bridge structures includes stockpiling the salvaged materials at the bridge site or the Contractor's storage area, disposing of the remainder of the bridge structure and leaving all work areas in a tidy and safe condition.

The Inspector shall ensure the Contractor is familiar with the list of materials to be salvaged in the contract documents.

The Contractor shall perform his work in a manner that prevents damage to or loss of materials listed for salvage. Where the Contractor causes damage to or loss of materials listed for salvage, the Contractor shall repair or replace these materials at his expense and to the approval of the Contract Administrator or Resident Engineer.

The salvage and surplus materials, which are the property of MIT, may not be used by the Contractor for any of their purposes. The Inspector must therefore enforce this, as well as ensure that these materials are taken to the correct destination, and that the appropriate material list, Record of Salvaged Material, is prepared by the Inspector and Contractor and forwarded to the Contract Administrator or Resident Engineer.

16.2 ENVIRONMENTAL CONSTRAINTS

- Be aware of the instream activity window in fish bearing stream.
- A silt fence, barrier, settling pond, berm or cofferdam shall be utilized to prevent siltation and minimize impact on water quality of the channel.
- Ensure equipment working in the water channel is well maintained, having no oil or fuel leaks, and free from other contaminants.
- Siltation monitoring may be required when working in the water channel. Efforts shall be made to minimize stirring up silt from the channel bed.
- Prior to final acceptance of the work, the Contractor is required to tidy up the site and restore disturbed areas to specified requirements.

16.3 SAFETY

Refer to the Manitoba's Workplace Safety and Health Regulation for specific safety requirements.

16.4 INSPECTOR'S RECORD

Prior to bridge dismantling, the Inspector should photograph and record every element of the bridge structure for future reference. These photographs document the conditions of the materials to be salvaged and establish the acceptance criteria for those materials salvaged by the Contractor.

- The Contractor is responsible to ensure that there are no utilities attached or in the vicinity of the bridge structure to be removed. If there are utilities, they should be accurately located and protected or relocated by the utility companies.

- All structures or improvements adjacent to the bridge site should be reviewed and photographed prior to bridge dismantling so that any damages claimed later can be verified as to whether or not they occurred during construction operations.

- Photographs and records of equipment used for dismantling and salvage of bridge structures are necessary for resolving disputes and claims.

16.5 EXCAVATION

All excavations necessary to dismantle bridge structures shall conform to the Standard Construction Specifications.

- For culverts, the excavation shall extend to the invert elevation and the width at this level shall be the culvert diameter plus 3 meters or wider as necessary to accommodate larger excavation machinery.

- For bridge abutments, the excavation shall extend to the ground level at the streamside of the abutment.

- The sides of all excavations shall be excavated at one horizontal to one vertical or as required for stability and in accordance with Workplace Health and Safety requirements.

16.6 DISMANTLE AND SALVAGE

Material not listed for salvage shall be disposed of in a manner and location acceptable to the Inspector.

- The portion of bridge abutments and piers located above natural ground level shall be completely removed.

- The portion 0.5 meters below the natural ground level may remain in place.

Materials listed for salvage shall be dismantled piece by piece removing all nails, bolts, drift pins and other hardware. Torch cutting to remove hardware or to dismantle these materials will not be permitted.

- Dismantle CSP by removing the couplers.

- Dismantle precast concrete girders individually:
  - Carefully chip grout out in shear keys and in connector pockets,
  - Disconnect and remove connector bolts,
  - Pry or jack precast concrete girders loose,
  - Remove drift pins and other hardware.

- Precast concrete units shall be lifted only at the designed lifting points, with the top of each unit up at all times, and shall be allowed to rest only on the designed bearing areas.

- The haul of salvage materials shall include loading and unloading, stockpiling and all associated handling of the materials.

16.7 CHECKLIST

16.7.1 Inspector's Responsibilities

- ☐ Review applicable Specifications, contract documents and Drawings
- ☐ Review and document the conditions of bridge materials to be salvaged with photographs.
- ☐ Check with Contractor to ensure their work plan, procedure and equipment satisfies environmental constraints governing the site.
- ☐ Review and report accidents and injuries.
- ☐ Assess deficient work and inform the Contract Administrator or Resident Engineer.
- ☐ Check to ensure that the Contractor has tidied up the site and restored all disturbed areas to original state or to the specified requirements.

SECTION 17 – WELDING

17.1 GENERAL

Prior to the start of any welding, the Inspector must check the qualifications of the welder (MIT requires a Certified Welder for all structural welds). The Contract Administrator or Resident Engineer must be consulted with the welder's qualifications and only at the Contract Administrator or Resident Engineer's discretion may a Non-Certified welder be allowed to do any part of structural welding.

