B960 - BURIED CORRUGATED STEEL STRUCTURES WITH SPANS GREATER THAN 3.0 m – OPSS 960

(As specified in OPSS 960 April 2026)

960.1 GENERAL

The work under these items consists of the construction of buried corrugated steel structures with span greater than 3.0 m (hereafter referred to as buried corrugated steel structures).

The designer selects the appropriate opening size that accommodates the design flow.

Adequate time must be allocated to the project schedule for the manufacturing of buried corrugated steel structures.

The designer shall specify materials used for appurtenances, foundations, bedding, backfill, geotextile, geomembrane and granular cover in the Contract Documents. If required, the material specifications for a clay seal shall be specified in the Contract Documents.

960.2 REFERENCES

- MTO Publication - Structural Manual
- MTO Drainage Management Manual
- MTO Culvert Design Workbook for MTO Culvert Design Assignments
- Drainage Management Technical Guidelines
- CSA G40.20-13/G40.21-13 General requirements for rolled or welded structural quality steel/Structural quality steel
- CSA G401:24 Corrugated steel pipe and buried structures
- CSA S6:25 Canadian Highway Bridge Design Code
- CDED B206-1 Earth Grading
- CDED B314 Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
- CDED B421 Pipe Culverts
- CDED B517 Dewatering and Temporary Flow Passage Systems (TFPS)
- CDED B902 Excavation and Backfill for Structures
- CDED B904 Concrete in Culverts
- CDED B905 Concrete Structures
- CDED B911 Coating Structural Steel and Railing Systems
- OPSS 100 MTO General Conditions of Contract
- OPSS 517 Dewatering and Temporary Flow Passage Systems
- OPSS 539 Temporary Protection Systems
- OPSS 1010 Aggregated - Base, Subbase, Select Subgrade, and Backfill Material
- OPSS 1205 Clay Seal
- OPSS 1350 Concrete - Materials and Production
- OPSS 1355 Precast Concrete - Materials and Production
- OPSS 1805 Corrugated Steel Structural Plate
- OPSS 1863 Geomembrane

960.3 TENDER ITEMS

Item Code	Title	Col Type	U.O.M.	PQP
0960-0010	Buried Corrugated Steel Structures, Fabrication	Normal	m	Y
0960-0020	Buried Corrugated Steel Structures, Delivery and Installation	Normal	m	Y
0960-0030	Geomembrane	Variable	m^2	Y
0960-0040	Clay Seal	Normal	lump sum	N

960.4 SPECIFICATIONS

The requirements for the work of the delivery and construction of buried corrugated steel structures are contained in OPSS 960. The requirements for the work of fabricating the corrugated steel structural plates that, when assembled, form the buried corrugated steel structure are contained in OPSS 1805.

Material requirements for geomembrane above the structure are contained in OPSS 1863.

Material requirements for clay seal are contained in OPSS 1205.

960.5 SPECIAL PROVISIONS - None

960.6 STANDARD DRAWINGS - None

960.7 DESIGN

960.7.1 General

The design shall be according to the Structural Manual and CSA S6.

For all buried corrugated steel structures, the recommendations for design, including protection systems, excavation, dewatering, bedding, backfilling, geotextile, geomembrane, clay seals, treatments at inlet/outlet for scour protection, and appurtenances shall be provided in the Foundation Investigation and Design Report (FIDR).

The FIDR shall address any issues related to complex subsurface conditions, including requirements for camber, articulation and construction staging. This includes the use of a temporary structure during embankment preload/surcharge and then proceeding to a permanent buried corrugated steel structures installation.

Prior to design, the designer shall evaluate potential environmental, hydrological, and geotechnical concerns and select appropriate criteria and/or standards for the designing of structure.

Cold weather installation is not recommended for buried corrugated steel structures. If required, the contractor shall consult with a Geotechnical Engineer to determine applicable cold weather construction procedures.

960.7.1.1 Structure Sizing, Geometry, and Alignment

The general alignment, rise and span of structure, type of structure, protective coating type, and camber are established by the designer, based on acceptable drainage and hydraulics theory, and environmental constraints, including possible fish passage and structural and foundations concerns. The designer shall use accepted drainage design methods by which to establish the buried corrugated steel structure plate design that satisfies required drainage standards or criteria for the highway project.

