# CHAPTER C
# CROSS-SECTION ELEMENTS

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## C.1 CROSS-SLOPE

### C.1.1 Minimum Cross-Slope

The selection of surface type has some influence on the geometric design of roadways and is worthy of consideration. Criteria for selection includes: traffic volume and composition, availability of materials, initial cost and the extent and cost of maintenance. When selecting a surface type, the following factors are to be considered:

- the ability of the surface to retain its shape for the anticipated volumes and traffic loads;
- the ability of the surface to drain stormwater; and
- the effect the surface will have on driver behavior.

Table C-1-1a, below, indicates minimum cross-slope requirements for the most common surface types used in roadway construction.

**Table C-1-1a Normal Cross-Slope Requirements for Various Surface Types**

| Surface Type | Minimum Cross-Slope (m/m) |
|---|---|
| Portland Cement Concrete | 0.015 |
| Asphalt Concrete Pavement (ACP) | 0.02 |
| Asphalt Surface Treatment | 0.02 |
| Double Seal Coat (Asphalt) | 0.02 |
| Gravel or Crushed Stone Surface | 0.03 |

### C.1.2 Normal Cross-Slope

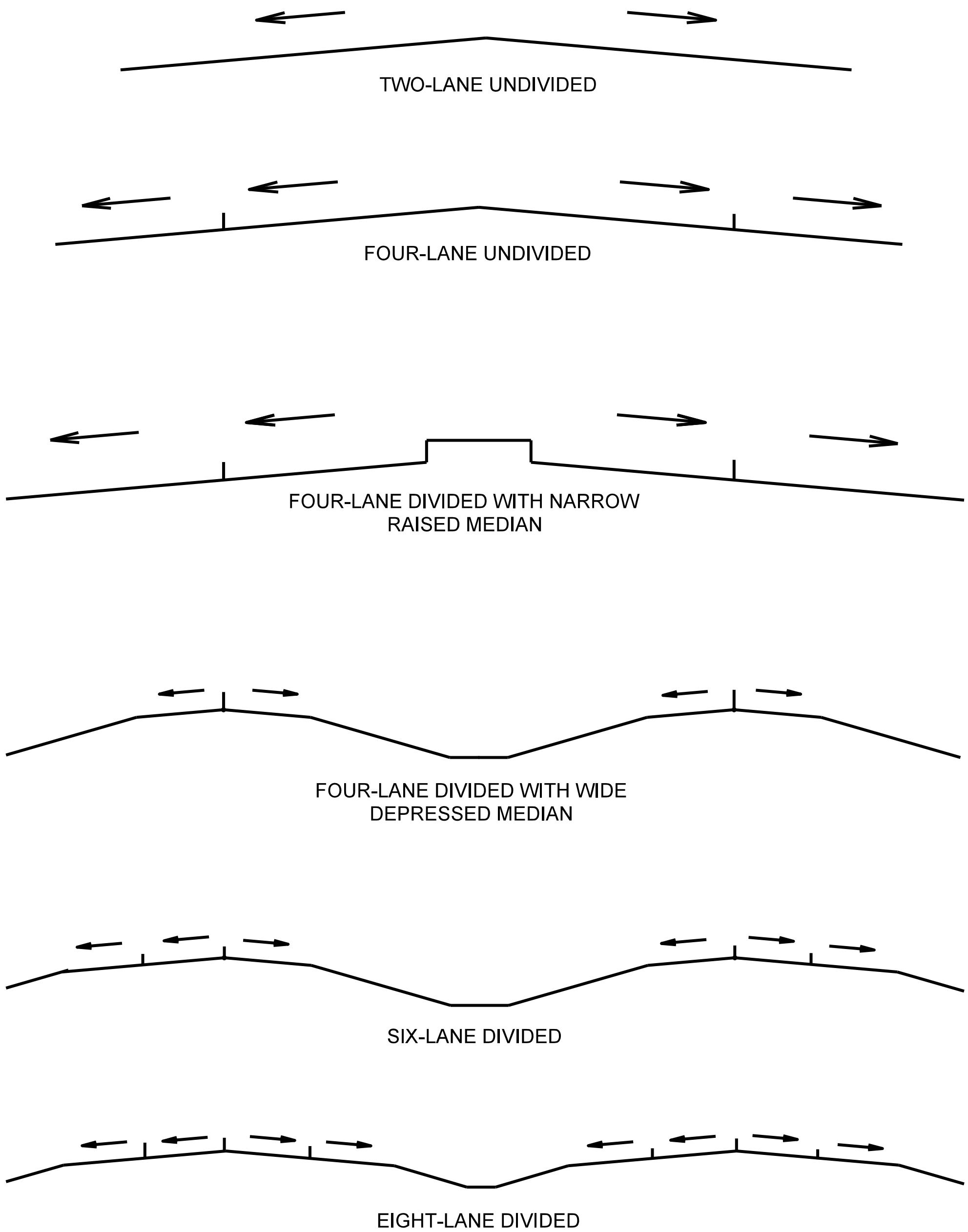
The following is based on an ACP surface on a tangent roadway (refer to Figure C-1-2a):

- On two-lane undivided highways, the pavement is normally crowned at the centreline and the pavement slopes down to the shoulder edge at a rate of 0.02 m/m;
- On four-lane undivided highways, and four-lane divided highways that have a narrow raised median, the crown is normally located in the centre of the pavement (four-lane undivided) or median (four-lane divided) and the pavement slopes down to the shoulder edge at 0.02 m/m;
- On four-lane divided highways with wide depressed medians, the crown is normally located at the centreline of each roadway with a cross-slope of 0.02 m/m down to each pavement edge. If the roadway eventually requires expansion to six lanes, the two additional lanes may be added to the median side or the outside depending on the median width, the ultimate configuration of the roadway, the presence (or absence) of at-grade crossings, or other factors. The additional lanes slope down away from the crown;
- On six-lane divided highways, the crown for each roadway is normally located at the common edge of the centre and median lanes. The two outside lanes have a 0.02 m/m cross-slope down toward the outside pavement edge. The median lane has the same cross-slope draining down

toward the median. If this roadway requires expansion to eight lanes, the additional lanes are accommodated in the median and adopt the same 0.02 m/m cross-slope down toward the median;

- For bridge requirements, refer to the Alberta Transportation, "Bridge Conceptual Design Guidelines" [1].

**Figure C-1-2a Cross-Slope Elements**

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| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: FS | Date: February 2022 | | Cross-Slope Elements | Figure C-1-2a |
| Checked: HC | Scale: NTS | | | |

# C.2 LANE WIDTH

The width of through lanes and auxiliary lanes have a significant impact on capacity, safety and driver comfort.

For rural undivided highways, the design width and the painted width of a through lane may differ for a given design designation.

- Regardless of the design speed, the design width of the through lane is either 3.7 m or 3.5 metres. For design designations that have a width greater than 10.0 metres, the design width is 3.7 metres. For design designations that have a width 10.0 metres or less, the design width is 3.5 metres.
- At the time of new construction or grade-widening, the overall surface width is generally greater than the width indicated by the design designation. The surface is wider to allow two future ACP overlays to be placed without the surface width being reduced to less than the width of the design designation. Refer to Section C.8.1.2, New Construction and Grade-Widening (to Accommodate Two Future Overlays).
- At the time of line painting, the painted width of the through lane is based on the overall surface width (not based on the design designation width). A 3.7 m wide through lane is painted for all rural undivided highways where the surface width exceeds 10 metres. When an overlay reduces the overall width to 10 metres or less, a 3.5 m wide through lane is painted. For example, for an RAU-210 designation, the design width of the through lane is 3.5 metres. At the time of new construction, the overall surface width is 11.28 metres, the painted through lane width is 3.7 m and the resultant shoulder width is 1.94 metres. Refer to Table C-8-1-2a.

For rural divided highways, regardless of the design speed, the width of the through lane (both design and painted) is 3.7 metres.

For urban undivided highways, the overall surface width remains constant due to the curb and gutter on both sides of the roadway (i.e., it doesn't change due to resurfacing). The width is as indicated in the typical cross-sections.

For urban divided highways, regardless of the design speed, the width of the through lane (both design and painted) is 3.7 metres. The UAD may have a 3.7 m or 4.3 m curb lane.

Auxiliary lane widths depend on the function of the lane and the design designation. Climbing, passing and bypass lanes are the same width (3.7 m or 3.5 m) as the design through lane in recognition of the higher operating speeds typically experienced in those lanes. All other auxiliary lanes (e.g., left turns, right turns, acceleration and deceleration) are typically 3.5 m wide. The lane width on single-lane exit ramps, entrance ramps and loops, at an interchange, is typically 4.8 metres. The lane width on dual-lane exit ramps, entrance ramps and loops is typically 3.7 metres. Refer to Chapter E, Freeways and Interchanges.

Oversized or wider loads beyond the legal load width of 2.6 m (the typical width of SU and WB design vehicles) are allowed to use the highway systems under special permit only. Log-haul trucks hauling tree-length logs are allowed a load width of 3.2 metres, however, the haul routes and times for log haul are also controlled by permit. Under special circumstances, a wider lane width may be designed, if required, to accommodate special vehicles. Excessive lane widths may lead to confusion, improper lane use and may encourage unsafe passing maneuvers, so lane widths are not normally increased to accommodate oversize vehicles unless approved by Alberta Transportation. For example, a wider right travel lane was approved on specific segments of Highway 63 in the northbound direction, south of Fort McMurray.

On existing, undivided rural roadways that are less than 7.0 m wide and do not conform to any of the design designations used for new construction, the lane width is less than 3.5 metres. Typically on these narrow rural highways, the lane widths are considered to be half of the pavement width (i.e., no allowance is made for shoulders). On narrow rural roads less than 7.0 m wide, shoulder lines are often not painted.

A centreline is generally painted on all highways that are less than 7.0 m wide that have a permanent driving surface (e.g., asphalt concrete pavement).

A summary of the typical design lane widths is contained in Table C-2a. Design lane widths are also illustrated in Section C.8.2, Typical Cross-sections for Design Designations.

**Table C-2a Design Lane Widths**

| Design Designation | Through Lane (m) | Climbing, Passing or Bypass Lane, as Applicable (m) | Turning, Acceleration or Deceleration Lane (m) |
|---|---|---|---|
| **All UFD**<br>**All RFD** | 3.7 | 3.7 | Refer to Chapter E. |
| **All UED**<br>**All RAD** | 3.7 | 3.7 | 3.5<br>(refer to Chapter E for interchange ramps) |
| **All UAD** | 3.7<br>(4.3 curb lane)<br>(see Note 1) | n/a | Left turn 3.5 m.<br>Right turn uses curb lane. |
| **Urban, Undivided with Curb & Gutter**<br>**UCU-414-70**<br>**UAU-209-70**<br>**UCU-209-70**<br>**ULU-209-60** | <br><br>3.5 (see Note 1)<br>4.5<br>4.5<br>4.5 | n/a | Left turn shares centre lane.<br><br>Right turn uses curb lane. |
| **RAU-212.4**<br>**RAU-212**<br>**RAU-211** | 3.7 | 3.7 | 3.5 |
| **RAU-210**<br>**RAU-209** | 3.5 | 3.5 | 3.5 |
| **RCU-210**<br>**RCU-209**<br>**RCU-208** | 3.5 | 3.5 | 3.5 |
| **RLU-210**<br>**RLU-209**<br>**RLU-208**<br>**RLU-207** | 3.5 | 3.5 | 3.5 |

Notes:

1. Under special circumstances, a wider right-hand curb lane may be used to accommodate motor vehicles and cyclists operating side-by-side, in a shared lane. For new, urban, arterial divided (UAD) construction projects, the width of the shared lane is typically 4.3 m minimum. The curb lane of the UCU-414 roadway may also be 4.3 metres. This applies when the design speed is less than 80 km/h. Refer to Figures C-8-2Uf, C-8-2Ug and C-8-2Uh.

## C.2.1 Parking Lane Width

Where permitted, parking lanes may be used on lower speed urban roadways (normally local and collector urban roads), but generally are not applied to urban roadways having a design speed greater than 70 km/h.

Typically, local roads in residential and industrial areas allow parking. If parking is prohibited, the recommended cross-section width should remain to allow for turning or stopped vehicles. In residential areas, there is a need to accommodate service vehicles and the occasional large truck (e.g., a delivery vehicle or moving truck) traveling through the area. Generally, curb return radii are not sized to accommodate such design vehicles. No parking zones, and the absence of raised islands or channelization, will allow a large truck to use the entire roadway width to successfully complete the turning manoeuver.

Parallel parking may be allowed on roadways classified as urban collectors and undivided arterials (UCU-209-70 and UAU-209-70) as long as the remaining width provides adequate capacity. A passenger car parked adjacent to a curb will occupy, on average, approximately 2.1 m of street width. On-street parking restrictions may be implemented to maintain capacity at certain times (e.g., morning and evening peak hours). Another alternative may be to provide a wider roadway, with a separate through lane and permanent parking lane, which maintains capacity without parking restrictions. A parking lane width as low as 2.1 m for a collector and 2.4 m for an arterial may be acceptable.

Parallel parking may be allowed on the UCU-414-70 but will likely reduce capacity of the four-lane cross-section. To maintain capacity, on-street parking should only be permitted during off-peak hours.

Parking lane widths do not include the gutter pan dimensions which, in practice, may be used for parking. The length of a typical parallel parking stall is 7.0 to 8.0 metres.

Snow-clearing operations should also be considered in determining the dimensions of parking lanes. Windrows of snow and ridges of snow and ice at the curb face reduce the available width of the parking lanes during winter conditions as the windrows not only reduce the available parking lane width, but restrict the opening of vehicle doors forcing drivers to park further from the curb face.

Table C-2-1a summarizes when parking may be considered and the recommended parking lane widths.

**Table C-2-1a Parking Locations and Widths on Urban Roadways**

| Functional Classification | Parking | Parking Lane Width |
|---|---|---|
| Freeway | Prohibited | N/A |
| Expressway | Prohibited | N/A |
| Divided Arterial | Prohibited | N/A |
| Undivided Arterial | Restricted | 2.4 m<br>3.5 m (if a future through lane) |
| Collector | Permitted | 2.1 to 2.4 m (residential)<br>2.4 to 3.3 m (commercial or industrial) |
| Local | Permitted | Included in the roadway width |

# C.3 SHOULDERS

A shoulder is the portion of the roadway running adjacent to the travel lanes. The shoulder performs a variety of functions including:

- provides lateral support for the roadway structure;
- provides an area that may be used to avoid a potential collision or to minimize collision severity;
- contributes to driving ease through a sense of openness created by shoulders of adequate width;
- maintains the intended capacity of the highway;
- provides a safety zone for vehicle parking that is clear of the travelled surface. Reasons for using the shoulder may be because of mechanical trouble, a flat tire, or requiring parking space for maintenance, emergency and law enforcement vehicles;
- improves sight distance in cut sections;
- improves sight distance on horizontal curves by providing an offset to objects such as barriers and bridge piers;
- provides lateral clearance for sign posts and on bridges;
- used by cyclists and other vulnerable users; and
- on curbed highways with enclosed drainage systems, shoulders store and carry water during storms, reducing water from spreading onto the travel lane.

On all paved highways, the shoulder is fully paved and of the same material as the travel lane. Cross-slope and superelevation requirements on the shoulder are the same as the travel lanes.

Except for urban roadways with curb and gutter on both sides of the roadway, at the time of new construction or grade-widening, the overall surface width is generally greater than the width indicated by the design designation. The surface is wider to allow two future ACP overlays to be placed without the surface width being reduced to less than the width of the design designation. Refer to Section C.8.1.2, New Construction and Grade-Widening (to Accommodate Two Future Overlays).

The design width of the shoulder varies between 0.0 m and 3.0 m and is based on the overall width of the design designation, regardless of the design speed. Because the surface is wider to allow two future ACP overlays, the in-place width of the shoulder is generally wider than the design width of the shoulder. For example, for an RAU-210 designation, the design width of the shoulder is 1.5 metres. At the time of new construction, the overall surface width is 11.28 m, so the painted through lane width is 3.7 m and the resultant shoulder width is 1.94 metres. Refer to Section C.2, Lane Width, for information regarding the width of a painted through lane.

The design shoulder width for all design designations of rural highways (and the urban roadways that do not have curb and gutter) are listed in Table C-3a. Design shoulder widths are also illustrated in Section C.8.2, Typical Cross-sections for Design Designations.