Pre-heating requirements must be checked. At no time will welding be allowed without pre-heating in below freezing temperatures or times of humidity greater than 50 percent. Welding of reinforcing steel or form accessories to steel girders will not be permitted unless authorized by the Contract Administrator or Resident Engineer.

17.2 INSTRUCTION FOR FIELD WELDING INSPECTION

17.2.1 General

- Ensure proper weld bead contour and smooth surface with edges of weld feathered into the parent metal.

- Check for undercutting, overlapping and unfilled craters or porosity.

17.2.2 Visual Inspection Prior to and During Welding

Visual inspection of structural steel welding operations involves two sets of observations: one while the operations are in progress, and the other, after the welding has been completed.

Before actually observing the weld being deposited on the metal, the following should be checked:

1) **The fitup of the parts to be welded.**
All joints to be welded shall be checked for fit-up.
i.e. Squareness of butt joints, correct bevelling, proper root opening and alignment of the parts to be joined.

NOTE: *It is very important that the surfaces to be welded are clean and free from scale, rust, oil, grease and water.*

2) **Quality and size of electrodes.**
Electrodes shall be dry and stored in a moisture-proof container before being used. Electrodes which have been wet shall not be used but may be re-dried once. Re-drying times shall be as stated in AWS latest edition. Electrodes shall be a maximum of 5 mm and a minimum of 3 mm in diameter.

When this preliminary check is completed and the conditions are found to be satisfactory, the Inspector should then observe the actual welding being done. These are usually included in a welding procedure and may contain the following:

(1) **Preheat temperature**
A Minimum preheat as established by the Welding Engineer is required for all surfaces to be welded: However, under no circumstances shall any welding be done if the moisture cannot be shown to be removed by the heat of welding.

(2) **Welder’s electrode manipulation technique**

The welder shall handle the electrode in a correct, constant manner to produce a satisfactory weld.

(3) **Penetration**
The required deposition of sound weld metal with full penetration must be achieved, especially if a root pass provides the initial fusion between two butting plates.

(4) **Amount of Fusion**
The weld metal must fuse to the parent metal i.e. a complete union and homogeneity must exist.

(5) **Chipping out slag from between weld passes**
Proper and complete cleaning of previously deposited weld metal is to be made.

(6) **Proper size of weld** metal build-up for that particular weld size and shall be measured with suitable gauges.

(7) By listening to the sound of the welding arc, an experienced Inspector can determine whether proper welding techniques are being used and whether adjustments of the machine or manipulation of the electrode are required. The normal arc should emit a sharp, consistent cracking or frying sound, free of sputtering, hissing, gurgling or whirring and should be continuous and uniform.

Welding should not be performed in inclement weather without protecting the work from the elements. Surfaces that are wet or icy or are exposed to an ambient temperature lower than 5°C should not be welded without preheating to approximately 20°C for steel of CSA G40.21M 300W less than or equal to 19 mm. If the section is greater than 19 mm or of different quality and strength material, the Inspector shuold check with Welding Engineer's welding procedure.

Root passes of multiple layer welds shall be carefully inspected. It is essential to deposit the root pass carefully to ensure that the weld is free of cracks, inadequate fusion, slag inclusion and porosity.

NOTE:

i. *Fillet welds greater than 8 mm shall be deposited by multiple pass welds rather than one pass weld.*
ii. *Tack welds, if incorporated into the final unit, shall not be less than 75 mm in length and are to be treated like other full pass welds, i.e. slag removal, pre-heat etc. must be followed.*
iii. *No root passes shall be allowed unless a non-charged electrode can, with the proper angle, reach to the bottom of the prepared opening. If not, the rod is too large or the angle of the opening is too small. Correct it before proceeding.*

17.2.3 VISUAL INSPECTION OF THE FINISHED WELD

An examination of the surface of a finished weld will usually aid the Inspector in determining its quality.

If the finished weld can be seen before and after the slag is removed, the way in which the slag covers or lies on the weld and the ease with which it is removed by the use of a chipping hammer, will usually give a good indication of the quality of the weld.

If the slag is difficult to remove from the edges where the weld metal has been fused with the base metal, such as at the toe of a fillet weld, the weld should be examined carefully; because this slag condition indicates that too great a travel speed or too hot a machine setting was probably used and resulted in a slight undercut or lack of fusion.

When the slag has been removed, without excessive chipping, and the margin where it has been removed is smooth, and neat, it is usually an indication of a good quality weld. The finished weld should be smooth and free from marked irregularities, regardless of the position used in welding.