The MTO Drainage Management Manual shall be used in the design of the buried corrugated steel structure, 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.

The structure dimensions shall make allowance for changes in shape due to camber, and any other effects that cause finished dimensions to differ from initial dimensions

Designers may use the MTO Culvert Design Workbook to follow a defined process for conducting hydraulic analysis and developing detailed culvert designs.

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

960.7.1.2 Corrugated Steel Structural Plate

For structures with a span less than or equal to 8.0 m, the designer shall complete the design according to CSA S6 and specify the plate corrugation profile and plate thickness on the Contract Drawings (supply-only by the Contractor).

For structures with a span exceeding 8.0 m, once the rise and span of the structure are anticipated based on the hydraulic requirements, the designer should consult with corrugated steel structural plate suppliers to determine the refined structural geometry along with the anticipated corrugation profile and plate thickness. The final design of the structure shall be left to the Contractor. When corrugation profile and plate thickness are not specified in the Contract Documents, OPSS 960 requires the Contractor to complete the design and submit Working Drawings sealed by two engineers (supply and design by the Contractor).

The designer shall refer to CSA G401, Annex A.1.4 for guidance on the minimum yield strength to be used in design. The designer shall not use the properties from CSA G401, Table 2 (Mechanical Properties of flat sheet prior to fabrication) in completing the design, as these values are prior to the corrugation of the plates.

To satisfy the design service life of 75 years specified in OPSS 960 when determining the required plate thickness, the designer shall account for the service life of corrugated steel structural plate coatings and the thickness loss of steel over the design service life due to corrosion, as described in Section 2 of CSA S6. The designer should account for the accelerated deterioration of steel in areas where standing water may accumulate and must address any concerns related to standing water during the design process.

Corrugated steel structural plates shall be coated to satisfy the durability requirements of CSA S6 and the Structural Manual. As listed in OPSS 960, coatings shall consist of hot dip galvanizing, thermoplastic copolymer coating, or epoxy duplex coating system. The coating system shall be specified by the designer and shall be suitable for the structure environment in accordance with Section 2 and Section 7 of CSA S6.

If epoxy duplex coating system is required, further design requirements are provided in CDED B911.

The designer shall specify the joint performance requirements in the Contract Documents. The Contractor is responsible for the design of the specific joint treatment to satisfy the performance requirements specified.

960.7.2 Hardware

The designer shall specify on the Contract Drawings the minimum hardware requirements. The minimum requirements for hardware shall be as specified by CSA S6, CSA G401, and OPSS 960.

960.7.3 Excavation and Backfilling

960.7.3.1 Excavation

Excavation for the foundation system shall be to the founding elevations specified in the FIDR. Founding soils shall be competent materials that can adequately support the design loads as described in the FIDR. Sub-excavation of unsuitable soils shall be carried out as recommended in the FIDR.

Design guidelines, documentation requirements, and quantity calculations are found in CDED B902 and as recommended in the FIDR.

960.7.3.2 Excavated Earth Material

Excavated earth material may be used for embankment construction or used as native backfill beyond the structure as determined by the designer based on FIDR. Surplus or unsuitable excavation material should be managed as outlined in CDED B206-1.

960.7.3.3 Dewatering and/or Temporary Flow Passage System

Requirements for the design, operation, and removal of a dewatering or temporary flow passage system or both to control water during construction, and the control of the water prior to discharge to the natural environment and sewer systems shall comply with OPSS 517. Refer to CDED B517 for design and documentation requirements for dewatering.

Where dewatering or temporary flow passage systems or both are required for the construction of the structure, the details shall be according to OPSS 517 or OPSS 902 when specified.

Recommendations for Intensity Duration Frequency (IDF) Curves and Return periods for the temporary flow passage system shall be obtained from the Drainage and Hydrology Report.

Although the Contractor is responsible for a dewatering plan, the designer shall note any recommendations included in the FIDR.

The designer shall provide the Foundation Investigation Report (FIR) to the Contractor as part of the Tender document.

The designer shall also refer to OPSS 100, General Conditions of Contract, Subsection GC 7.10, Approvals and Permits, for additional requirements that may need to be specified in the Contract.