**Table C-3a Design Shoulder Widths**

| Design Designation | Design Width (m) | | Adjacent to Auxiliary Lane (m) (see Note 1) | |
|---|---|---|---|---|
| | Left | Right | Left | Right |
| RFD-820.8-130/110 | 3.0 | 3.0 | n/a | 2.5 (single-lane ramp)<br>3.0 (dual-lane ramp)<br>Refer to Chapter E |
| UFD-820.8-110/100/90 (see Note 2) | 3.0 (flush median) | 3.0 | n/a | |
| RFD-616.6-130/110<br>UFD-616.6-110/100/90 | 2.5 | 3.0 | n/a | |
| RFD-412.4-130/110<br>UFD-412.4-110/100/90 | 2.0 | 3.0 | n/a | |
| UFD-617.1-90 (see Note 2) | 3.0 (flush median) | 3.0 | n/a | |
| UED-617.1-90 (see Note 2) | 3.0 (flush median) | 3.0 | n/a | 1.5 |
| UED-412.4-90 | 2.0 | 3.0 | 0.0 (slotted left) | 1.5 |
| RAD 616.6-120 | 2.5 | 3.0 | 0.5 | 1.5 |
| RAD-412.4-120 | 2.0 | 3.0 | 0.5 | 1.5 |
| UED-614.1-80<br>UED-410.4-80<br>(see Note 2) | 0.0 (next to curb & gutter) | 3.0 | 0.0 (parallel left) | 1.5 |
| RAU-212.4-110 | 2.5 | 2.5 | 1.5 | 1.5 |
| RAU-212-110 | 2.3 | 2.3 | 1.5 | 1.5 |
| RAU-211-110 | 1.8 | 1.8 | 1.5 | 1.5 |
| RAU-210-110<br>RCU-210-110/100/90<br>RLU-210-90 | 1.5 | 1.5 | 1.5 | 1.5 |
| RAU-209-110<br>RCU-209-110/100/90<br>RLU-209-90 | 1.0 | 1.0 | 1.0 | 1.0 |
| RCU-208-110/100/90<br>RLU-208-90<br>RLU-208-60 | 0.5 | 0.5 | 0.5 | 0.5 |
| RLU-207-60 | 0.0 | 0.0 | 0.0 | 0.0 |

Notes:

1. Auxiliary lanes include climbing, passing, bypassing, turning, acceleration, and deceleration lanes.
2. A long-life pavement design is often used adjacent to curb and gutter. Pavement maintenance and rehabilitation occurs by milling and replacing the surface layer. Refer to the Alberta Transportation, "Pavement Design Manual" [2] and Section C.8.1.2, New Construction and Grade-Widening (to Accommodate Two Future Overlays), for further information.

A 3.0 m shoulder is considered a full-width shoulder. Three metres is wide enough to serve the functions of a shoulder, while still not being so wide that it might be confused for a lane. Although it may be desirable to provide a 3.0 m shoulder on each side of all roadways, the additional cost for construction and maintenance may not be justified. To minimize costs and optimize benefits, a design shoulder width has been developed for each design designation, which provides a reasonable width based on safety needs, design consistency and consideration of all road users, including cyclists.

Divided highways generally have a narrower shoulder on the left side (median) of the roadway than the right side (outside) of the roadway. The shoulder on the left is not intended to serve the same purpose and does not need to be as wide. A reasonably wide shoulder on both sides of divided highways is still desirable due to the high percentage of larger vehicles.

- On four-lane divided highways, a full-width shoulder (3.0 m wide) is provided on the right side. The shoulder on the left is 2.0 m wide. The exception is the UED-410.4-80, which has no left shoulder next to the curb and gutter (raised median).
- On six-lane divided highways, a full-width shoulder (3.0 m) is provided on the right side and a 2.5 m shoulder on the left side to allow for occasional use by disabled vehicles. The exceptions are the UED-614.1-80 (which has no left shoulder next to the curb and gutter) as well as the UFD-617.1-90 and UED-617.1-90 (which have a 3.0 m left shoulder as part of the flush median).
- On eight-lane divided highways, a full-width shoulder (3.0 m) is provided on both sides. It may not be possible for a vehicle that is having mechanical problems in the left lane, to travel to the right shoulder before stopping.

On undivided highways, shoulder widths range from 0.0 m to 2.5 metres. A width of 0.5 m is considered the practical minimum to provide lateral support to the pavement structure.

On undivided highways, the shoulder width adjacent to an auxiliary lane is the same as the design shoulder width, to a maximum of 1.5 metres.

On divided highways, the shoulder width adjacent to a right-side auxiliary lane is 1.5 metres. The exception is for freeways, where the shoulder width is 2.5 m for single-lane entrance and exit ramps (3.0 m for dual-lane ramps). Refer to Chapter E, Freeways and Interchanges. The shoulder width adjacent to a left-side auxiliary lane is between 0.0 m and 0.5 metres for non-freeway facilities. Freeways do not have left-side auxiliary lanes.

In urban areas, shoulders are utilized on all freeways and expressways. The high cost of right-of-way and/or constraints in urban areas may make the provision of shoulders difficult to justify on other streets where vehicle speeds are lower. Refer to Figures C-8-2-2Ud through C-8-2-2Uh, which illustrate typical urban cross-sections with curb and gutter on both sides of the roadway.

For shoulder widths on bridge structures, refer to the Alberta Transportation, “Bridge Conceptual Design Guidelines” [1].

# C.4 DRAINAGE FOR RURAL HIGHWAYS

## C.4.1 General

Drainage design should provide the most effective and economical methods to ensure that runoff water can be passed through and removed from the roadway. The primary objectives are to provide culvert openings for natural drainage channels, prevent undue accumulation and retention of water upon and adjacent to the roadway, and protect the roadway against storm and subsurface water damage. The installation of drainage facilities must not create hazardous conditions for traffic or have any adverse affect on adjoining property. Highway drainage systems are not permitted to alter the natural drainage pattern of adjacent land without first obtaining a permit from Alberta Environment and Parks.

For bridge-specific drainage considerations, refer to the Alberta Transportation, "Bridge Conceptual Design Guidelines" [1].

## C.4.2 Drainage Requirements

When determining drainage requirements, a critical factor is the expected intensity of rainfall during a storm. Predicting rainfall intensity is difficult unless it is based on actual statistics recorded over a considerable time. Observations of drainage patterns during springtime, when surface water runoff is considerable, give a good indication of drainage requirements. Staff from the Construction and Maintenance Division of Alberta Transportation, or from local municipalities, can often provide valuable drainage information when existing highways or local roads are to be constructed or improved.

Alberta Transportation has established minimum culvert sizes for particular installations, even though these sizes may have capacity exceeding the discharge requirements. The minimum diameter for circular section pipes serving as cross drains (i.e., centreline culverts) is 800 mm on the main alignment and local roads. Culverts of 600 mm diameter are used to drain medians on divided highways. The minimum diameter on field and farm accesses is 600 mm. The purpose of the minimum size is to facilitate pipe cleaning maintenance operations and to minimize freeze-up problems.

On a typical highway design project, it is generally not necessary to undertake a detailed drainage design calculation for smaller culverts because these culverts are generally oversized for ease of maintenance. Larger bridge-sized culverts or structures require a more extensive investigation as outlined in the Alberta Transportation, "Bridge Conceptual Design Guidelines" [1].

When a detailed design is required for a culvert (e.g., at stormwater retention ponds and drainage channels), the following guidelines should be used:

- Provide a capacity based on a return period of 100 years for freeways, expressways, and arterials; 50 years for collectors; and 25 years for local roads;
- The overall drainage system should be considered including ditches, outfalls, ponds, etc.;
- Culverts may be designed to allow water to back up no higher than 0.3 metres below the top of the subgrade (not the top of the surfacing material) for a short period;
- If the water depth is expected to exceed 1 m in a ditch or retention pond, the duration of such high water should be very limited unless the water hazard is outside of the clear zone or is protected by traffic barriers; and
- Stormwater velocities and erosion control measures should be considered as required, taking into account gradients, soil types, flow conditions, vegetation cover and previous experience with erosion in the vicinity.

## C.4.3 Drainage Channels

Drainage channels perform the function of removing surface water from the highway right-of-way. Where possible, they should be designed to have sufficient capacity to keep water velocities below scour limits.

There are five basic types of drainage channels:

- Roadside channels (ditches) are used in cut sections to remove water from the highway cross-section;
    - For wide ditches (3 m or greater width), the desirable minimum longitudinal grade is 0.2% and the absolute minimum is 0.05%. For narrower ditches (less than 3 m wide), the desirable minimum ditch slope is 0.5% and the absolute minimum is 0.2%. The minimum slopes are intended to eliminate ponding in the ditches. Refer to Chapter B.4.3, Minimum Gradient. The desirable maximum slope for a ditch is three percent. Ditches that exceed a three percent

grade for long distances may require special erosion control measures. Highly erodible soils (e.g., silty soils) may experience some scouring, even at relatively low grades.

- Channels located at the toe-of-slope convey water from the cut section, and from adjacent slopes, to a natural watercourse;
- Catch-water ditches placed at the top of a cut slope intercept surface water, from adjacent lands, from flowing down and eroding the cut slope;
- Chutes carry collected water down steep cut or fill slopes; and
- Swales (shallow depressions) are generally used to drain medians or islands.

All channels should be streamlined in cross-section for safety, ease of maintenance and to minimize the effect of drifting snow. Design configurations for the various drainage channels are indicated on the typical cross-sections (refer to Figures C-8-2a through C-8-2q).

### C.4.3.1 Ditch Configuration

The trapezoidal ditch configuration shown in all of Alberta's typical cross-sections has been adopted primarily based on safety. A study [3] has shown that, of the common ditch configurations (v-ditch, round ditch, narrow trapezoidal ditch or wide trapezoidal ditch), the latter is the safest for errant vehicles that leave the road surface and traverse the roadside area (i.e., the sideslope, ditch and backslope). The same study found that sideslopes of 4:1 or flatter are desirable to reduce collision severity in the roadside area (particularly by reducing the occurrence of rollovers), and to permit vehicle recovery onto the road surface, especially where embankment surfaces are firm and smooth. Based on this and other studies, sideslopes steeper than 4:1 are recommended only where site conditions do not permit the use of flatter slopes. Refer to the Alberta Transportation, "Roadside Design Guide" [4] to determine warrants for barrier, or other mitigating measures, if slopes steeper than 4:1 are used.

### C.4.3.2 Standard Height of Fill (Depth of Ditch)

Generally, the standard height of fill (sometimes called the depth of ditch) used for all design designations is one metre. This is the difference in elevation between the graded (subgrade) shoulder and the toe of the sideslope. If the elevation of the subgrade shoulder is less than one metre above natural ground, a ditch is excavated as per the typical cross-sections. This is termed a cut section. Where the height of fill exceeds one metre, ditches are often not required, but an independent design ditch could be placed at the bottom of the fill to prevent ponding or to direct flow to an alternate location such as a watercourse.

The principal reason for using a one-metre standard height of fill is to ensure that the roadway embankment will be essentially free of differential, frost-heave problems [5]. This is achieved by excavating wet or unsuitable frost-susceptible soil and replacing it with selected clay or granular material from common or borrowed excavations. The embankment material is selected based on suitability for road construction. Materials with the lowest degree of frost susceptibility are preferred. Other soil characteristics include moisture content and maximum density. The material is placed in layers in the embankment at optimum moisture content and at a high degree of compaction. By building a one-metre high embankment, there is an opportunity to ensure that at least one metre of the clay material underlying the road pavement structure is less frost susceptible, of optimum moisture content and of high density. Although this practice does not eliminate the occurrence of frost heave, it does provide consistency and reduces the occurrence of localized bumps due to severe heaves. The construction of the embankment above natural ground also helps keep the subgrade relatively dry, as the natural water table generally will not rise above the natural ground line.

Additional benefits of a one-metre standard height of fill are:

- provision of adequate snow storage capacity in the ditches;
- reduction of snow-drifting on the road surface as wind will clear lighter accumulations;
- better line-of-sight for drivers;

- adequate cover over most culverts; and
- standard highway right-of-ways are wide, which generally contributes to a safer roadside area and less severe run-off-road incidents.

## C.4.4 Culvert Types

Pipe culverts are manufactured in various sizes and shapes and from various types of materials. Some types of pipe available for use include:

- CMP (Corrugated Metal Pipe) – general term for corrugated pipes made of steel or aluminum;
  - CSP (Corrugated Steel Pipe) – galvanized with or without polymer coating;
  - CSP Arch (Corrugated Steel Pipe-Arch) – galvanized with or without polymer coating;
  - CAP (Corrugated Aluminum Pipe); and
  - CAP Arch (Corrugated Aluminum Pipe-Arch).
- RCP (Reinforced Concrete Pipe) – round or elliptical, commonly used as storm sewer;
- RGRCP (Rubber Gasket Reinforced Concrete Pipe) – uses a flexible watertight rubber-type gasket;
- RCB (Reinforced Concrete Box);
- PP (Polyethylene Pipe) - commonly used as a perforated pipe subdrain or as a liner placed inside an existing culvert;
- PVC (Polyvinyl Chloride Pipe) – commonly used as a drainage pipe or as a liner placed inside an existing culvert; and
- SWSP (Smooth Wall Steel Pipe) – commonly cored/pushed under an existing embankment or used as a liner placed inside an existing culvert.

Large size multi-plate pipe culverts and anti-corrosive pipe are also available. Alberta Transportation considers any culvert with an equivalent diameter of 1,500 mm or greater to be a bridge-size culvert.

The standard corrugated steel pipe is galvanized. If the culvert is to be installed in a corrosive environment (e.g., an alkali soil), a polymer coating or an aluminized steel pipe may be used to provide a longer life.

Concrete culverts are generally used only in special circumstances where long life is a major consideration. Examples are at high embankments or locations with high traffic volumes (e.g., interchange ramps) where the replacement of an existing culvert would be very inconvenient. With improvements in the commonly available methods for coring and pushing of pipes through existing embankments, the need to use concrete culverts around interchange areas is less critical. Special materials, such as liners, may also be used in the rehabilitation of existing culverts. Refer to Section C.4.6, Culvert Installation, for more information.

The Alberta Transportation documents, “Best Practice Selection of Culvert Types (Guidelines for Culvert Material Selection)” and “Best Practice Guidelines for Culvert Liner Selection” are located in the “Best Practice Guidelines” website [6].

## C.4.5 Culvert Strength Requirements

Pipe culverts are manufactured to several different strength requirements. The principal factors that influence the strength requirements for pipe culverts are the height of fill and, in the case of reinforced concrete culverts, the type of backfill.

Table C-4-5a identifies the thickness requirements for circular (round), five percent vertically elongated, and arched (pipe-arch) Corrugated Steel Pipe (CSP). The required metal thickness is indicated for various combinations of pipe diameter, pipe shape and height of cover above the top of the culvert. Cover is the distance from the top of the culvert to the elevation of the finished roadway surface.

In the case of the vertically elongated CSP, to obtain the benefit of the increased strength, the culvert must be installed with the long axis of the pipe standing vertically.

Table C-4-5b shows the required metal thickness of corrugated aluminum pipe for various diameters and height of cover above the top of the culvert. This information is based on standard highway loadings (as used in the other figures). The load carrying capacity of aluminum culverts is much less than that of steel culverts due to lower pipe stiffness and lower yield strengths.

Table C-4-5c indicates the required class of reinforced concrete pipe based on the pipe diameter and the height of cover above the top of the pipe.

**Table C-4-5a Thickness of Corrugated Steel Pipe**

<table>
<tr><th colspan="32">Table A – Metric Circular CSP (Corrugation Profile 68 mm x 13 mm)</th></tr>
<tr><th rowspan="2">Dia. (mm)</th><th rowspan="2">Area ($m^2$)</th><th colspan="30">Height of Cover above Top of Culvert (metres)</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th><th>20</th><th>21</th><th>22</th><th>23</th><th>24</th><th>25</th><th>26</th><th>27</th><th>28</th><th>29</th><th>30</th></tr>
<tr><td>400</td><td>0.126</td><td colspan="14">1.6</td><td colspan="6">2.0</td><td colspan="10">2.8</td></tr>
<tr><td>500</td><td>0.196</td><td colspan="10">1.6</td><td colspan="7">2.0</td><td colspan="13">2.8 available</td></tr>
<tr><td>600</td><td>0.283</td><td colspan="5">1.6</td><td colspan="9">2.0</td><td colspan="7">2.8</td><td colspan="9">3.5</td></tr>
<tr><td>700</td><td>0.385</td><td colspan="11">2.0</td><td colspan="6">2.8</td><td colspan="8">3.5</td><td colspan="5">4.2</td></tr>
<tr><td>800</td><td>0.503</td><td colspan="8">2.0</td><td colspan="4">2.8</td><td colspan="8">3.5</td><td colspan="10">4.2 (see Note 1)</td></tr>
<tr><td>900</td><td>0.636</td><td colspan="5">2.0</td><td colspan="5">2.8</td><td colspan="4">3.5</td><td colspan="16">4.2 (see Note 1)</td></tr>
<tr><td>1000</td><td>0.785</td><td colspan="8">2.8</td><td colspan="4">3.5</td><td colspan="18">4.2</td></tr>
<tr><td>1200</td><td>1.131</td><td colspan="6">2.8</td><td colspan="2">3.5</td><td colspan="3">4.2</td><td colspan="19">For Fills Over 11 Metres, Use Table B</td></tr>
<tr><td>1400</td><td>1.539</td><td colspan="6">3.5</td><td colspan="3">4.2</td><td colspan="21">For Fills Over 9 Metres, Use Table B</td></tr>
</table>

Notes:

1. When the height of cover over an 800 mm diameter CSP exceeds 21 metres or when the height of cover over a 900 mm diameter CSP exceeds 19 metres, the Imperfect Trench Condition installation method is to be used. Refer to Figure C-4-6d.