Often a series of small bumps, resembling blisters or little peaks, will appear in a row down the middle of the weld. This indicates that a slightly excessive heat was used. Normally such a weld is acceptable.

The examination of the weld at locations where the electrode has been stopped and started again is very important. These places should be smooth and free of slag pockets. The welding operator may fail to fill in the arc crater where the “tie-ins” start or deslag his last pass at the end where his new starting point is. This results in poor workmanship and faulty welding giving rise to crater cracks.

In multiple layer welding, always insist that the preceding weld pass is clean and free from fused welding flux before depositing the next weld pass. Slag removal or cleaning of the weld requires the use of a chipping hammer or pneumatic scaling tools, followed by a vigorous wire brushing. When pneumatic scaling tools are used, avoid excessive peening so as not to deface or work harden the weld. Insist that intermediate passes have a smooth transition at their edges so the next pass can fuse in properly.

It is important to see that the required joint fitup has the correct alignment so the weld metal will provide a smooth rounded transition between the parts being joined. Butt welds in built up sections or rolled sections which do not match well or are misaligned may cause serious notch effects, giving rise to stress risers.

See that good workmanship standards are maintained, always insisting that the arc be struck in the welding groove where the weld metal will be deposited, not outside the weld area on the base metal. Checking should continue during the job for proper weld size, length, and location, conforming to the shop or design drawings.

17.2.4 Acceptable Types of Welding Electrodes

Electrodes shall be of the low hydrogen type in All cases.

Acceptable electrodes are: E7015, E7016, E7018, E7028, for most cases, except some root passes in field welding.

17.2.5 Corrections

Defective or unsound welds shall be corrected as follows:

(a) **Excessive Convexity** – should be reduced by removing excess weld metal.

(b) **Excessive Concavity or undercutting** – should be cleaned and additional weld metal deposited while the original weld remains “hot”.

(c) **Excessive Porosity, incomplete fusion** – the defective portions should be removed by Arc-Air Gouging – **NOT** with the Oxy-Acetylene Torch and the material re-welded. After grinding or wire brushing of the deposited surface carbon that the Arc-Air carbon rod has left behind.

(d) **Cracks in the Weld** – determine the extent of the crack and then remove the crack as above and also the solid metal two inches beyond each end of the crack and then reweld the material.

SECTION 18 – SURVEYING

18.1 DIFFERENTIAL LEVELING

18.1.1 Definitions

(a) ***Bench Mark (B.M.)*** – is a definite point on an object, the elevation and location of which are known. The Land Surveyor's Bench marks consist of bronze plates set in stone or concrete and marked with the elevation above mean sea level. Other objects frequently used as benchmarks are pegs driven into the ground, nails or inserts in trees or hydro-poles and marks painted or chiseled on street curbs.

(b) ***Turning Point (T.P.)*** – is an intervening point between two bench marks upon which point foresight and backsight rod readings are taken. It may be any stable object such as a stable rock, street curb, and peg driven into the ground or a nail in trees or hydro-poles. The nature of the turning point is usually indicated in the notes, but no record is made of its location unless it is to be reused. A benchmark may be used as a turning point.

(c) ***A Backsight (B.S.)*** – is a rod reading taken on a point of known elevation as a benchmark or a turning point. Usually it will be taken with the level sighting back along the line, hence the name.

(d) ***A Foresight (F.S.)*** – is a rod reading taken on a point, the elevation of which is to be determined, as on a turning point or on a bench mark that is to be established.

(e) ***The Height of Instrument (H.I.)*** – is the elevation of the line of sight of the telescope when the instrument is levelled.

In surveying with the transit, the terms backsight, foresight, and height of instrument have meanings different from those here defined.

18.2 PROCEDURE

In Fig. 9-2, B.M. 1 represents a point of known elevation (benchmark), and B.M. 2 represents a bench mark to be established some distance away. It is desired to determine the elevation of B.M. 2. The rod is held at B.M. 1, and the level is set up in some convenient location, as L1, along the general route B.M. 1 to B.M. 2. The level is placed in such a location that a clear rod reading is obtainable, but no attempt is made to keep on the direct line joining B.M. 1 and B.M. 2. A backsight is taken on B.M. 1. The rodman then goes forward and, as directed by the leveller, chooses a turning point T.P. 1 at some convenient spot within the range of the telescope along the general route B.M. 1 to B.M. 2. It is desirable, but not necessary, that each foresight distance, as L1-T.P.1, be approximately equal to its corresponding backsight distance, as B.M. 1-L1. The chief requirement is that the turning point shall be a stable object at an elevation and in a location favorable to a rod reading of the required precision. The rod is held on the turning point, and a foresight is taken. The leveller then sets up the instrument at some favorable point, as L2, and takes a backsight to the rod held on the turning point; the rodman goes forward to establish a second turning point T.P.2; and so the process is repeated until finally a foresight is taken on the terminal point B.M.2.

