422.1 GENERAL

The work under these tender items consists of the fabrication and installation in open cut of precast reinforced concrete box culverts with a standard-sized opening.

This section refers solely to box culverts, but the content is equally applicable to box sewers.

The designer selects the appropriate opening size that accommodates the design flow from the available sizes listed in OPSS 1821, within the allowable fill covers specified. For fill cover depths outside those shown in OPSS 1821, the Regional Structural Section shall be consulted.

Manufacture of precast box culverts typically requires eight weeks. Adequate time must be allocated to the project schedule for manufacture and for late season work the box culverts may need to be pre-ordered under a separate tender.

422.2 REFERENCES

MTO Drainage Management Manual
Ontario Provincial Standards Specifications
Ontario Provincial Standards Drawings
Drainage Management Technical Guidelines
Roadside Safety Manual

422.3 TENDER ITEMS

422.3.1 1800 mm x 900 mm Precast Concrete Box Culvert
1800 mm x 1200 mm Precast Concrete Box Culvert
2400 mm x 1200 mm Precast Concrete Box Culvert
2400 mm x 1500 mm Precast Concrete Box Culvert
2400 mm x 1800 mm Precast Concrete Box Culvert
2500 mm x 1830 mm Precast Concrete Box Culvert
3000 mm x 1500 mm Precast Concrete Box Culvert
3000 mm x 1800 mm Precast Concrete Box Culvert
3000 mm x 2100 mm Precast Concrete Box Culvert
3000 mm x 2400 mm Precast Concrete Box Culvert
Standard sizes, as listed above, should be specified whenever possible. Designers should choose the next largest size meeting the hydraulic opening requirements.

The use of a non-standard tender item may be considered when non-standard dimensions must be used, such as to match and extend existing culverts. Any conflicts with OPSS 1821 must be addressed, and reinforcement requirements must be detailed.

### 422.3.2 Associated Tender Items

The designer should be aware of the following tender items that are used in conjunction with precast concrete box culverts:

- Earth Excavation for Structure (for box culvert and appurtenances)
- Rock Excavation for Structure
- Dewatering Structure Excavations
- Clay Seal

OPSS 902 governs the above tender items. Design guidelines, documentation requirements and quantity calculations are found in section B902 of this manual.

Earth and rock excavation required for appurtenances are included under the tender items, Earth Excavation for Structure or Rock Excavation for Structure, as applicable.

- Granular A, B Type I, B Type II, B Type III, SSM Compacted

The appropriate tender item(s) in the contract for granular material covers the supply, placement and compaction of the granular bedding, levelling course, cover and backfill required. Design guidelines, documentation requirements and quantity calculations are found in section B902 of this manual. A levelling course is required at each culvert installation.

### Concrete Appurtenances

The flow through a box culvert may need to be controlled to prevent erosion damage to the area around it or to the box culvert structure itself. Concrete appurtenances such as headwalls, wing walls, energy dissipators, aprons, collars or other such types of structures are used to direct flow, slow velocities to prevent erosion, offset buoyancy forces, etc. The designer shall consider the need for a cut off wall to prevent scour and undermining of each end.

Concrete and steel for concrete appurtenances are according to OPSS 904 and OPSS 905, respectively. The following tender items are used in conjunction with concrete appurtenances for precast concrete box culverts:
OPSS 904, Concrete in Culverts
OPSS 905, Reinforcing Steel Bar

422.4 SPECIFICATIONS

The requirements for fabrication and installation of precast concrete box culverts are covered by OPSS 1821 and OPSS 422 respectively.

422.5 SPECIAL PROVISIONS

Refer to Chapter 'E' of this manual to review the applicable standard special provisions.

422.6 STANDARD DRAWINGS

There are no Ontario Provincial Standard Drawings available for use with these tender items. Ministry of Transportation Ontario Drawing (MTOD) 803.021 entitled "Bedding and Backfill for Precast Concrete Box Culverts" is to be included.

422.7 DESIGN

422.7.1 General

The designer shall verify whether there are significant environmental, hydrological and geotechnical concerns and determine the criteria and/or standards to which the culvert will be designed.