<table>
<tr><th colspan="32">Table B – Metric 5% Vertically Elongated CSP (Corrugation Profile 68 mm x 13 mm)</th></tr>
<tr><th rowspan="2">Dia. (mm)</th><th rowspan="2">Area ($m^2$)</th><th colspan="30">Height of Cover above Top of Culvert (metres)</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th><th>20</th><th>21</th><th>22</th><th>23</th><th>24</th><th>25</th><th>26</th><th>27</th><th>28</th><th>29</th><th>30</th></tr>
<tr><td>1200</td><td>1.131</td><td colspan="8">2.8</td><td colspan="14">3.5</td><td colspan="8">4.2</td></tr>
<tr><td>1400</td><td>1.539</td><td colspan="16">3.5</td><td colspan="12">4.2</td><td colspan="2">X</td></tr>
</table>

<table>
<tr><th colspan="10">Table C – Metric Pipe-Arch CSP(Corrugation Profile 68 mm x 13 mm)<br>(An Equivalent Size of Round Pipe is Preferred)</th></tr>
<tr><th rowspan="2">Span (mm)</th><th rowspan="2">Rise (mm)</th><th rowspan="2">Area ($m^2$)</th><th rowspan="2">Equivalent Diameter (mm)</th><th colspan="6">Height of Cover above Top of Culvert (metres)</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr>
<tr><td>450</td><td>340</td><td>0.112</td><td>400</td><td colspan="6">1.6</td></tr>
<tr><td>560</td><td>420</td><td>0.175</td><td>500</td><td colspan="6">1.6</td></tr>
<tr><td>680</td><td>500</td><td>0.255</td><td>600</td><td colspan="6">2.0</td></tr>
<tr><td>800</td><td>580</td><td>0.342</td><td>700</td><td colspan="6">2.0</td></tr>
<tr><td>910</td><td>660</td><td>0.443</td><td>800</td><td colspan="4">2.0</td><td colspan="2">2.8</td></tr>
<tr><td>1030</td><td>740</td><td>0.564</td><td>900</td><td colspan="6">2.8</td></tr>
<tr><td>1150</td><td>820</td><td>0.701</td><td>1000</td><td colspan="5">2.8</td><td>3.5</td></tr>
<tr><td>1390</td><td>970</td><td>1.022</td><td>1200</td><td>3.5</td><td colspan="2">2.8</td><td colspan="3">3.5</td></tr>
<tr><td>1630</td><td>1120</td><td>1.401</td><td>1400</td><td>4.2</td><td colspan="3">3.5</td><td colspan="2">4.2</td></tr>
</table>

Notes:

1. For all tables, the height of cover is for finished construction. During construction, sufficient cover is to be provided to protect the structure from damage.
2. The culvert strength for all tables is based on Design Specification CAN-CSA-S6-88 Design Live Load CS750.

**Table C-4-5b Thickness of Corrugated Aluminum Pipe**

<table>
<tr><th rowspan="2">Dia. (mm)</th><th rowspan="2">Area ($m^2$)</th><th colspan="20">Height of Cover above Top of Culvert (metres)</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th><th>≥ 20</th></tr>
<tr><td>400</td><td>0.126</td><td colspan="7">1.6</td><td colspan="4">2.0</td><td colspan="5">2.8</td><td colspan="4"></td></tr>
<tr><td>500</td><td>0.196</td><td colspan="5">1.6</td><td colspan="3">2.0</td><td colspan="4">2.8</td><td colspan="8"></td></tr>
<tr><td>600</td><td>0.283</td><td colspan="3">1.6</td><td colspan="4">2.0</td><td colspan="3">2.8</td><td colspan="3">3.5</td><td colspan="7"></td></tr>
<tr><td>700</td><td>0.385</td><td colspan="6">2.0</td><td colspan="3">2.8</td><td colspan="2">3.5</td><td colspan="9"></td></tr>
<tr><td>800</td><td>0.503</td><td colspan="5">2.0</td><td colspan="2">2.8</td><td colspan="2">3.5</td><td colspan="11"></td></tr>
<tr><td>900</td><td>0.636</td><td colspan="3">2.0</td><td colspan="2">2.8</td><td colspan="2">3.5</td><td colspan="13">Hatched Zone is Not Recommended</td></tr>
<tr><td>1000</td><td>0.785</td><td colspan="4">2.8</td><td colspan="2">3.5</td><td colspan="14"></td></tr>
<tr><td>1200</td><td>1.131</td><td colspan="3">2.8</td><td>3.5</td><td colspan="2">4.2</td><td colspan="14"></td></tr>
<tr><td>1400</td><td>1.539</td><td colspan="4">3.5</td><td>4.2</td><td colspan="15"></td></tr>
</table>

Notes:

1. The height of cover is for finished construction. During construction, sufficient cover is to be provided to protect the structure from damage.
2. Culvert strength is based on H-20 Live Loading.

**Table C-4-5c Class of Reinforced Concrete Pipe**

<table>
<tr><th colspan="5">Class of Reinforced Concrete Pipe<br>Based on Live Load CS750 in Design Specification CAN-CSA-S6-88</th></tr>
<tr><th rowspan="2">Dia. (mm)</th><th rowspan="2">Area ($m^2$)</th><th colspan="3">Height of Cover above Top of Culvert (metres)</th></tr>
<tr><th>1 – 4</th><th>4 – 6</th><th>6 – 8</th></tr>
<tr><td>375</td><td>0.111</td><td>I I I</td><td>I V</td><td>V (see Note 1)</td></tr>
<tr><td>450</td><td>0.159</td><td>I I I</td><td>I V</td><td>V (see Note 1)</td></tr>
<tr><td>600</td><td>0.283</td><td>I I I</td><td>I V</td><td>V (see Note 1)</td></tr>
<tr><td>750</td><td>0.442</td><td>I I I</td><td>I V</td><td>V (see Note 1)</td></tr>
<tr><td>900</td><td>0.636</td><td>I I I</td><td>I V</td><td>V (see Note 1)</td></tr>
<tr><td>1200</td><td>1.131</td><td>I I I</td><td>I V</td><td>V (see Note 2)</td></tr>
</table>

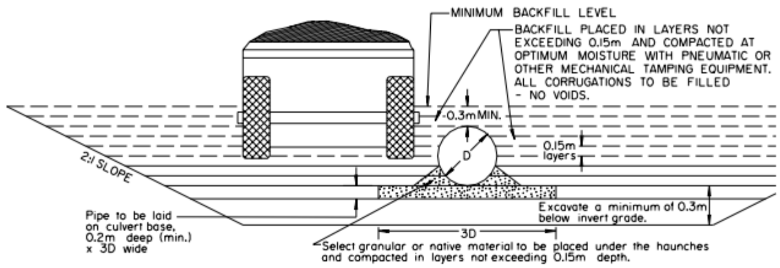
Notes:

1. For culverts less than or equal to 900 mm in diameter, the Negative Projecting Embankment Method is to be used when the height of cover exceeds 8 metres. Refer to Figure C-4-6e.
2. For 1200 mm diameter culverts, the Negative Projecting Embankment Method is to be used when the height of cover exceeds 6 metres. Refer to Figure C-4-6e.
3. If the fill height exceeds 8 metres, a detailed load calculation is required with an assessment of the factor of safety for concrete pipe strength.
4. Reinforced concrete pipe manufactured in accordance with the requirements of CAN-CSA Specification S6-88 are classified according to supporting strength capacity values. Consistent with the supporting strength capacity specified, the various classes of pipe can generally be grouped and described as to intended use as follows:
   - Class I and Class II are primarily intended to carry water or sewage by gravity under moderately low heights of cover and light traffic loads.
   - Class III and Class IV are intended for normal highway drainage use and for sewers in deep trenches with above-normal loading conditions.
   - Class V is a high strength classification for highway drainage culverts under high fills, and for sewers in deep trenches with severe loading conditions.

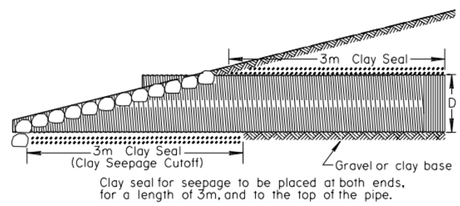
## C.4.6 Culvert Installation

A corrugated metal pipe (CMP) culvert installation is shown in Standard Drawing CB6-2.4M1 “Corrugated Metal Pipe Culvert Installation (Open-Cut Method)” [7]. This drawing illustrates excavation, culvert base construction, backfilling and compaction. The excavation must be wide enough to allow pipe assembly and to accommodate the operation of compaction equipment on both sides of the culvert. The culvert bed is constructed using select native or granular material. Select material is also placed under the haunches prior to backfilling. A clay seal cut-off is placed around the pipe at both ends of the culvert to prevent seepage along the pipe.

**The following diagrams are for illustration only**. Refer to Standard Drawing CB6-2.4M1 for specific requirements.




Excavation, Culvert Base and Backfilling




Clay Seal Detail

Sloped end sections are specified for most pipe installations since they provide better entrance and exit flow characteristics, fit closely to the subgrade slope, and are less of an obstruction to a vehicle leaving the roadway surface. Figures C-4-6a, C-4-6b and C-4-6c are to be used by the designer to determine culvert installation lengths and the appropriate sloped end treatment for round CMP, pipe-arch CMP and plastic culverts, respectively.

When culverts are installed on skew, the degree of skew is measured as the angle between the pipe installation and a line perpendicular to the highway centreline. A culvert angle is described in terms of which end is forward (i.e., left-hand forward or right-hand forward). For example, if the left-hand end of the culvert, while looking along the highway alignment in the direction of increasing chainage, is ahead of the line perpendicular to the centreline, and the angle is 15 degrees, the installation would be described as 15 degrees left-hand forward.

Two special methods of culvert installation, the imperfect trench condition and the negative projecting embankment, are illustrated in Figures C-4-6d and C-4-6e, respectively. Both installation types reduce the loading due to backfill and increase the safe height of fill that can be carried.

Where existing culverts need to be extended (e.g., due to roadway widening or sideslope improvement), rehabilitated (e.g., due to corrosion), or replaced (e.g., to increase capacity), a variety of methods are available.

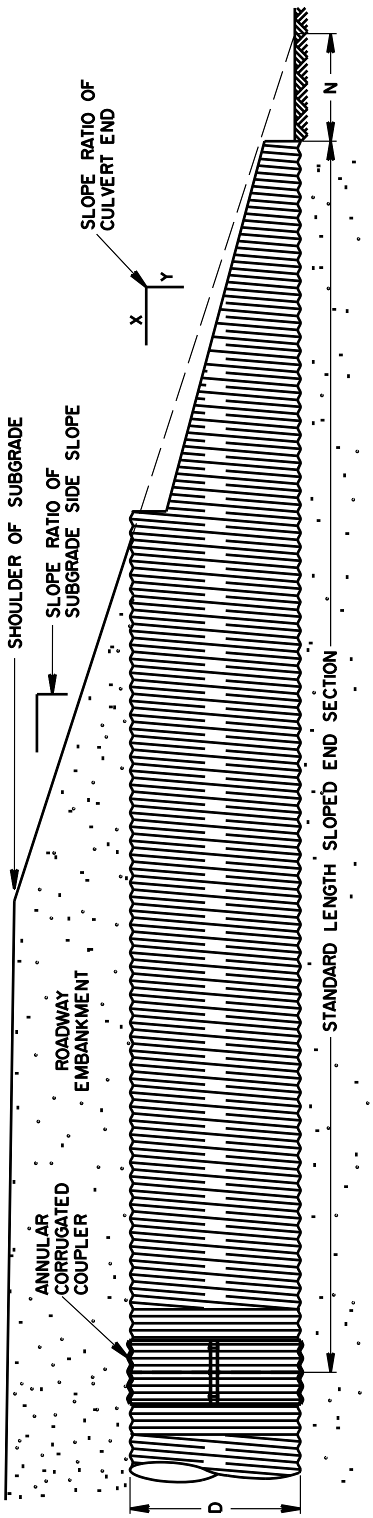
Extending an existing culvert involves removal of the existing sloped end section and installation of the additional pipe using trenching or an open-cut excavation. The existing sloped end section may be removed, salvaged and reinstalled, or a new sloped end may be required, as shown on the drawings or as directed by the consultant. Refer to Standard Drawing CB6-2.4M18, “Culvert Installation by Trenching” [7].

When an existing culvert is corroded or collapsed, and the pipe has retained most of its form and alignment, rehabilitation may involve the installation of a plastic pipe or smooth wall steel pipe as a liner inside the existing culvert. If required, the liner is extended beyond the ends of the existing culvert using trenching or an open-cut excavation. Using a low-pressure pump, grout is placed into the void between the liner and the surrounding existing culvert. The liner must remain at the existing culvert invert elevation during the grouting operation. Refer to Standard Drawing CB6-2.29M1, “Plastic and SWSP Liner Installation and Grouting within Existing Culverts” [7].

For culvert replacement, methods include coring and pushing a pipe (smooth wall steel pipe or reinforced concrete pipe) through an existing embankment, or placement of a corrugated metal pipe on a prepared base using trenching or conventional open-cut excavation.

Centreline smooth wall steel pipe installation consists of coring and pushing a portion of the steel pipe through the existing highway embankment without disturbing the embankment or surfacing structure. The remainder of the steel pipe is installed on a prepared base using trenching or an open-cut excavation. The total length of pipe required for both the coring and trenched or open-cut installations is based on the design cross-sections. Refer to Standard Drawing CB6-2.4M19, “Culvert Installation by Coring and Trenching” [7].

## Figure C-4-6a Sloped End Treatment and Length for Round Corrugated Metal Pipe




| C.M.P. DIAMETER D (mm) | SLOPE RATIO OF CULVERT END X: Y | N (METRES) | | | | INVERT LENGTH OF SLOPED END SECTION (METRES) |
|---|---|---|---|---|---|---|
| | | WITH 3: 1 SUBGRADE SLOPE RATIO | WITH 4: 1 SUBGRADE SLOPE RATIO | WITH 5: 1 SUBGRADE SLOPE RATIO | WITH 6: 1 SUBGRADE SLOPE RATIO | |
| 400 | 4 : 1 | 0.3 | 0.5 | 0.8 | 1.2 | 6.0 |
| 500 | 4 : 1 | 0.3 | 0.6 | 0.9 | 1.5 | 6.0 |
| 600 | 4 : 1 | 0.3 | 0.6 | 1.0 | 1.6 | 6.0 |
| 700 | 4 : 1 | 0.3 | 0.8 | 1.2 | 2.0 | 6.0 |
| 800 | 4 : 1 | 0.4 | 0.9 | 1.4 | 2.3 | 6.0 |
| 900 | 4 : 1 | 0.5 | 1.0 | 1.6 | 2.5 | 6.0 |
| 1000 | 4 : 1 | 0.5 | 1.2 | 1.8 | 2.8 | 6.0 |
| 1200 | 3 : 1<br>4 : 1 | 0.9<br>0.6 | 1.7<br>1.4 | 2.4<br>2.2 | 3.7<br>3.5 | 6.0 |
| 1400 | 3 : 1<br>4 : 1 | 1.0<br>0.6 | 1.9<br>1.6 | 2.8<br>2.5 | 4.3<br>3.9 | 6.0 |

<u>SELECTION OF SLOPE RATIO FOR SLOPED END SECTION:</u>

A 4 : 1 SLOPED END SECTION SHALL BE USED IN CONJUNCTION WITH ALL SUBGRADE SIDE SLOPES WITH THE EXCEPTION OF 1200mm DIAMETER AND LARGER, WHERE APPLICABLE.