960.7.3.4 Temporary Protection Systems

During construction of a buried corrugated steel structure, protection systems shall be considered where excavation may compromise the stability, safety or function of an existing roadway, railway or any structure or slope may be threatened or impaired.

Where a protection system is required for installation of the structure, the design, installation, monitoring, and removal are the Contractor's responsibility in accordance with OPSS 539. The designer shall include a Performance Level, and the Contractor shall design and construct the protection system to satisfy the performance requirements. The designer shall review Complex soil conditions, high groundwater tables or other installation issues, if identified in the FIDR so as to red flag these conditions in the Contract Package.

The Foundation Investigation Report (FIR) shall be provided when the contract is advertised for the Contractor's reference.

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

960.7.3.5 Granular

The designer shall specify granular material for backfill, bedding, and frost tapers in the Contract Document. The specified material for bedding and backfill shall satisfy the requirements of Section 7 of CSA S6. The various backfill zones, as required in Section 7 of CSA S6, shall be shown on the Contract Drawings.

960.7.3.6 Fill Material

To prevent damage to the culvert due to loads, fill materials are provided as protective and support layers. During installation of buried corrugated steel structures, fill material is placed in distinct bedding, backfill and cover layers.

The FIDR will include recommendations for the specification, supply and placement of fill material or any special conditions for bedding, backfill and cover layers.

The designer shall specify the engineered fill materials required for the installation in the Contract Documents based on the recommendations of the FIDR, Section 7 of CSA S6, and OPSS 1010.

In accordance with Annex A7.1.8 of CSA S6, the invert of a closed-bottom culvert shall be placed on a specified thickness of uncompacted bedding. This thickness shall be determined based on the corrugation profile and shall be shown on the Contract Drawings.

Refer to CDED B314 for design guidelines, documentation requirements, and quantity calculations for fill material.

960.7.3.7 Clay Seals

When recommended by the FIDR, the designer shall select a natural clay or a Geosynthetic Clay Liner in accordance with OPSS 1205 and the recommendations in the FIDR to prevent piping due to seepage gradients in the backfill and cover to the structure. Refer to CDED B902 for design and documentation requirements for clay seals.

Warrants for clay seals to be installed at the structure site may include:

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

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

c) There is significant hydraulic head differential between the upstream and downstream ends of the structure.

960.7.3.8 Camber

A camber is typically designed in consideration of a predicted settlement profile anticipated along the length of the culvert. The FIDR shall contain information and design requirements for the camber depths needed for a precast concrete culvert installation.

960.7.3.9 Frost Protection

The designer shall refer to the FIDR for recommendations for frost protection and frost tapers. The FIDR shall contain information regarding recommended fill materials and the configuration and extent of frost taper excavations.

960.7.3.10 Scour Protection

Special consideration for scour protection at the structure inlet or outlet may be required and the designer shall refer to the MTO Drainage Management Manual for assistance.

Scour protection shall be based on the erodibility of the founding soils/rock and the scouring forces due to the water velocities.

960.7.4 Geotextile

The designer shall refer to the FIDR to determine which class and filtration opening size (FOS) to specify on the Contract Documents.

960.7.5 Geomembrane

The material requirements for geomembrane are provided in OPSS 960 and OPSS 1863.

The designer shall refer to the FIDR to determine the geomembrane to specify on the Contract Documents. The geomembrane shall be suspended in the backfill above the structure, in accordance with Section 7 of CSA S6.1-25.

Geomembrane shall be designed as a non-replaceable component in accordance with Section 7 of CSA S6-25.

The required depth of cover from the structure obvert to the geomembrane, and from the geomembrane to the road grade shall be shown on the Contract Documents. The required width of the geomembrane, as specified in OPSS 960, shall be shown on the Contract Documents.

The designer shall show on the Contract Drawings that the geomembrane shall be placed between two layers of geotextile to reduce the risk of punctures from granular material.

Placement of geomembranes within the frost penetration depth shall be avoided, as frozen drainage systems can lead to pavement cracking or heaving. In such cases, suspension of the geomembrane above the structure shall not be permitted, in accordance with OPSS 1863.