The general alignment, size and type of culvert are established by the designer, based on acceptable drainage theory, environmental constraints, including possible fish passage and structural and foundations concerns. The designer shall use accepted drainage design methods by which to establish the culvert design that satisfies required drainage standards or criteria for the highway project.

The MTO Drainage Management Manual shall be used in the design of box culvert, grades and the setting of upstream invert elevations. Complete requirements for design, analysis methods and other information are available in the MTO Drainage Management Manual.
422.7.2 Advantages of Precast Box Culverts versus Cast-in-place Open Footing Culverts

Where feasible, consideration should be given to a precast concrete box culvert installation instead of a cast in-place open footing culvert. Advantages of using a precast concrete box culvert include:

1) Relatively short construction time resulting in reduced environmental impact;

2) Feasibility for installation during cold weather conditions;

3) Relatively short period of use and maintenance of detours and subsequently quicker roadway reinstatement;

4) Reduced dewatering duration.

5) Placing and curing concrete in shop conditions

When articulation and/or cambering is required to accommodate predicted settlements, a precast concrete culvert is the preferred option.

Discussion of alternatives of precast concrete box culvert versus cast-in-place open footing culvert and recommendations for the preferred alternative may be found in the geotechnical and foundation reports.

422.7.3 Trench

A. Excavation

Excavated earth material may be used for embankment construction or used as native backfill to the excavated trench as determined by the designer based on foundation or geotechnical reports. Surplus or unsuitable excavation material should be managed as outlined in B206-1 of this manual.

Due to the high unit cost of rock excavation, the designer shall endeavour to reduce the volume of excavation by relocating the box culvert or skewing to optimize fit.

B. Frost Protection

Special treatment of box culverts may be required for frost protection. Frost treatment is required if the frost line falls below the top of the box, within the bedding layer or below the bedding layer. Foundation or geotechnical reports shall contain information regarding recommended fill materials and the configuration and extent of frost taper excavations.
Frost tapers are not required when the frost line falls above the box culvert or when the box culvert is constructed in rock fill.

C. Dewatering

Dewatering refers to pumping, bailing, temporary ditching or vacuum removal of uncontaminated groundwater, rain water, melt water, surface runoff, water pipe leakage from excavations and trenches or within sheeted coffer dams to improve the soil stability or for other construction purposes. Dewatering also refers to the lowering of the groundwater table in the excavation site area in a manner that enables completion of the construction work.

Where dewatering is required for the installation of a culvert, details shall comply with the requirements of OPSS 517 and OPSS 902.

Although the Contractor is responsible for a dewatering plan, the designer shall note any recommendations included in the Foundation Investigation and Design Report, if available.

Information on subsurface conditions required for design of the dewatering system, including Record of Borehole sheets and laboratory testing results, can be found in the foundation/geotechnical report included in the tender documents.

D. Fill Material

To prevent damage to the box culvert due to loads, fill materials are provided as protective and support layers. Fill material for box installations is placed in distinct bedding, backfill and cover layers.

A foundation or geotechnical report will include recommendations for the specification, supply and placement of fill material or any special conditions for bedding, backfill and cover layers. In addition, special consideration for scour protection at the box inlet or outlet may be required and the designer shall refer to the MTO Drainage Management Manual for assistance.

The designer shall specify the fill materials required for the installation, based on the recommendations of the Foundation Investigation and Design Report or Geotechnical report.

The contractor, not the designer, is responsible for selecting the appropriate box culvert installation method at the time of installation based on the soil types found on the construction site in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.
E. Protection Systems

Protection systems shall be considered where the stability of excavation, safety or function of an existing roadway, railway or any structure or slope may be threatened or impaired due to the construction of a box culvert.

The design, installation, monitoring, and removal of protection systems are the Contractor’s responsibility and the Contractor should base his plan on information provided in the Foundation Investigation Report or Geotechnical Report. Complex soil conditions, high groundwater tables or other installation issues, if identified, would give rise to recommendations regarding the design, installation and removal of protection systems. Conceptual recommendations for design as well as recommendations for performance levels could be found in Foundation Investigation and Design Reports.

Where protection system is required for installation of culvert, details shall comply with OPSS 539.

When required, a protection system shall be paid for under a separate tender item.