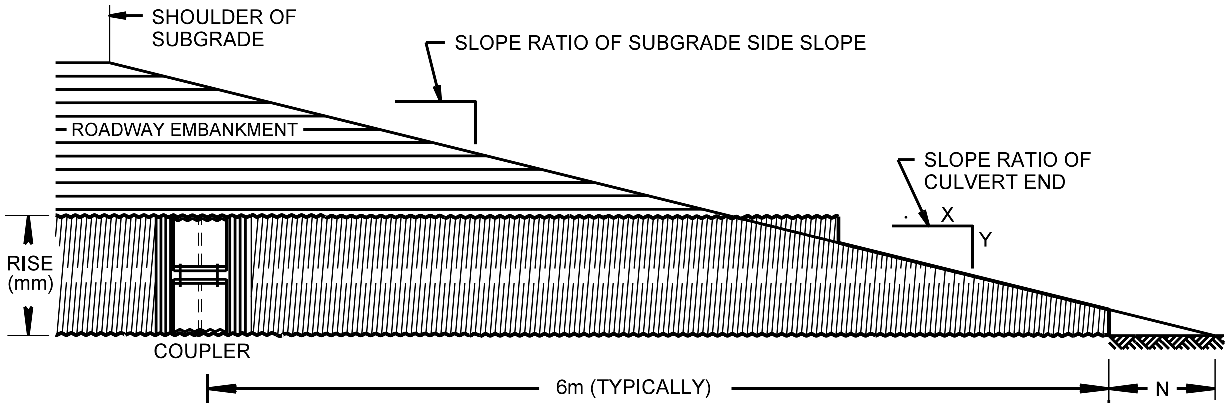
<u>DETERMINING INSTALLATION LENGTH:</u>

THE LENGTH OF PIPE CULVERT TO BE INSTALLED SHALL BE DETERMINED AS FOLLOWS:

1. ESTABLISH THE THEORETICAL LENGTH BASED ON SLOPE STAKE REQUIREMENTS. WHERE NO SPECIAL TREATMENT IS REQUIRED, CULVERT INVERT ELEVATIONS ARE TYPICALLY SET AT (0.15 X DIAMETER) BELOW THE DRAINAGE COURSE ELEVATION.
2. ADJUST THE THEORETICAL LENGTH BY APPLYING THE END CORRECTION "N", AS DETERMINED FROM THE TABLE, TO EACH END OF THE CULVERT.
3. INSTALLATION LENGTH SHALL BE THE LENGTH DETERMINED IN STEP 2, ABOVE, ROUNDED TO THE NEAREST METRE.

| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
|---|---|---|---|---|
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Sloped End Treatment and Length for Round Corrugated Metal Pipe | Figure C-4-6a |
| Checked: HC | Scale: NTS | | | |

## Figure C-4-6b Sloped End Treatment and Length for Pipe-Arch Corrugated Metal Pipe




| ARCH DIMENSIONS | | SLOPE RATIO OF CULVERT END X:Y | N (METRES) | | | | | INVERT LENGTH OF SLOPED END SECTION (METRES) |
|---|---|---|---|---|---|---|---|---|
| SPAN (mm) | RISE (mm) | | WITH 3:1 SUBGRADE SLOPE RATIO | WITH 4:1 SUBGRADE SLOPE RATIO | WITH 5:1 SUBGRADE SLOPE RATIO | WITH 6:1 SUBGRADE SLOPE RATIO | WITH 8:1 SUBGRADE SLOPE RATIO | |
| 450 | 340 | 4:1 | 0.0 | 0.3 | 0.6 | - | - | 6.0 |
| | | 5:1 | - | 0.1 | 0.4 | 0.6 | 1.2 | 6.0 |
| 560 | 420 | 4:1 | 0.0 | 0.4 | 0.7 | - | - | 6.0 |
| | | 5:1 | - | 0.1 | 0.5 | 0.9 | 1.6 | 6.0 |
| 680 | 500 | 4:1 | 0.0 | 0.4 | 0.9 | - | - | 6.0 |
| | | 5:1 | - | 0.2 | 0.6 | 1.1 | 2.0 | 6.0 |
| 800 | 580 | 4:1 | 0.0 | 0.5 | 1.0 | - | - | 6.0 |
| | | 5:1 | - | 0.2 | 0.6 | 1.2 | 2.1 | 6.0 |
| 910 | 660 | 4:1 | 0.0 | 0.5 | 1.2 | - | - | 6.0 |
| | | 5:1 | - | 0.2 | 0.8 | 1.5 | 2.3 | 6.0 |
| 1030 | 740 | 4:1 | 0.0 | 0.5 | 1.3 | - | - | 6.0 |
| | | 5:1 | - | 0.2 | 0.8 | 1.5 | 2.5 | 6.0 |
| 1150 | 820 | 4:1 | 0.0 | 0.6 | 1.4 | - | - | 6.0 |
| | | 5:1 | - | 0.3 | 0.8 | 1.5 | 3.0 | 6.0 |
| 1390 | 970 | 4:1 | 0.0 | 0.6 | 1.5 | - | - | 6.0 |
| | | 5:1 | - | 0.1 | 0.8 | 1.6 | 3.0 | 6.0 |
| 1630 | 1120 | 4:1 | 0.0 | 0.7 | 1.5 | - | - | 6.0 |
| | | 5:1 | - | 0.1 | 1.1 | 2.2 | 3.7 | 6.0 |

DETERMINING INSTALLATION LENGTH:

THE LENGTH OF PIPE CULVERT TO BE INSTALLED SHALL BE DETERMINED AS FOLLOWS:

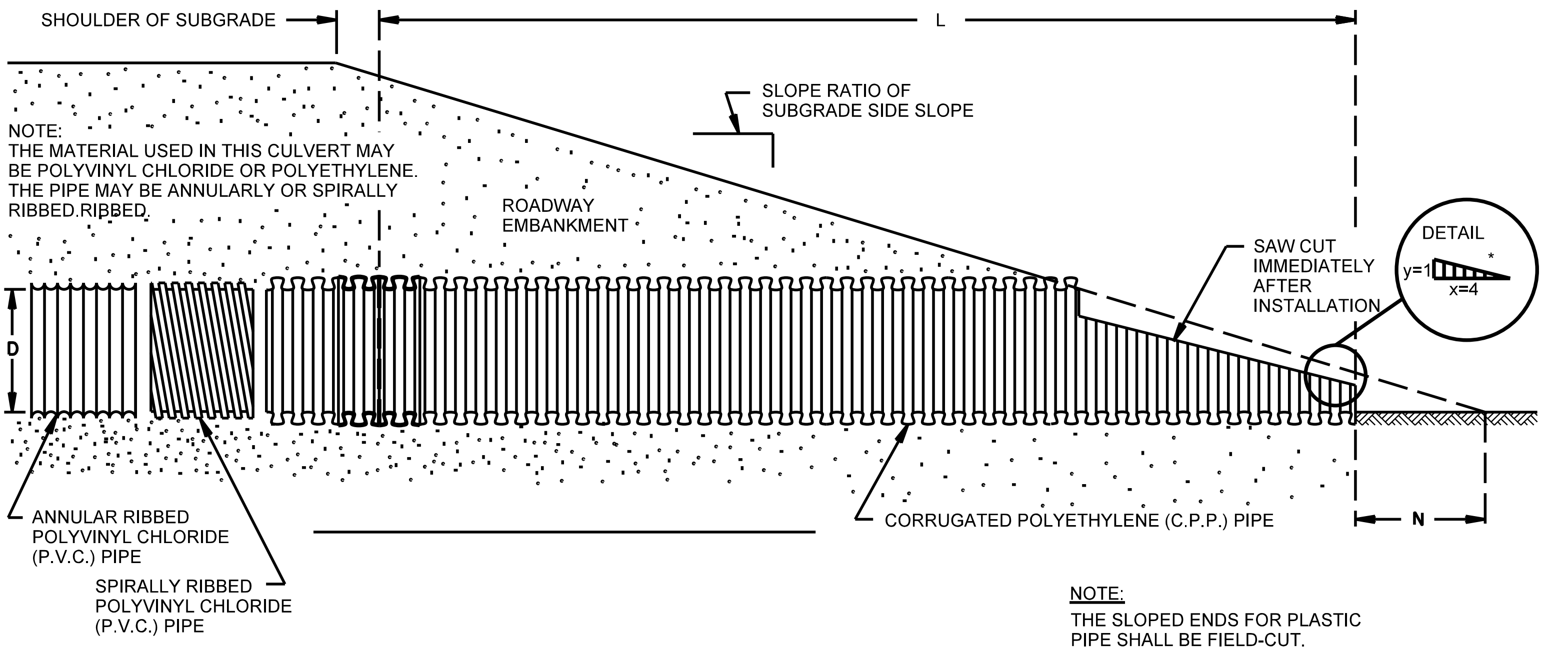
1. ESTABLISH THE THEORETICAL LENGTH BASED ON SLOPE STAKE REQUIREMENTS. WHERE NO SPECIAL TREATMENT IS REQUIRED, CULVERT INVERT ELEVATIONS ARE TYPCIALLY SET AT (0.15 X DIAMETER) BELOW THE DRAINAGE COURSE ELEVATION.
2. ADJUST THE THEORETICAL LENGTH BY APPLYING THE END CORRECTION "N", AS DETERMINED FROM THE TABLE, TO EACH END OF THE CULVERT.
3. INSTALLATION LENGTH SHALL BE THE LENGTH DETERMINED IN STEP 2, ABOVE, ROUNDED TO THE NEAREST METRE.

SELECTION OF SLOPE RATIO FOR SLOPED END SECTION:

1. A 4:1 SLOPED END SECTION SHALL BE USED IN CONJUNCTION WITH SUBGRADE SIDE SLOPES OF 3:1 UP TO 5:1.
2. A 5:1 SLOPED END SECTION SHALL BE USED IN CONJUNCTION WITH SUBGRADE SIDE SLOPES OF 5:1 TO 8:1.

| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
|---|---|---|---|---|
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Sloped End Treatment and Length for Pipe-Arch Corrugated Metal Pipe | Figure C-4-6b |
| Checked: HC | Scale: NTS | | | |

## Figure C-4-6c Sloped End Treatment and Length for Round Plastic Culverts




NOTE:
THE SLOPED ENDS FOR PLASTIC PIPE SHALL BE FIELD-CUT. (Refer to Standard Drawing CB6-2.4M9)

| INSIDE DIAMETER D (mm) | SLOPE RATIO OF CULVERT END X:Y | N (METRES) | | | | MINIMUM LENGTH OF SECTION FOR SLOPED END L (METRES) |
|---|---|---|---|---|---|---|
| | | WITH 3:1 SUBGRADE SLOPE RATIO | WITH 4:1 SUBGRADE SLOPE RATIO | WITH 5:1 SUBGRADE SLOPE RATIO | WITH 6:1 SUBGRADE SLOPE RATIO | |
| 400 | 4:1 | 0.3 | 0.5 | 0.8 | 1.2 | FOR PVC PIPE L=4.0 |
| 500 | 4:1 | 0.3 | 0.6 | 0.9 | 1.5 | |
| 600 | 4:1 | 0.3 | 0.6 | 1.0 | 1.6 | FOR CPP PIPE L=6.0 |
| 750 | 4:1 | 0.4 | 0.8 | 1.3 | 2.1 | |
| 900 | 4:1 | 0.5 | 1.0 | 1.6 | 2.5 | |

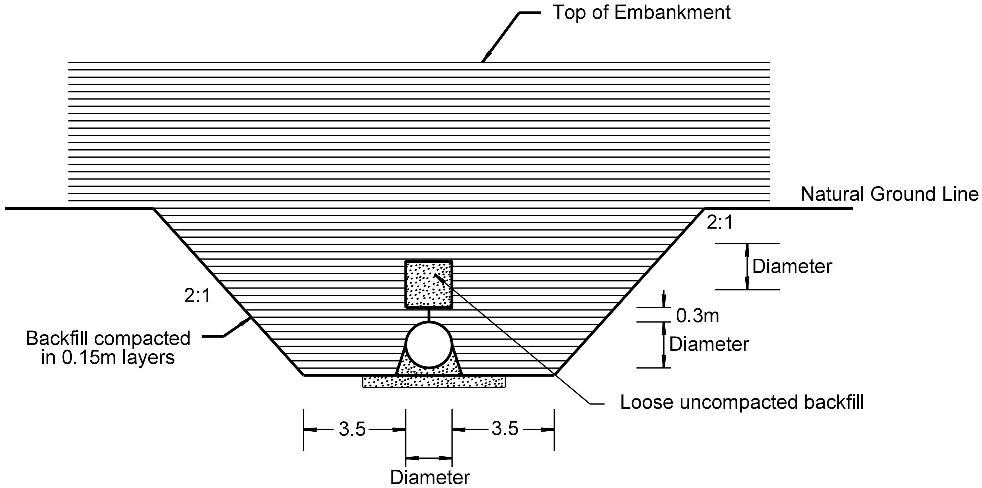
DETERMINING INSTALLATION LENGTH:

THE LENGTH OF PIPE CULVERT TO BE INSTALLED SHALL BE DETERMINED AS FOLLOWS:

1. ESTABLISH THE THEORETICAL LENGTH BASED ON SLOPE STAKE REQUIREMENTS. WHERE NO SPECIAL TREATMENT IS REQUIRED, CULVERT INVERT ELEVATIONS ARE TYPICALLY SET AT (0.15 X DIAMETER) BELOW THE DRAINAGE COURSE ELEVATION.
2. ADJUST THE THEORETICAL LENGTH BY APPLYING THE END CORRECTION "N", AS DETERMINED FROM THE TABLE, TO EACH END OF THE CULVERT.
3. INSTALLATION LENGTH SHALL BE THE LENGTH DETERMINED IN STEP 2, ABOVE, ROUNDED TO THE NEAREST METRE.

| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
|---|---|---|---|---|
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Sloped End Treatment and Length for Round Plastic Culverts | Figure C-4-6c |
| Checked: HC | Scale: NTS | | | |

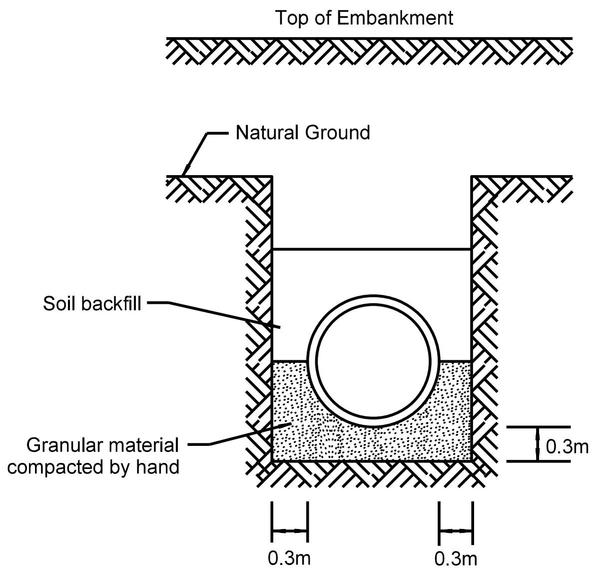
## Figure C-4-6d Special Culvert Installation Method - Imperfect Trench Condition




NOTE:
The imperfect trench method of construction decreases the backfill or embankment load on the culvert, thus increasing the safe height of fill that can be carried. This method involves thorough compaction of the bed and material around and over the culvert in the normal way up to a height of diameter plus 0.3m above the culvert. A trench of width equal to the diameter of the culvert is then dug down to within 0.3m of the top of the culvert and refilled with loose uncompacted material after which the remainder of the fill is completed in the normal manner.

| | | | | |
|---|---|---|---|---|
| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Special Culvert Installation Method<br>Imperfect Trench Condition | Figure<br>C-4-6d |
| Checked: | Scale: NTS | | | |

## Figure C-4-6e Special Culvert Installation Method - Negative Projecting Embankment




NOTE:
A negative projecting culvert is one that is installed in undisturbed natural soil in a narrow ditch extending upward some distance from the top of the culvert. This type of construction results in much less loading from the same fill than would result from a conventional installation method as shown in Standard Drawing CB6-2.4M1.

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### C.4.6.1 Culvert Slope and Invert Elevation

In areas that are generally flat, the culvert invert elevations should be set as low as, or lower, than the lowest area adjacent to the right-of-way without changing the existing drainage pattern. Invert elevations are generally set approximately (0.15 x diameter) below the drainage course or ditch elevation.

When setting the slope for culverts (the average slope between the inlet and outlet), it is desirable to ensure that the slope is steep enough to prevent sedimentation or ponding. The slope must still be flat enough to prevent high-speed flow, which can cause scouring at joints or erosion at the outlet.