It is seen in Fig. 9-2 that a backsight added to the elevation of a point on which the backsight is taken gives the height of instrument, and that a foresight subtracted from the height of instrument determines the elevation of the point on which the foresight is taken. Thus if the elevation of B.M. 1 is 721.05 ft. and the B.S. is 7.11 ft., then the I.I with the instrument set up at L1 is 721.05 + 7.11 = 728.16. And if the following F.S. is 1.24 ft., the elevation of T.P. 1 is 728.16 ft. Also the difference between the backsight taken on a given point and the foresight taken on the following point is equal to the difference in elevation between the two points. It follows that the difference between the sum of all backsights and the sum of all foresights gives the difference in elevation between the benchmarks.

18.3 DIFFERENTIAL-LEVEL NOTES

For ordinary differential levelling such as elevations of excavations, pile cut-offs, bearing seats, etc., the record of field work is kept in the form indicated by Fig. 9-3. The left page is divided into columns for numerical data, and the right page is reserved for descriptive notes concerning bench marks and turning points. In the same horizontal line with each turning point or benchmark shown in the first column are all data concerning that point. The heights of instrument and the elevations are computed as the work progresses. Thus, when the backsight (7.11) has been taken on B.M. 1, it is added to the elevation (721.05) to determine the H.I. (728.16). The height of instrument is recorded on the same line with the backsight by means of which it is determined. When the first foresight (1.24) is observed, it is recorded on the line below and is subtracted from the preceding H.I. (728.16) to determine the elevation of T.P. 1 (726.92). And so the notes are continued. Usually at the foot of each page of level notes the computations are checked by comparing the difference between the sum of the backsights and the sum of the foresights with the difference between the initial and the final elevation, as illustrated at the bottom of Fig. 9-3. Agreement between these two differences signifies that the additions and subtractions are correct but does not check against mistakes in observing or recording.

Benchmarks should be briefly but definitely described and should be so marked in the field that they can be readily identified. They are usually marked with paint or with crayon that will withstand the effects of the weather.

18.4 CHECKLISTS

18.4.1 Layout

- ❑ 1 station (preferably 1 of the abutments.)
- ❑ Centerline of roadway (ensure all points are well marked so they are not hit.)
- ❑ Benchmark (ensure it matches existing elevations shown on Drawings).
- ❑ Ensure centerline of bridge or culvert is centerline of channel unless obviously designed differently.

SECTION 19 – SAFETY

19.1 GENERAL

Safety is a serious issue receiving special attention, particularly in the construction industry. Any accident could result in a financial loss at best, or may involve a loss of life depending on the severity of the accident.

It is MIT's policy that the responsibility for ensuring compliance with Manitoba Workplace Safety and Health Act and Regulations should reside with the person(s) performing the work. MIT through its Contracts assigns the designation of Prime Contractor (as defined under Manitoba's Workplace Safety and Health Act) to the Contractor. The Contract Administrator, Resident Engineer and Inspector must familiarize himself/herself with the applicable safety regulations.

Hard hats and steel-toed safety boots **must be worn at all times** when on the site. If work is being conducted in amongst traffic, reflectorized vests **must** also be worn during that time.

When an "imminent danger" situation is observed, the Resident Engineer or Inspector must immediately order the stoppage of the work activity until the violation is corrected and it is safe for the work to resume. If the Contractor or his employees do not comply, the Inspector must contact the Contract Administrator or Resident Engineer **immediately**. If the situation is not resolved at this stage, the Contract Administrator will contact MIT's Safety Officer for assistance. The Resident Engineer and the Inspector must document the issue and action/response in the weekly reports. Examples of "imminent danger" situations are:

- Traffic Control not meeting specification and placing workers and/or motorists at imminent risk.
- Workers in an unshored and/or improperly shored excavation. (Shoring may not be required if the height of excavation is less than 1.5 meters. If in doubt, verify the specific shoring requirements with the Contract Administrator or Resident Engineer).
- Workers using improper fall arrest/restraint equipment and/or systems.
- Workers in "confined space" without proper safety procedures and/or equipment.