Cold weather installation is not recommended for geomembrane. If required for the design, the designer shall consult with a Geotechnical Engineer to determine applicable cold weather construction constraints for inclusion in the Contract Documents.

The designer shall specify in the Contract Documents the working temperature conditions for in-situ or imported materials that are susceptible to freezing or may be affected by ice or snow.

960.7.6 Appurtenances

The designer shall specify the requirements for appurtenances, as defined in OPSS 960, required for the structure.

The design, computation, and documentation of concrete appurtenances and steel reinforcement within concrete appurtenances is contained in CDED B904 and CDED B905, respectively.

All steel used for appurtenances shall be designed and detailed according to CSA G40.20-13/G40.21-13.

Steel appurtenances shall be coated to satisfy the durability requirements of CSA S6 and the Structural Manual. As listed in OPSS 960, coatings shall consist of hot dip galvanizing, thermoplastic copolymer coating, or epoxy duplex coating system. The coating system shall be specified by the designer and shall be suitable for the structure environment in accordance with Section 2 and Section 7 of CSA S6.

If epoxy duplex coating system is required, further design requirements are provided in CDED B911.

960.8 COMPUTATION

960.8.1 Sources of Information

The main sources of information for the above tender items are the Regional Structural Section, the FIDR, survey, drainage and hydrology information.

960.8.2 Method of Calculation

960.8.2.1 Buried Corrugated Steel Structures, Fabrication

The unit of measurement is the length in metres.

Measurement for the fabrication of the structure shall be by the horizontal length in metres along the centreline of the invert of the structure.

When multiple cells are required for a single structure, each cell of the structure shall be measured separately.

960.8.2.2 Buried Corrugated Steel Structures, Delivery and Installation

The unit of measurement is the length in metres.

Measurement for the fabrication of the structure shall be by the horizontal length in metres along the centreline of the invert of the structure.

When multiple cells are required for a single structure, each cell of the structure shall be measured separately.

960.9 DOCUMENTATION

960.9.1 Contract Drawings

New structures receive a site number and shall be shown on the plans and profiles of the Contract Drawings. Structural alignment and skew shall be shown on the plans. The designer shall refer to CDED B421 for the determination of skew number.

Locations and details of structure appurtenances shall be shown on the plans and labelled. Appropriate invert elevations are to be shown.

Requirements for protection systems and dewatering/temporary flow passage systems shall be noted on the Contract Drawings.

Stratigraphical sections and profiles shall be included in the Contract Drawings. The Designer shall ensure that the invert elevations on these drawings in no way conflict with the Contract Drawings.

Any requirements for cambering shall be illustrated on the Contract Drawings.

Material types required for bedding and backfilling requirements shall be clearly noted on the Contract Drawings.

Requirements for the placement of the bedding and backfill, including the placement of the minimum granular cover of the structure obvert, shall be noted on the Contract Drawings.

The contractor, not the designer, is responsible for selecting the appropriate structure 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.

All locations and details of the connector plates shall be illustrated on the Contract Drawings.

Any requirements clay seals shall be shown on the Contract Drawings.

960.9.2 Quantity Sheets

The Ministry's Contract Preparation System (CPS) is used for the preparation of Quantity Sheets.

Information is entered on the "Quantities - Structures" sheet. Information includes structure MTO site number, station and location. Offset is included when required. The length of each structure is entered under the appropriate column heading labelled with the tender item name, indicating the structure's span and rise. There should be two tender items for each structure, one for fabrication and one for delivery and installation.

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

Concrete and steel reinforcement quantities, when applicable, shall be included on the "Quantities - Structures" sheet, with location and description in sufficient detail to link the quantities to the buried corrugated steel structure.

960.9.3 Variation Items

a) Geomembrane

Geomembrane is a variation item. The variation is the type of geomembrane (HDPE or LLDPE or PVC) and geomembrane thickness (0.75 mm or 1.0 mm). The quantities for each type of variation are documented in separate columns on the Quantity Sheets. The variation information is entered upon creation of the individual columns and is displayed in the resultant column headings.

The number of geomembrane variations shall be minimized by the designer to the extent possible.

960.9.4 Documentation Accuracy

The length of the structure shall be rounded to the nearest 0.1 m. Stations are recorded in whole numbers.