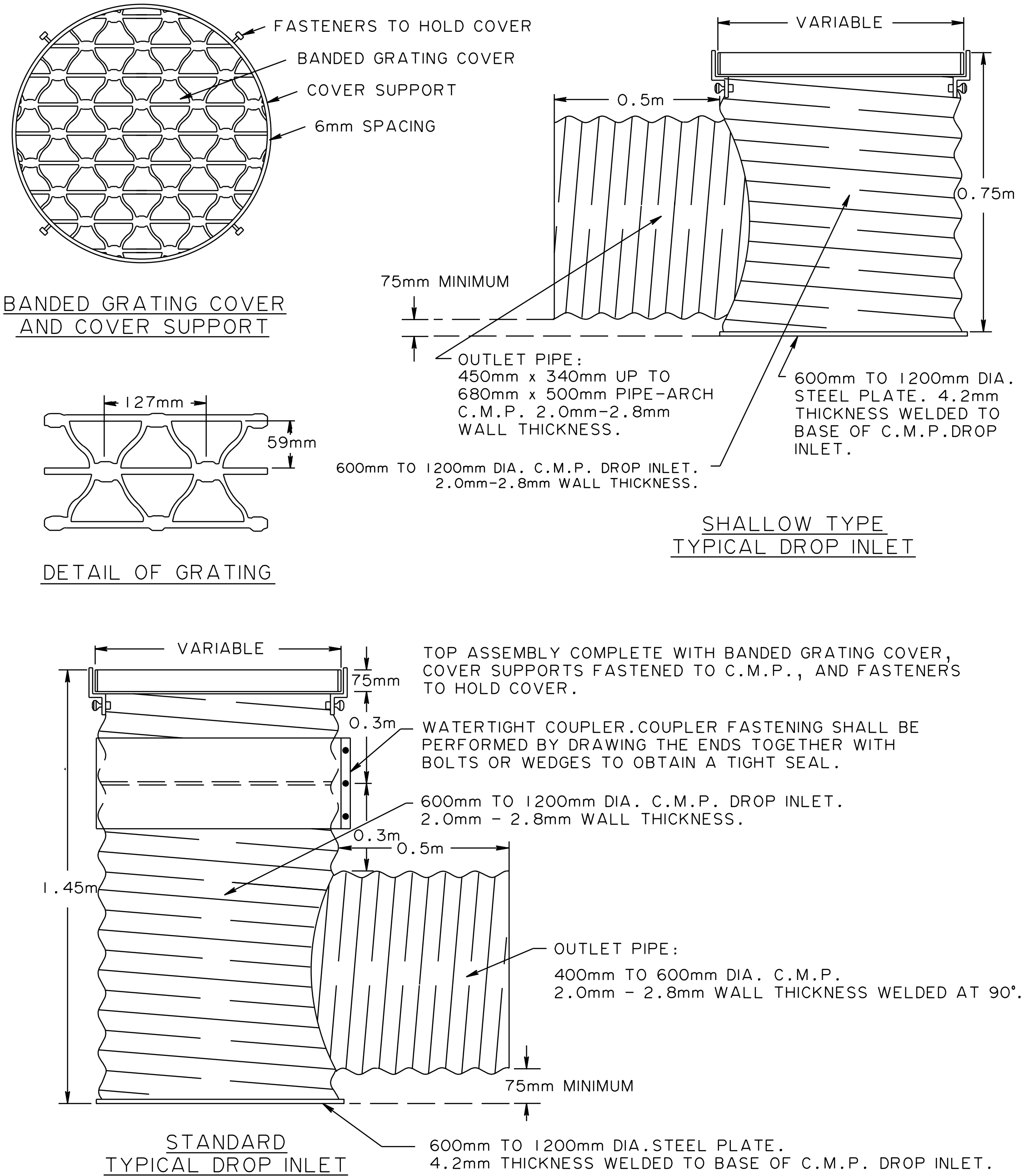
A slope of one percent to two percent is advisable to give a culvert its critical slope, which maximizes the capacity while still keeping the water velocity within permissible limits. In general, a minimum slope of 0.5 percent will avoid sedimentation.

For smooth-wall culverts such as concrete, smooth steel or smooth plastic, the water velocity for any given slope will be higher than it would be for a corrugated metal pipe. A flatter slope should be considered for these pipes.

Where it is necessary to have an elevation difference between the inlet and outlet that results in a greater than maximum gradient, a special hydraulic design may be required. Based on the design, a drop inlet, baffles inside the culvert, or an energy dissipating pond may be necessary to minimize erosion at the outlet of the culvert.

A large difference in elevation between a culvert inlet and outlet may result when a culvert is placed through a high embankment that is built on a side hill, or placed to drain the median of a divided highway in a high fill location. Rather than having an excessively steep culvert grade, measures to control water velocity and the resultant erosion may be required. Placing the culvert outlet above the toe of the embankment to minimize the water velocity in the culvert is generally not a viable option; the result may be erosion of the sideslope and at the toe of the embankment. A corrugated steel pipe drop inlet may be used for large differences in elevation. Refer to Figure C-4-6-1a and Figure C-4-6-1b for examples of typical drop inlet assemblies.

## Figure C-4-6-1a Typical Corrugated Metal Pipe Drop Inlet Assembly

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| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Typical Corrugated Metal Pipe Drop Inlet Assembly | Figure C-4-6-1a |
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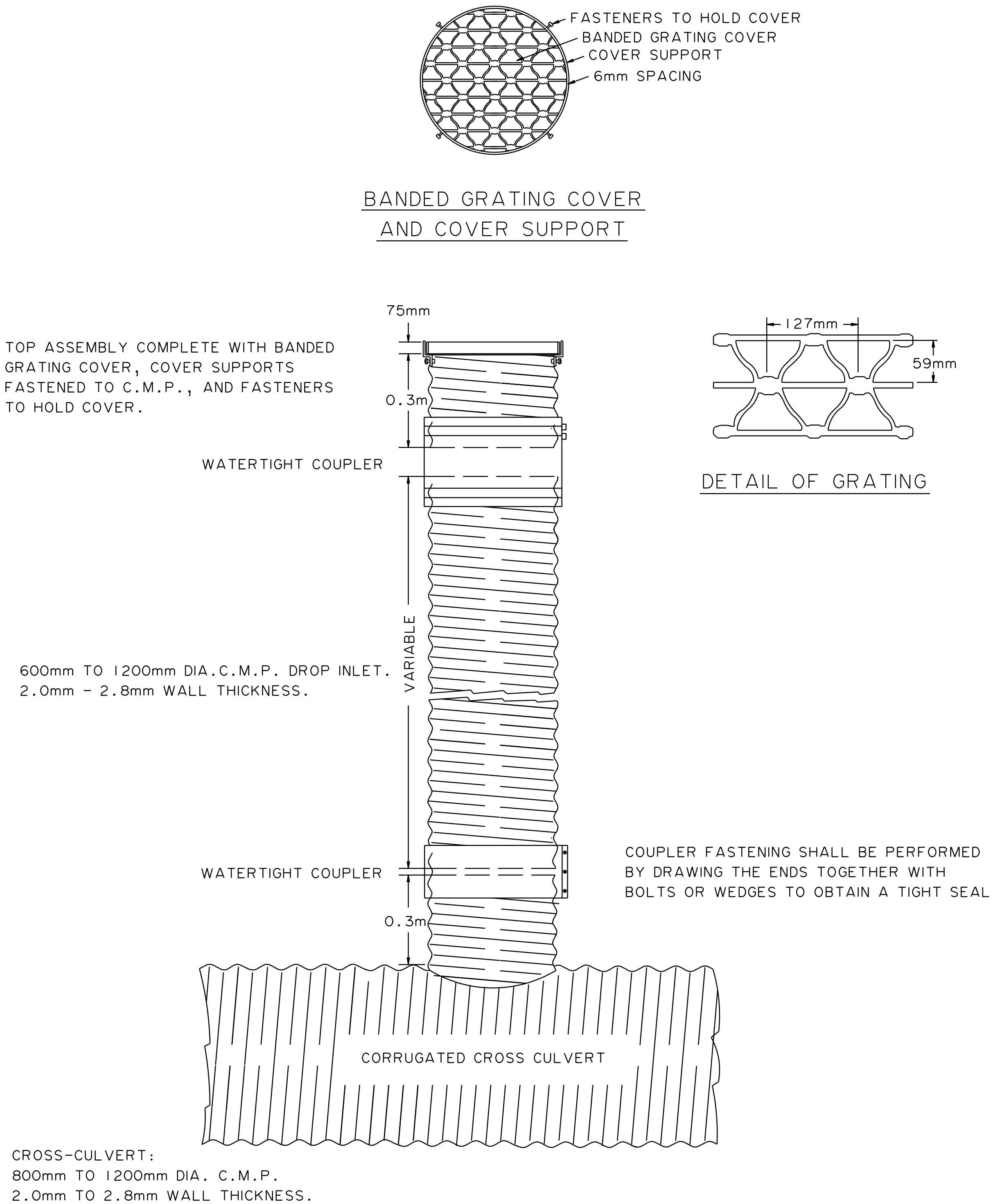
## Figure C-4-6-1b Typical Drop Inlet into Corrugated Metal Pipe Cross-Culvert

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| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Typical Drop Inlet Into Corrugated Metal Pipe Cross-Culvert | Figure C-4-6-1b |
| Checked: HC | Scale: NTS | | | |

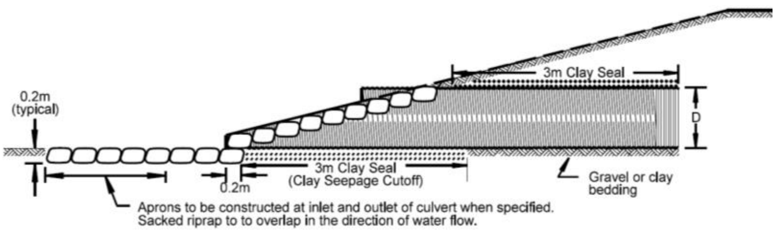
## C.4.7 Riprap

Riprap is a protective covering of randomly deposited rock; hand-laid rock; hand-laid sacked concrete; or hand-laid, sacked, cement-stabilized material. Where rock is available, rock riprap is generally preferred due to its longer life. Where rock is not readily available, the sacked concrete or sacked cement-stabilized material may be used as a substitute.

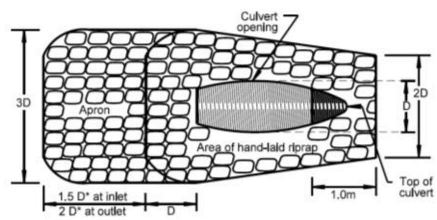
Riprap is placed around culvert inlets and outlets as well as along slopes and embankments, ditches, gutters, spillways, or other locations where erosion is a concern. The chief purpose of riprap is to prevent erosion of constructed fills and channels by water movement. A secondary purpose, in the case of culvert ends (especially plastic pipe), is to provide some weight through downward force, which will counteract the upward forces that can cause culvert ends to rise above the channel bed.

Riprap is placed at the inlet and outlet of all culvert installations. Additional riprap, in the form of aprons, may also be required at some installations. Unless specified otherwise in the contract documents (i.e., the Special Provisions or drawings), the riprap and aprons at culvert inlets and outlets is hand-laid. Refer to Standard Drawing CB6-2.5M1, Hand-Laid Riprap (Rock or Sacked Material) [7] for more details.

**The following diagrams are for illustration only**. Refer to Standard Drawing CB6-2.4M1 for specific requirements.




Section




Plan View

Generally, designers should determine apron locations and requirements based on the flow volume and velocity of the water through the culvert, as well as the type of soil. On projects that have highly erodible soil, aprons may be required at most culvert installations.

Placement of riprap only (i.e., without an apron) at the culvert inlet and outlet is assumed, unless noted otherwise in the construction documents. Aprons are generally built only when specified in the Special Provisions or shown on the drawings.

Where aprons are used, the typical minimum length is 1.5 times the diameter at the inlet and two times the diameter at the outlet. If required, these minimum lengths may be exceeded at a particular site. Where a watercourse is required to change direction at the inlet to a culvert, an apron is generally required. If a culvert outlet occurs above the natural ground elevation (where there will be a drop at the outlet) or where the slope of the culvert exceeds the desirable rate (generally about two percent), the use of an apron at the outlet is recommended to prevent scouring.

## C.4.8 Fish Passage Requirements for Culverts

Alberta Transportation is responsible for the design, construction and maintenance of Alberta's provincially managed roadways, including culverts and watercourse-crossing structures (i.e., bridges). Alberta Transportation recognizes that watercourse crossings must meet provincial legislative requirements and works closely with Alberta Environment and Parks (AEP) to ensure compliance.

In March 2019, a Memorandum of Understanding (MOU) was established to set forth the terms and understanding between the provincial ministries of Alberta Transportation and Alberta Environment and

Parks regarding culvert design and inspection of fish passage at road crossings managed by Alberta Transportation. As part of this MOU, culvert crossings under the jurisdiction of Alberta Transportation shall be inspected in accordance with the AEP, “Roadway Watercourse Crossing Inspection Manual” [8] and designed in accordance with the Alberta Transportation, “Bridge Conceptual Design Guidelines” [1].

The design and inspection standards will apply to all roadway watercourse crossings under the jurisdiction of Alberta Transportation, including those culverts less than 1.5 m in diameter. Where fish passage is required, the following guidelines are recommended:

- assessment for fish passage shall only be required for those culverts where a permanent watercourse channel exists for at least 50 metres upstream and downstream of a crossing (Section 5.2 of the AEP “Roadway Watercourse Crossing Inspection Manual” [8]);
- replacement design for structures determined to require fish passage shall be completed as indicated in the Alberta Transportation, “Bridge Conceptual Design Guidelines” [1]; and
- the Alberta Transportation Regional Environmental Coordinator shall coordinate the assessment of existing and proposed structures for fish passage.

# C.5 DRAINAGE FOR URBAN ROADWAYS

## C.5.1 General

The section includes stormwater management practices for roadways under provincial jurisdiction in urban environments. An urban environment refers to a location within an urban municipality (city, town or village) and it may include a highly developed area within a rural municipality. This should not be confused with the presence of an urban cross-section (curb and gutter).

These guidelines are intended for the use of Alberta Transportation or its consultants when undertaking design of highway drainage systems, or when reviewing proposed drainage works by others, which may affect a particular section of highway. They are intended to provide guidance for Alberta Transportation where drainage works located outside of the highway right-of-way, by urban municipalities or private landowners, may affect the highway drainage system.

## C.5.2 Design Criteria

Generally, highway drainage systems, including detention storage facilities and outfalls, shall be designed in accordance with the Alberta Environment and Parks (formerly Alberta Environmental Protection), “Stormwater Management Guidelines for the Province of Alberta” [9] or the local municipal guidelines, whichever governs. The highway drainage system is to accommodate the runoff from a 1-in-100-year event storm with minimal to no interruption to vehicle access. Flow depths and ponding of water are not to create a public hazard or cause erosion or flooding damages to private or public property.

A major-minor drainage system approach is generally used in which the minor system comprises the underground storm sewer system (catch basins, manholes, storm sewers, underground storage) and the major drainage system comprises the surface drainage system (ditches, swales, curb and gutter, detention storage). When using urban drainage (curb and gutter), the minor system associated with this type of system shall be designed to accommodate the runoff from a 1-in-5-year event storm with no surcharging.

Where curb and gutter drainage systems are used, flow or ponding depths are to be limited to the following:

- Posted Speed > 80 km/h: The 1-in-5-year event water resulting from ponding in low areas, or the normal flow along the curb and gutter, is not to encroach into the highway through lanes. For the

1-in-100-year event, the water shall not flow across the high point of the road cross-section and at least one lane of traffic shall remain open in each direction; two lanes for 8- to 10-lane facilities.

- Posted Speed ≤ 80 km/h: The depth of water on the road surface shall not exceed 0.15 m for the 1-in-5-year event with at least 1 lane of traffic free of inundation in each direction. At least two lanes shall be free of inundation for a 6- to 8-lane facility and three lanes free for a 10-lane facility. For the 1-in-100-year event, ponding or flow depths at the gutter should not exceed 0.3 m and at least one lane of traffic shall remain open in each direction; two lanes for 8- to 10-lane facilities.
- The 1-in-100-year event depth of water ponding on the roadway shall not exceed 0.5 metres.

Where the minor system is oversized above the 1-in-5-year event to meet the above ponding and flow depth limitations, surcharging may be allowed provided the hydraulic grade line (HGL) does not rise to the ground surface. Underground storage or nearby surface storage should be considered as an alternative where economically feasible.

The highway drainage systems should be designed based on rainfall-runoff analysis in accordance with Alberta Environment and Parks guidelines or the local municipal guidelines. Either a synthetic design storm or historic storm shall be used in accordance with the local municipal guidelines. As a minimum, and where the local guidelines do not specify otherwise, a 1-in-100-year event design storm of the Chicago distribution shall be used, with a storm duration of 4 hours for conveyance systems and 24 hours for detention storage facilities. A time interval of five minutes shall be used with the rainfall distribution. Longer intervals, such as 15 minutes, may be used for the longer 24-hour duration storm. The ratio of time to storm peak versus storm duration (“r”) shall be 0.3. Where IDF (Intensity-Duration Frequency) data or design storm parameters are not specified by the local municipal guidelines, the 1-in-100-year event storm shall yield a total rainfall amount of 60 mm for the 4-hour duration and 110 mm for the 24-hour duration.

Storm sewer systems may be designed using the Rational Method in accordance with the urban municipality’s design guidelines. For areas larger than that suggested by the local guidelines, or for storm ponds, major drainage systems and overall watershed drainage planning, computer modeling is to be used for all hydrologic analyses.

Overland escape routes are to be provided to accommodate all runoff in excess of the 1-in-100-year event. If an overland escape route from a detention storage facility is not available, additional freeboard should be considered.

When used, underground storm sewer material, sizes, manholes, catch basins, etc. shall be specified in accordance with the local municipal specifications.

For wide ditches (3 m or greater width), the desirable minimum longitudinal grade is 0.2% and the absolute minimum is 0.05%. On narrower ditches (less than 3 m wide), the desirable minimum ditch slope is 0.5% and the absolute minimum is 0.2%. The minimum slopes are intended to eliminate ponding in ditches. Highway ditches should be sloped to minimize velocities to avoid excessive erosion.