19.2 WORKPLACE SAFETY AND HEALTH – PRIME CONTRACTOR

It is MIT's expectation that the Contract Administrator, Resident Engineer and Inspector have familiarized themselves with Manitoba's Workplace Safety and Health Act and Regulations. They must ensure the Contractor's compliance with the Act and Regulations in the performance of their duties.

It is also MIT's expectation that the Resident Engineer and Inspector take appropriate action in situations where they are aware that the Contractor is not complying with the Workplace Safety and Health Act and Regulations. In situations of recognized imminent danger, this would involve ordering suspension of the work and immediately notifying MIT Safety Officer.

19.3 ADMINISTRATIVE RESPONSIBILITIES

Some general administrative responsibilities of the Contract Administrator, Resident Engineer and Inspector are:

- On complex projects or projects that involve the use of specialized work methods or equipment, require the Contractor to provide operational safety policies and plans specific to the work (i.e. safe work procedures for site specific hazards such as erecting girders, installing suspended work platforms).
- Review the Contractor's operational safety policies and plans to ensure compliance with Workplace Safety and Health Act and Regulations.

- Notify the Contractor's site representative of any safety and health violations related to the Contractor's activities, that the Inspector is aware of or observes.
- Provide Contract Administrator or Resident Engineer with copies of any written correspondence on safety issues/concerns pertaining to the Contractor's activities.
- Provide Contract Administrator or Resident Engineer with copies of any orders issued to the Contractor by Manitoba Workplace Safety and Health.
- Provide to Contract Administrator or Resident Engineer, within 24 hours, copies of any worksite injury or accident report involving employees of the Contractor or Sub-Contractor. The Inspector will be responsible for obtaining and forwarding reports provided by the Contractor.
- Attend the Contractor's safety meetings whenever possible.
- Provide Contract Administrator or Resident Engineer with a copy of the Monthly Safety and Health Summary Reports (these reports are completed by the Contractor).
- Provide MIT's Project Manager with a copy of the Project Completion Safety and Health review Report. This form is completed by the Contractor within 2 days of the completion of the Project.

19.4 TRAFFIC ACCOMMODATION

The Resident Engineer and Inspector must make sure that ***all*** construction signs, barricades, flashers, etc., as shown in the Specifications are in operation before allowing the Contractor to proceed with ***any*** portion of the work or to close a structure to traffic. They may not accept assurances that signs, flashers, and barricades are on the way to the site and will arrive shortly. In other words, unless all traffic signage are positioned, traffic may not be detoured or work started. If the Contractor has not supplied his portion of the traffic control signage as described in the Specifications, a written field order should be issued immediately.

If MIT has not supplied traffic control signage as described in the Specifications, the Inspector must contact the Contract Administrator or Resident Engineer immediately.

During the course of the project, the Inspector should check all traffic control signage daily and ensure that it is being maintained by the responsible party.

MIT has published a manual entitled "The Work Zone Traffic Control Manual for Provincial Roads and Highways" to provide information and guidance to various parties to ensure that the accommodation of traffic is handled in a consistent, safe and effective manner. This document identifies the primary roles and responsibilities of each of the parties for public safety, outlines general considerations for developing an effective traffic accommodation strategy and provides guidelines for the use of various Traffic Control Devices. Also included are a series of drawings detailing minimum temporary signing requirements for typical Work Zones on the provincial highway system.

The Contract Administrator or Resident Engineer is also responsible for monitoring the traffic accommodation measures used by the Contractor and ensuring that these measures both comply with the contract and safely and effectively accommodate vehicular and pedestrian traffic through and around the work zone.

On many construction sites, traffic accommodation is a major safety item. The Resident Engineer and Inspector should be aware that the traffic accommodation requirements will vary depending on the construction activities at the site, (i.e. whether the Contractor is pouring concrete, forming deck or erecting girders over a busy highway). In consultation with MIT's Safety Officer, the Contract Administrator, Resident Engineer or the Inspector may be required to recommend to the Contractor that minor signage changes may be necessary to suit the traffic condition.

19.5 CHECKLIST

19.5.1 RESIDENT ENGINEER AND INSPECTOR'S RESPONSIBILITIES:

- ❑ Be familiar with the current MIT document entitled "The Work Zone Traffic Control Manual For Provincial Roads and Highways".
- ❑ Know the approved traffic control plan requirements.
- ❑ Carry out checks as required to insure traffic signs are functioning properly.
- ❑ Ensure that the signs are cleaned, visible and upright.
- ❑ Where applicable, the brightness of the arrow-board should be adjusted to suit the daylight condition. Promptly fill out all the appropriate forms required for any accidents and advise MIT's Safety Officer as soon as possible.