F. Clay Seals

Warrants for clay seals to be installed at the culvert sites may include:

1) The natural sub-base and culvert foundation materials are of a granular nature;

2) The embankment material is of a non-cohesive nature; or

3) There is significant hydraulic head differential between the upstream and downstream ends of the box culvert.

Recommendations are found in a Foundation Investigation and Design Report or Geotechnical Report.

G. Camber

A Foundation Investigation and Design Report or Geotechnical Report will contain information and design requirements for the camber depths needed for a box culvert installation.

422.8 COMPUTATION

These are Plan Quantity Payment items.
422.8.1 Sources of Information

1. Regional Geomatics Section

Survey information

The survey information provides profiles along the drainage course at both existing and new culvert locations and other drainage courses.

Drainage and Hydrology Information

Provides information to assist in the calculation of culvert sizes by providing drainage areas, mosaic studies, soil types, etc.

2. Regional Geotechnical Section

Provides advice on backfill requirement and the need for placing clay seals for non-structural (typically less than 3 m span) culverts and at sites where subsurface conditions are not complex. However, for non-structural culverts located in areas of highly complex subsurface conditions such as soft, sensitive soils and saturated cohesionless soils, the recommendations for design shall be available in the Foundation Investigation and Design Report.

3. Foundation Investigation and Design Report

For all culverts larger than 3 m, and for non-structural culverts (less than 3 m), located at sites where complex subsurface conditions are present, recommendations for design, including excavation, dewatering, bedding, backfilling, cover, clay seals, treatments at inlet/outlet for scour protection shall be provided in the Foundation Investigation and Design Report.

The Foundation Investigation and Design Report shall address any issues related to complex subsurface conditions, including requirements for camber, articulation and construction staging. This includes use of a temporary culvert during embankment preload/surcharge and then proceeding to a permanent precast concrete box installation.


The Drainage Management Manual provides overall guidance on the design of culverts and storm drainage systems. It should be used together with the MTO Drainage Management Technical Guidelines.

In design of the culvert sizes, the foundation requirements provided in the Foundation Investigation and Design Report or Geotechnical Report shall be considered.
422.8.2 Method of Calculation

The unit of measurement for length of the precast concrete box culvert is the metre.

Working with design cross-sections, standard drawings, drainage profiles and the size of culvert previously determined, the designer calculates the box length. The design length \( L \) of the box is the distance between the toes of embankment slopes where they meet the streambed profile measured to the nearest 0.1 metre.

422.9 DOCUMENTATION

a) Contract Drawings

New precast concrete box culverts and existing culverts requiring extension are numbered and shown on the plans and profiles of the contract drawings. Culvert alignment and skew is shown on the plans (refer to B421 to determine skew). Locations and details of culvert appurtenances are shown on the plans and labelled. Appropriate invert elevations are to be shown.

Any requirements for cambering shall be illustrated on the contract drawings.

Bedding, backfilling and cover requirements shall be illustrated and noted on the contract drawings.

Requirements for the inspection of the founding soil prior to placement of the bedding shall be noted on the contract drawings.

b) Quantity Sheets

Information is entered on the Quantities - Miscellaneous 1 sheet. Information includes culvert number, station and location. Offset is included when required. The length of each culvert is entered under the appropriate column heading labelled with the tender item name, indicating the box opening size.

Granular material quantities used for bedding and levelling courses, cover, backfill and frost tapers shall be shown under the appropriate column headings for granular material tender items, when applicable.

Concrete and reinforcing steel quantities for concrete appurtenances are included in the Quantities – Structures sheet, with location and description details sufficient to link the quantities to the box culvert locations.
c) Non-standard Special Provisions (NSSPs)

An NSSP to alert the Contractor of subsurface and groundwater conditions is included on a project specific basis, when recommended in the Foundation Investigation and Design Report.

In some cases, a levelling slab may be required using mass concrete, clear stone, or other material. The requirement would be shown by non-standard detail in the contract drawings. An NSSP is used to include payment with the box culvert item.

When a non-standard precast box culvert size is required, a non-standard drawing detail and NSSP is typically required.

422.9.1 Documentation Accuracy

Length of culvert rounded to the nearest 0.1m. Stations are recorded in whole numbers.