For highways with rural cross-sections (open ditch), culverts should be sized while accounting for ditch storage at the inlet of the culverts (i.e., hydrologic routing), using the ratio

$$\frac{\mathrm{HW}}{\mathrm{D}} \leq 2.5$$

where:

$\mathrm{HW}$ = headwater measured to the culvert invert
$\mathrm{D}$ = culvert diameter

Additionally, headwater should be no higher than 0.3 metres below the top of the subgrade (not the top of the surfacing material) for a short period. Roadside design principles are to be considered when designing ditch storage so that hazards are mitigated or located outside of the clear zone.

## C.5.3 Best Management Practices

Best management practices (BMPs) are to be incorporated in the highway drainage system to provide both quantity control and quality improvement objectives. Discharges to natural receiving watercourses shall be limited to pre-development rates, except where otherwise specified by Alberta Environment and Parks. Discharges to a municipal storm drainage system shall be limited to the specified rate of discharge for that system. Appropriate measures are to be incorporated in the highway drainage system to provide a minimum of 85% removal of sediments of particle size 75 μm or larger prior to discharge occurring to a natural drainage course. Refer to the Alberta Environment, "Municipal Policies and Procedures Manual" [10].

The Alberta Environment and Parks (formerly Alberta Environmental Protection), “Stormwater Management Guidelines for the Province of Alberta” [9] describe a number of possible BMPs that can be implemented. The following BMPs are commonly used and are considered practical for application with highway drainage systems:

- Detention Storage Facilities temporarily detain the runoff from a catchment. The outlet controls the discharge to the receiving watercourse or municipal storm sewer system. They can be very effective for improving the quality of the stormwater, primarily by facilitating removal of sediments. These facilities may be designed as one, or a combination of three main types:

  - Dry Ponds drain completely dry and are often incorporated as multi-use recreational areas. Typically, the maximum allowable fluctuation depth for the 1-in-100-year event is 1.5 m, and the bottom slope is 1.5% to 2.0%, to ensure that long-lasting wet/soft areas do not develop. Dry ponds are often designed to pass low flows without inundation occurring. For this reason, they are not as effective as other types of facilities in providing sediment removal.
  - Wet Ponds incorporate a permanent pool of water year round, usually 2.0 m to 3.0 m deep. All of the stormwater from a catchment passes through a wet pond, so they are effective for sediment removal. The permanent pool should not be too large so as to become stagnant. A common rule of thumb is the permanent volume should be turned over twice each year from the annual runoff. The allowable fluctuation depth above the permanent pool is 2.0 m, so less overall pond area is required compared to a dry pond.
  - Wetlands – Storm ponds constructed as wetlands are becoming popular due to their environmental benefits as well as educational and recreational characteristics. The permanent pool is much smaller and shallower than a wet pond and supports emergent and submergent vegetation. This vegetation is useful at removing other types of pollutants but it is sensitive to sediment loadings in the stormwater. An important design consideration is a separate sediment forebay to facilitate removal of the majority of sediments. The storage fluctuation depths are typically lower than a wet pond. The area requirement for a wetland can be larger than either a wet pond or dry pond.

    Existing wetlands are often used as detention storage facilities due to their convenience and environmental significance. Changes to the wetland characteristics should be expected due to the increase in annual runoff from a developed catchment area. These changes are not necessarily good or bad; they need to be properly identified and assessed for the benefit of the regulatory authorities. The effect of sediment loading on existing habitat is also a concern, so separate cells/forebays are required to facilitate removal of the sediments.

- Grassed/Vegetated Ditches are the standard design practice used by Alberta Transportation for highway systems. When adequately vegetated, they are economical and practical stormwater BMPs. The amount of rainfall that infiltrates into the subsoil is higher than that which would occur with curb and gutter systems. Ditches can reduce flow velocities and provide some detention of the runoff from frequent rainstorm events. The vegetation in the ditches can improve the quality of the stormwater runoff by filtering some of the sediments.

- Underground Oil-Grit Separators are commonly associated with underground storm sewer systems. They are becoming popular for providing water quality improvement for private developments and arterial/freeway roadways in urban areas where detention storage cannot be easily incorporated. They tend to be more costly to install than utilizing a regional storm pond, but removal of sediments and scum is done more easily. The design targets the low flows resulting from frequent rainfall events, while bypassing higher flows from intense, less frequent storm events (which may re-suspend material that had been previously retained). Underground oil-grit separators are currently available from several manufacturers.
- Infiltration Conveyance and Ponding allows water to pond in conveyance ditches and detention areas to promote soil infiltration. This method may not be suitable where the subsoil material has poor permeability (e.g., clay, silt) but is practical and effective where the soil is comprised of a deep layer of sand or gravel. This method should not be used without the support of a geotechnical engineer.

Many urban municipalities incorporate detailed criteria and design guidelines for these facilities, particularly detention storage facilities. Reference to the local guidelines is required when designing these facilities.

Highway ditches should be maintained at least once per year by mowing grass (minimum height of 75 mm), removing debris at culvert inlets/outlets and repairing erosion.

## C.5.4 Policy Issues

Alberta Transportation, by agreement, may participate in sharing of drainage facilities with the local municipality or adjacent developer where the facility accommodates drainage from the highway and the location is suitable relative to topography, land availability and discharge to an existing drainage course. In these cases, the urban municipality is to undertake all maintenance of the shared facility. Alberta Transportation will share in the capital construction and annual maintenance costs based on apportionment of the flow for conveyance systems or the storage volume requirement for detention storage facilities.

Alberta Transportation may consider developer-based proposals for drainage facilities within the highway right-of-way where there is a benefit to Alberta Transportation and there is no alternative solution that is reasonably economical or practical. The developer shall be responsible for all costs, approvals and agreements unless otherwise determined by Alberta Transportation. The municipal authority must be willing, by agreement, to be responsible for future operation and maintenance of the developer-proposed facility.

Notwithstanding the requirement for the highway drainage system to accommodate existing upstream drainage noted previously, drainage from adjacent developments to the highway shall not be allowed unless the municipality agrees to undertake all necessary improvements to the highway drainage system and downstream drainage course, as well as secure the appropriate regulatory approvals.

Alberta Transportation is responsible for managing the stormwater from the highway, within the municipal boundaries, to the receiving drainage course or municipal drainage system. Alberta Transportation may enter into an agreement with the local municipality to cover maintenance of the highway drainage system, whereby the municipality would be compensated for all associated costs, excluding any premium costs imposed on the municipal drainage system on a proportional basis for handling additional flows from the highway. Where the highway drainage system is not maintained by the municipality, but it outlets to the municipal drainage system, Alberta Transportation will enter into an agreement with the municipality to compensate for the storm drainage costs on a proportional basis. Alberta Transportation shall also be responsible for hazardous spills from the highway right-of-way.

### C.5.5 Environmental Considerations

Applications for regulatory approvals are to be undertaken as follows:

- In the cities of Calgary and Edmonton, applications to Alberta Environment and Parks shall be submitted by the respective city. Alberta Transportation's consultant will prepare the applications (on behalf of Alberta Transportation, but for submission by the city) when Alberta Transportation is sponsoring the project. Alberta Transportation (or its consultant) shall make submissions to Fisheries and Oceans Canada (DFO) following consultation with all stakeholders including the city, Alberta Environment and Parks, fishermen's associations, etc.
- In all other areas of the province (urban or rural), Alberta Transportation (or its consultant) shall be responsible for making submissions to Alberta Environment and Parks and DFO as required. Detailed plans showing proposed drainage facilities and associated works shall be circulated to all stakeholders for their input prior to submission to the appropriate environmental agency.
- In all cases, Alberta Transportation or its consultant shall take all reasonable care to ensure that outfalls located upstream of potable water supplies or intakes are suitably protected from highway stormwater and other highway spillages.
- All other current environmental regulations shall also be followed.

Existing drainage patterns are to be maintained as much as possible and existing drainage from upstream lands is to be accommodated by the highway drainage system. Natural low areas shall be maintained or replaced where practically possible.

Protection/replacement of wetland habitat is encouraged. A biophysical impact assessment is to be undertaken where wetlands are impacted, either directly by the highway drainage system or the addition/reduction of contributing runoff. Reasonable design measures are to be incorporated to minimize the risk of hazardous spills from entering a natural wetland or drainage course.

DFO staff are to be consulted where in-stream works or in-stream cross-drainage structures are proposed so that they may determine if there is a potential impact to fish or fish habitat.

## C.6 MEDIANS

Medians are provided on multi-lane divided highways to separate opposing flows of traffic. Apart from the safety benefits, medians also provide space for left-turn lanes, snow storage, collection of surface water, addition of future lanes and refuge for pedestrians at crosswalks. The median width is measured between the inside (left) edges of the left-most travel lanes of opposing directions of traffic.

### C.6.1 Depressed Medians

Depressed medians are most commonly used in rural applications (RFD and RAD) but may also be used in urban designs such as the interim stages of UFD (where additional lanes may be added later) or some UED. In cases where additional lanes are to be added, the median width in the interim stages is determined by the median requirements of the final stage. Figure C-6-1a illustrates the typical staging procedure on a rural divided highway. Section C.8.2, Typical Cross-sections for Design Designations, includes cross-sections for rural and urban roadways that have depressed medians.

A centreline spacing of 58 m or more is desirable on new, rural, divided arterials and staged freeways, when the land is considered not suitable for cultivation or grazing, and the provision of grade separations is expected to be deferred for many years. If required due to constraints, a reduced median may be used between intersections, but provision for refuge of design vehicles in the median of at-grade intersections is a key factor. Consequently, a centreline spacing of 58 m or more is desirable at all major at-grade intersections to accommodate tractor-trailer movements. The use of a 58-metre centreline spacing and the resultant wide median has many economic advantages coming from safety, capital, maintenance and operational savings.

- Many of the typical design vehicle lengths have increased over the last several years. The length of the WB-36 (Turnpike Double) and WB-23 (Double Trailer Combination) are currently 41 m (was 40 m) and 27.5 m (was 25 m) respectively. Due to the use of these long vehicles as well as Log Haul Trucks (30.5 m), it is very desirable to have a median that is wide enough to allow these vehicles to take refuge while crossing a divided highway or making a left turn onto a divided highway. Narrow medians that do not provide refuge lead to pressure to build grade separations many years earlier than would be required with a wider median.
- Although not included in the overall length of design vehicles, the dimension of the following front and rear devices should be considered when vehicle storage and refuge requirements are applicable (e.g., when determining median width, stacking distance at intersections near railways, and service road bulbing).

  - Front heavy-duty bumpers or other devices installed to reduce the impacts of wildlife collisions, which do not extend more than 0.30 m beyond the front of trucks or tractors, are excluded from the overall length of the design vehicle.
  - Rear aerodynamic devices installed at least 1.90 m above the ground and not extending more than 1.52 m beyond the rear of trucks or trailers, are excluded from the overall length of the design vehicle.
  - The centreline spacing is partly based on the length of the design vehicle as well as the additional allowance (1.82 m) for the front bumper and rear wing. Refer to Figure C-6-1b for an example of how these front and rear devices are considered when determining the centreline spacing requirement on a divided highway.
  - Refer to Chapter A.2.5.2, Long Combination Vehicle Routes, for information related to LCV routes and the associated operating conditions.

- At at-grade intersections, an adequate median width provides vehicle refuge with a buffer area that meets the suggested shy line offset values in the 2017 Transportation Association of Canada (TAC), “Geometric Design Guide for Canadian Roads” [11]. Refer to Figure C-6-1b, which illustrates this concept for a WB-36 design vehicle.
- Greater separation of opposing lanes of traffic, due to an increased median width, reduces the problems of headlight glare and cross-the-median head-on crashes and may eliminate the need for median barriers.
- A wide median provides greater flexibility for roadway planning and staging of interchange construction. Interchange construction can often be deferred due to the enhanced operation of the at-grade intersections.
- Wide medians permit the use of independent roadway alignments (both vertically and horizontally) which may contribute to blending the divided highway into the natural topography and decreasing construction costs.

  - Flexibility in setting gradelines and greater separation between opposing roadway embankments provide for the desirable 6:1 sideslopes. As a result, vehicles accidentally leaving the highway have a good chance of recovery with minimum vehicle damage or occupant injury.

- The minimum depressed median width in an urban situation (UED-412.4 or UFD-616.6) is normally 15.4 metres. This width does not allow for 6:1 sideslopes nor a 1 m subgrade depth. A catch basin/manhole with leads and/or centreline culverts should be considered.

Often, a four-lane, rural divided highway (arterial or freeway) is expanded to six lanes (arterial or freeway) or eight lanes (freeway) to increase the capacity or level of service. The first set of additional lanes are generally added to the outside. This practice preserves the median width, which is especially beneficial for at-grade intersections at the arterial stage. When eight lanes are required, the final two lanes are generally added on the median side. Eight-lane divided facilities are freeways that have very strict access control and grade-separated crossings. At-grade intersections do not exist, so the operational difficulties associated with long vehicles and narrow medians are not present. Figure C-6-1a illustrates the rural divided highway staging procedure.

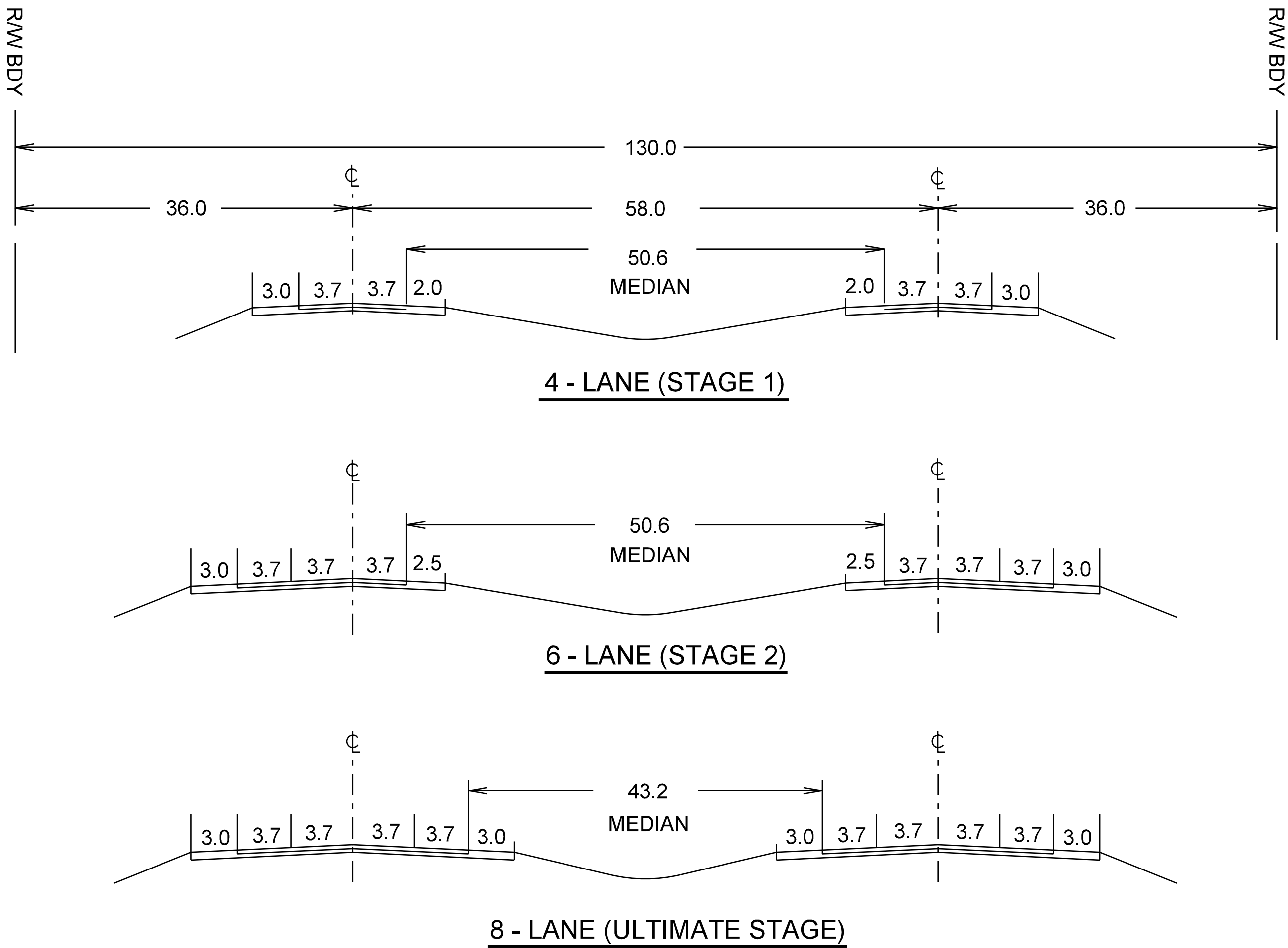
The choice of median width impacts the cost of interchange construction due to the length of the required structure. The 50.6 m wide median at the 4-lane and 6-lane stages is generally supported because of the safer operation of at-grade intersections at the non-freeway (RAD) stage. The wider median may also defer the need for grade separation due to enhanced operation of the at-grade intersections.

Where the desirable centreline spacing (58 metres) is not economical or not feasible, a minimum centreline spacing of 45 m may be acceptable. The 45 m minimum spacing at an intersection accommodates design vehicles up to WB-23 (27.5 m length). Because WB-23 and WB-21 design vehicles are allowed to travel throughout the provincial rural highway network without restriction or permit, it is prudent to design for these units at any intersections that will have daily truck traffic entering, leaving or crossing the divided highway.

Sites where the desirable centreline spacing is not economical or feasible may include a bridge crossing of a watercourse, a roadway crossing over a centreline culvert, areas with excessively large cuts or fills, or areas with poor geotechnical conditions. At locations where the median width is limited by bridge requirements or other constraints, suitable transitions of the median width are required. Refer to Chapter B, Alignment Elements. At locations where interchanges will ultimately replace at-grade intersections, the width should be reassessed at the interchange stage to ensure optimization of the overall design.

When a new divided highway is built to be immediately operated as a rural freeway facility with a depressed median (RFD), a narrower (40 m) centreline spacing is used to minimize the length of bridge structures. Intersection storage is not a consideration because access is restricted to grade-separated interchanges.

## Figure C-6-1a Rural Multi-Lane Divided Highway Staging




NOTES:

1. The desirable 58.0 m centreline spacing is shown.
2. For the minimum centreline spacing of 45.0 m, the median width is 37.6 m in Stages 1 and 2 and 30.2 m in the 8-lane stage. This centreline spacing accommodates design vehicles up to WB-23 (27.5 m length) in the 4-lane and 6-lane stages.
3. A centreline spacing of 40.0 m is only used for a new divided highway that is built to be immediately operated as a rural freeway. The median width is 32.6 m in Stages 1 and 2, and 25.2 m in the 8-lane stage. This centreline spacing does not accommodate a WB-23 design vehicle.

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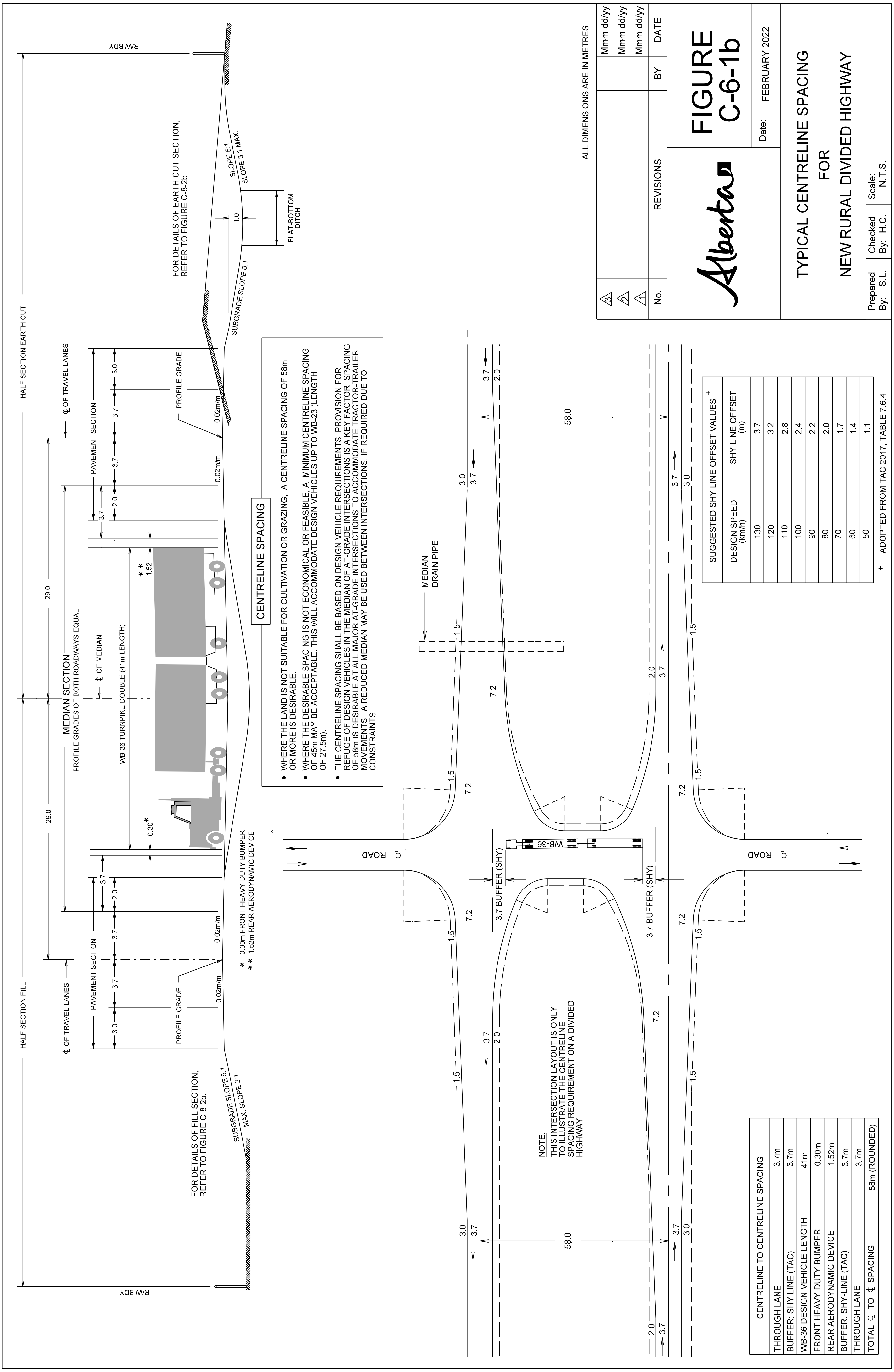
**Figure C-6-1b Typical Centreline Spacing for New Rural Divided Highway**



## C.6.2 Raised Medians

Raised medians are most commonly used on lower speed urban arterial divided (UAD) and some urban expressway divided (UED) facilities with a design speed of 80km/h or less. The desirable raised median width is 6.0 m, consisting of a 5.0 m wide raised section (from curb face to curb face) and two, 0.50 m gutters. This width allows for placement of a bridge pier protected by a semi-rigid (W-Beam or Modified Thrie Beam) barrier, depending on site-specific conditions. The 6.0 m width also provides for placement of a 3.5 m wide parallel left-turn lane, with space for traffic signal poles and signing as required.

Figures C-8-2Ug and C-8-2Uh show typical cross-sections for UAD facilities that have a raised median.

Figure C-8-2Uc indicates two typical UED cross-sections that have a raised median. This figure also illustrates the conversion from an initial four-lane roadway to the final six-lane roadway. Widening occurs to the outside because both roadways have a raised median.

### C.6.2.1 Raised Medians at Frontage Roads

When a frontage (service) road runs parallel to an urban arterial, a separation is required between the arterial road and the frontage road. The width of the separation depends on whether the frontage road operates as a one-way or a two-way road. When a two-way frontage road is provided, the driver on the arterial must contend with approaching traffic on both the frontage road and the arterial road. To minimize the effects of the approaching traffic, particularly with regard to headlight glare on non-illuminated sections, a raised median width in the range of 4.0 to 6.0 m is desirable. The recommended minimum is 3.0 metres. The minimum width will typically be governed by the clearance required for installation of street lighting poles.

For one-way frontage roads, the separation distance may not need to be as wide. A minimum width of 3.0 m should still be provided.

When a frontage road intersects a cross-street, the separation between the arterial road and the frontage road must be increased to accommodate vehicle storage on the cross-street as well as turning movement requirements. This can usually be achieved by bulbing the frontage road. The setback distance from the arterial is determined by the amount of storage required between the arterial/cross-street intersection and the frontage road/cross-street intersection, as well as the turning radii required to accommodate the design vehicles. Refer to Chapter D.5.4, Bulbing of Service Road Intersections to Accommodate Design Vehicles.

## C.6.3 Flush Medians

Flush medians are commonly used on urban expressways (UED) and freeways (UFD) where the median is relatively narrow (generally 8.0 m wide). Typically, the elevation of the inside edge of the left shoulder is the same for both directions of traffic. A cast-in-place or extruded concrete median barrier (Single Slope or F-Shape) separates opposing directions of traffic and is used to prevent cross-over-median collisions. The barrier also shields vehicles from hazards that are located in the median such as bridge piers, overhead sign structures and overhead lighting. Surface water is collected at storm drain inlets placed in the median. Refer to the Standard Drawings in the Alberta Transportation website, “CB6 Highway Standard Plates – Active Drawings” [7] as well as the Alberta Transportation, "Roadside Design Guide” [4].

Figure C-8-2Ua indicates a typical UFD cross-section that has a flush median. This figure also illustrates the four-lane and six-lane roadways with a depressed median (UFD) that are interim stages in the conversion to the final eight-lane roadway with a flush median (UFD). The centreline separation is the same and widening occurs to the inside.

Figure C-8-2Ub indicates a typical UED/UFD cross-section that has a flush median. This figure also illustrates the initial four-lane roadway with a depressed median (UED) that is an interim stage in the conversion to the final six-lane roadway with a flush median (UED/UFD). The centreline separation is the same and widening occurs to the inside.

## C.6.4 Median Crossovers

A median crossover transfers traffic across a depressed median on a divided highway, between lanes of traffic travelling in opposite directions. This section provides guidance to planners and designers regarding the spacing, placement, signing and geometric details of median crossovers. When designing median crossovers on divided highways, there is a need to consider roadside safety, highway operations, access management, access by emergency and law enforcement vehicles, and cost.

Many divided highways are twinned initially as arterial or expressway facilities with the ultimate objective of upgrading to a freeway in the future. The duration of the staging period may be several decades. In the interim, there may be little or no supporting network of parallel arterial, collector or local roads. At the time of the initial twinning, decisions are made regarding access management as well as the spacing and location of median crossovers. It may be necessary to provide direct, at-grade access from the divided highway to the crossing roadways or adjacent lands until alternate access is provided through service roads and interchanges. Providing at-grade access generally includes providing a median crossover. A median crossover provided for access to land adjacent to the divided highway is considered temporary and subject to removal when an alternate access is provided.

Where access is not a concern, but interchange and/or at-grade intersection spacing exceeds 8 km, emergency median crossovers are often provided to avoid excessive travel for emergency and law enforcement vehicles. When necessary, they also provide detours for highway traffic (e.g., due to collisions or other incidents). Between interchanges or intersections, emergency crossovers are spaced at intervals of 5 to 6.5 km. Maintenance crossovers may be required at one or both ends of interchange facilities for the purpose of snow removal, and at other locations to facilitate maintenance operations.

Maintenance or emergency crossovers should generally not be closer than 450 m from a structure or the end of a speed-change taper (e.g., at a ramp). Crossovers should be located where the available stopping sight distance exceeds the minimum requirement and should not be located on superelevated curves.

The crossover should have a width sufficient to provide for safe turning movements of the appropriate design vehicles and a pavement structure capable of supporting maintenance vehicles. Generally, the middle of the crossover is slightly depressed below the shoulder elevation of the driving lanes. Sideslopes are 15:1 or flatter to minimize the effect on run-off-road vehicles. Crossovers should not be placed in a median unless the median is sufficiently wide to accommodate the length of the design vehicle. Where median barriers are present along the driving lanes, each end of the barrier, at the median crossover, may require a crashworthy terminal. Median barriers should not create sightline issues for vehicles using the median crossover.

For further information on median barriers, refer to the Alberta Transportation “Roadside Design Guide” [4].

To restrict public use of maintenance and emergency median crossovers, signing as shown in typical drawing TEB 1.63, Maintenance Equipment Crossings on Four-Lane Divided Highways, is used. Refer to the Alberta Transportation website, “Typical Signage Drawings” [12]. The yellow edge line pavement markings are continuous through maintenance and emergency median crossovers.

For information regarding the geometric design of median openings on multi-lane divided highways, refer to Chapter D.8.5, Median Openings on Multi-Lane Divided Highways.

# C.7 SAFE ACCESSIBLE PEDESTRIAN ENVIRONMENTS

Pedestrians are among the most vulnerable roadway users and require distinct design considerations. Well-designed and maintained pedestrian facilities make access to transportation more equitable by allowing pedestrians to travel safely and comfortably. As well as being safe, functional, and attractive, pedestrian environments for use by the general public should be accessible to all persons, including those with disabilities. Although the majority of pedestrians are ambulatory, a significant number of pedestrians have somewhat restricted mobility due to disability or age. A design should provide for safe and convenient access and movement for all pedestrians.

Chapter 6 in the 2017 Transportation Association of Canada (TAC), “Geometric Design Guide for Canadian Roads” [11] includes the detailed design philosophy, considerations, and common elements of pedestrian integrated design.

## C.7.1 Streetscape

To ensure that the design of pedestrian environments accommodates the greatest possible number of people, it is desirable to adhere to the following:

- Allow a clear path of travel, free of obstructions to a minimum height of 2 metres. Examples of obstructions are directional signs, tree branches, guy wires and street furniture. Refer to Figure C-7-1a.
- Provide a firm, even, non-slip, glare-free surface (e.g., a broomed concrete finish).
- Ensure that gradients along the path of travel are very gradual to allow access by all. Landings may be required along sidewalks with gradients steeper than 2 percent.
- Provide a sufficiently wide clear path of travel to suit the intended traffic. Generally, an unobstructed clear width of 1.80 metres is desirable.
- Provide standardized ramps where necessary. Ramps for users of wheelchairs and bicycles should be located at all junctions of crosswalks and sidewalks. The ramp must provide direct access to the crosswalk. The maximum ramp gradient is 0.08 m/m and applies to the sides of the ramp as well as to the ramp proper. This maximum should also be applied where driveways or alleyways cross sidewalks.

    - Figure C-7-1c shows an urban intersection with a typical layout of crosswalks and the location and type of sidewalk ramps.
    - Figure C-7-1d shows a typical sidewalk and ramp layout on smaller islands and medians.
    - Standard Drawing CB6-4.2M86 [7] shows the layout and construction details for a Type 1 ramp, where an urban sidewalk (on tangent) meets a crosswalk.
    - Standard Drawing CB6-4.2M87 [7] shows the layout and construction details for a Type 2 ramp, where an urban sidewalk (at a corner) meets a crosswalk.

- Provide tactile cues for people with impaired vision. For example, the use of a cane-detectible lip (10 mm high) is suggested to delineate the edge of the roadway (at the bottom of the ramp) or other significant boundaries. The lip still provides a smooth path for wheelchairs. Grooves on the sidewalk ramps alert visually impaired persons of the curb-cut and street crossing. See Standard Drawings CB6-4.2M86 and CB6-4.2M87 [7].
- Provide audible crosswalk signals for people with impaired vision, where warranted. Where crosswalks are controlled by signals with a push-button system, the sidewalks and ramps must allow access, by wheelchair, to the push-button. For additional information on Accessible Pedestrian Signals, refer to the “Manual of Uniform Traffic Control Devices for Canada” (MUTCDC) [13], published by the Transportation Association of Canada.
- Grates for non-drainage structures (e.g., electrical vaults or access hatches) should be located off the clear path of travel. When it is necessary to install a grate in a pathway, it must be flush with

the surface and the cover should be oriented so that the long dimension of an elongated opening is perpendicular to the path of travel. Openings in the grate should be restricted so they do not permit the passage of a spherical object with a diameter larger than 13 mm. Figure C-7-1a shows the maximum recommended opening size and orientation for non-drainage grates located in pedestrian areas.

- Where possible, ensure that drainage grates on the covers of catch basins or manholes are located off the clear path of travel (i.e., not on curb ramps). Where it is not feasible to relocate a catch basin off a ramp (e.g., due to excessive cost on a retrofit project) the second choice is to offset the ramp, if the ramp will still provide direct access to the crosswalk. The third choice is to have the grate installed in the ramp. In this case, the cover should be installed as shown in Figure C-7-1b so the long dimension of the elongated opening is perpendicular to the pedestrian path of travel on the ramp. Standard Drawing CB6-2.10M34 [7] shows the details of a special catch basin/manhole frame and cover that is suitable for use on a curb ramp.

Although many pedestrian environments are generally barrier-free, some construction and operational practices present barriers to the general public. These barriers may have a much more restrictive impact on people with transportation disabilities.

Street furniture includes light poles, fire hydrants, traffic signals, signs, benches, mail boxes, sandwich boards, tables, bike racks, waste receptacles, bollards and trees. While frequently needed or desired on streets, their placement should not create an obstacle or hazard for people with impaired vision, wheelchair users or other pedestrians.

An even concrete surface is preferred for the main path of travel through pedestrian areas. The use of paving stones or bricks in pedestrian areas may present difficulties because of the uneven surface that can result from differential settlement, or the rounded edges, which may create a wider and deeper joint. The uneven surfaces and joints can cause pedestrians to trip and provide a less than ideal riding surface for people using wheelchairs. Paving stones and bricks should not be placed across the main path of travel where they would be a barrier or possible hazard to some pedestrians. Ideally, they should only be used as borders (e.g., on the outside edge of a sidewalk, adjacent to the curb). This provides a good tactile cue for people with impaired vision while also ensuring that the main path of pedestrian travel is separated from the roadway traffic.

In general, a safer and more functional pedestrian environment results if a clear path of travel is provided by ensuring that decorative finishes and other street furniture do not encroach on the path of travel.

- For lower volume sidewalks in residential or light industrial areas, where a monolithic curb, gutter and sidewalk has been selected, it is preferred that street furniture be placed off the sidewalk, on the side away from the roadway, so as not to encroach on the clear path of travel for pedestrians.

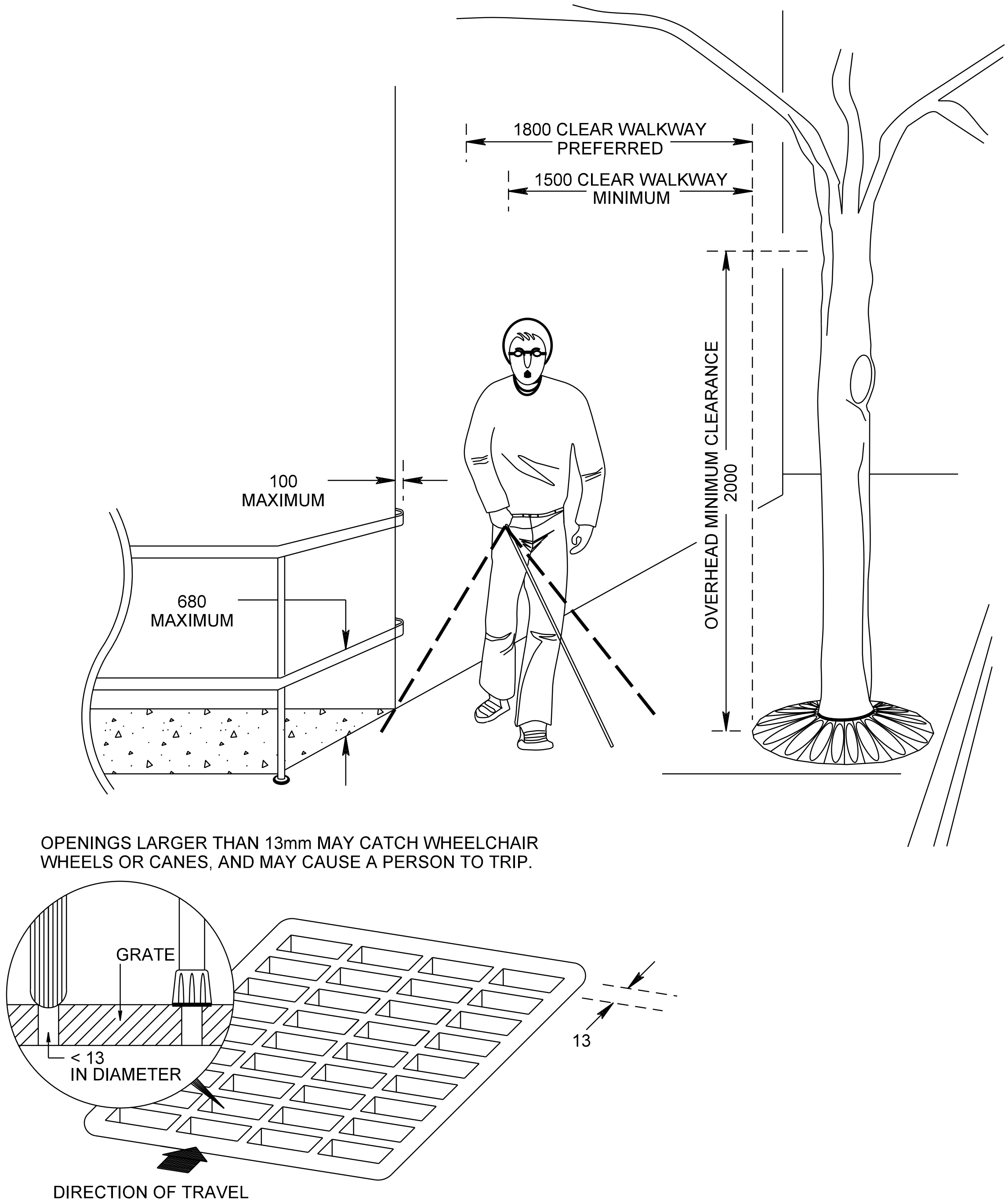
  Where right-of-way is available, a boulevard between the roadway and sidewalk provides greater safety for pedestrians while allowing for placement of street furniture off the pedestrian surface.
- Where wider sidewalks are required (e.g., in commercial or business areas, or in the vicinity of education or health care facilities) the sidewalk should be wide enough to accommodate street furniture (so it does not encroach on the clear path of travel) while maintaining a minimum 800 mm offset from the curb to allow for vehicle door-openings. Where sidewalks are constructed adjacent to buildings, it is best to place street furniture on the curb side of the walkway. This provides a greater offset between the pedestrian clear path of travel and the roadway traffic, as well as keeping obstructions away from the face of the buildings.
- Where higher speeds and higher traffic volumes are expected, a 3.0 m wide boulevard between the curb and sidewalk is desirable. When a boulevard is used, the width should allow for placement of street furniture, while maintaining a minimum 800 mm offset from the curb to allow for vehicle door-openings. For wide boulevards, a grass surface is used to provide a contrasting colour and texture. Narrow boulevards are normally paved.
- Refer to Section C.8.2.2, Urban Cross-sections and the following Standard Drawings from the Alberta Transportation website, “CB6 Highway Standard Plates – Active Drawings” [7]:

- CB6-4.2M78 shows stand-alone, poured-in-place concrete sidewalk.
- CB6-4.2M88 shows monolithic concrete sidewalk, barrier curb and gutter.
- CB6-4.2M89 shows poured-in-place standard curb and gutter.

The following additional points should be considered when determining the need and design parameters for a sidewalk or bicycle facility:

- When constructing new roads or reconstructing existing roads through an urban municipality, Alberta Transportation will work with the urban municipality to achieve continuity with their existing or proposed bicycle facilities and sidewalks;
- Currently, Alberta Transportation has no warrants for determining whether to provide sidewalks. Each location is assessed on a case-by-case basis;
- Where property is limited, or where wider sidewalks are required to accommodate pedestrian traffic, boulevards may be narrower than the standard width or, in some cases, omitted entirely. Examples of where this may occur are in business or commercial areas that are fully developed with offices and retail stores;
- Provision of a parallel bike path, pedestrian sidewalk or shared multi-use trail is typically not allowed on existing and proposed limited access freeways;
- Bicycle use on the paved, outside shoulders is typically not accommodated on limited access freeways;
- On bridges, pedestrians and cyclists will be accommodated where an existing facility exists and is being replaced, where a network plan is in place that will be built in the near future, or where vehicle and pedestrian safety concerns exist. If these conditions do not exist, Alberta Transportation may consider pedestrian and cyclist accommodation at the cost of the requesting party;
- On bridges, pedestrian or bicycle movements should be separated from vehicular traffic by an approved barrier. Bicycles may be accommodated by a wider outer lane or shoulder. Refer to the Alberta Transportation, “Bridge Structures Design Criteria” [14] for further information.

## Figure C-7-1a Pedestrian Path of Travel




NOTES:

1. ALL DIMENSIONS IN mm.
2. IT IS PREFERRED THAT GRATES BE LOCATED OFF THE CLEAR PATH OF PEDESTRIAN TRAVEL. WHERE IT IS NECESSARY TO INSTALL GRATES IN A PATH, THE COVER SHOULD BE ORIENTED SO THAT THE LONG DIMENSION OF THE ELONGATED OPENING IS PERPENDICULAR TO THE PEDESTRIAN PATH OF TRAVEL.
3. THIS DRAWING IS ADOPTED FROM THE ALBERTA MUNICIPAL AFFAIRS, "BARRIER-FREE DESIGN GUIDE".

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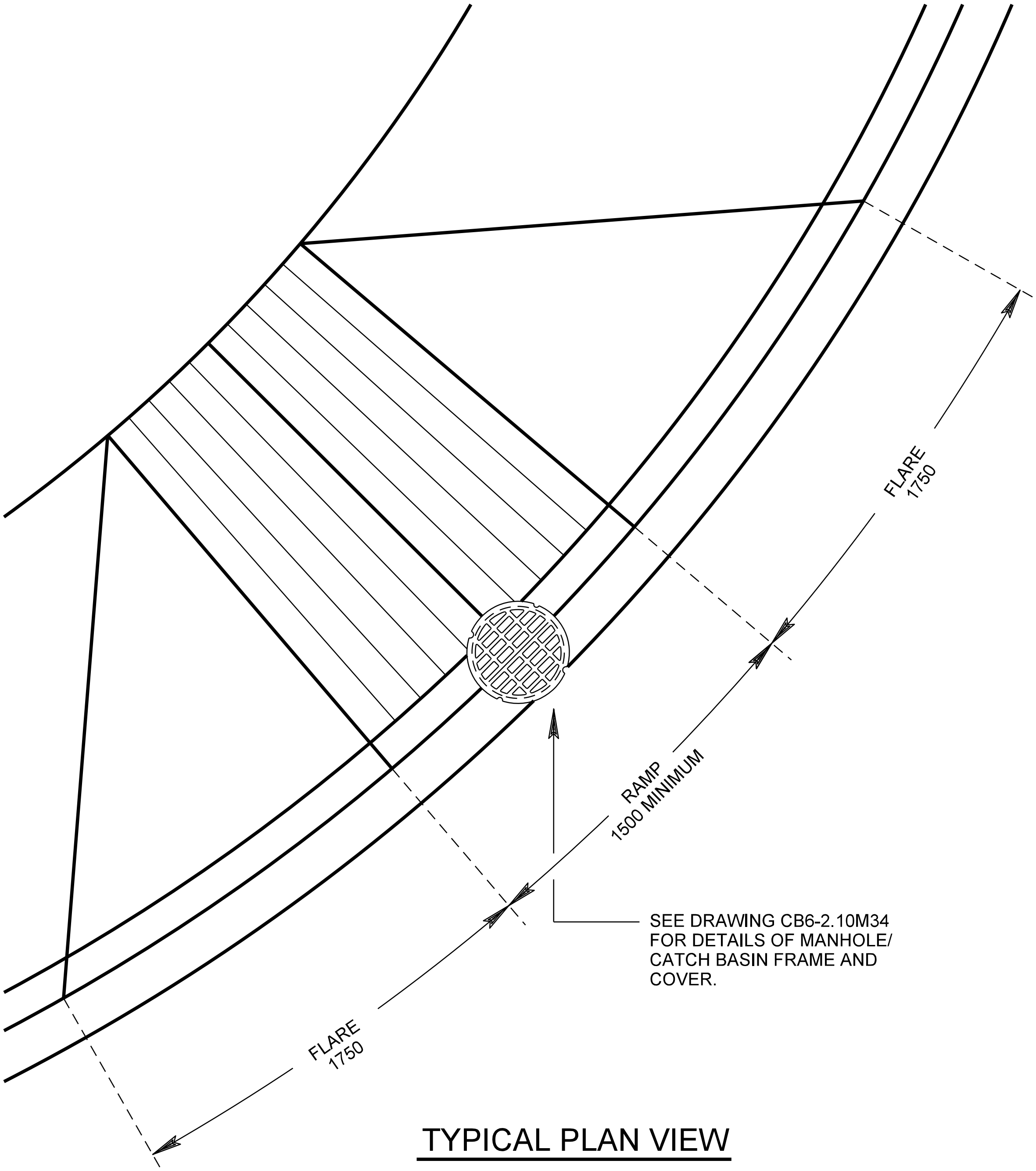
| Checked: HC | Scale: NTS | | | |

**Figure C-7-1b Urban Intersection Wheelchair Ramp – Special Catch Basin/Manhole Location**




TYPICAL PLAN VIEW

NOTES:

1. ALL DIMENSIONS IN mm.
2. IT IS PREFERRED THAT GRATES BE LOCATED OFF THE CLEAR PATH OF PEDESTRIAN TRAVEL. WHERE IT IS NECESSARY TO INSTALL GRATES IN RAMPS, THE COVER SHOULD BE ORIENTED SO THAT THE LONG DIMENSION OF THE ELONGATED OPENING IS PERPENDICULAR TO THE PEDESTRIAN PATH OF TRAVEL ON THE RAMP.

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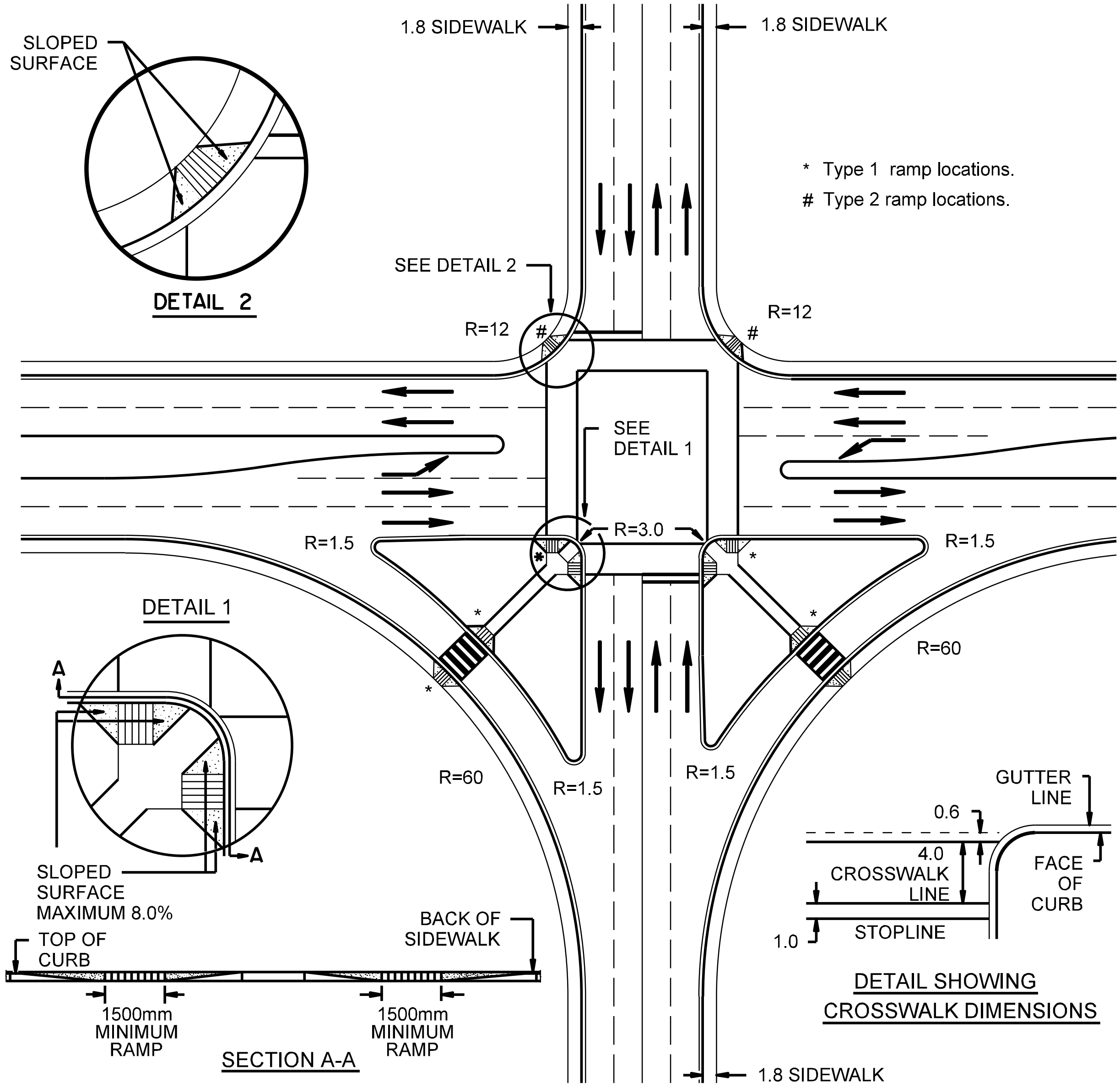
| Prepared: SL | Date: February 2022 | | Urban Intersection Wheelchair Ramp, Special Catch Basin/Manhole Location | Figure C-7-1b |
| Checked: HC | Scale: NTS | | | |

## Figure C-7-1c Urban Intersection – Typical Crosswalk Layout and Location & Type of Sidewalk Ramps




NOTES:

1. All dimensions are in metres unless otherwise specified.
2. Sidewalk ramps must provide access directly to crosswalks.
3. The selection of curb ramp type is dependent on the location of the crosswalk relative to the curb face. Where the curb return radius is greater than or equal to 4.0m, one Type 2 ramp can be used. Where the curb return radius is less than 4.0m, two Type 1 ramps are required.
4. Refer to Standard Drawings CB6-4.2M86 and CB6-4.2M87 for details of Type 1 and Type 2 ramps.
5. On a sharp corner where two Type 1 ramps are being used, the slope on the flared areas between the two ramps can be less than the 0.08m/m maximum shown. This will provide a smoother sidewalk for general use, especially for pedestrians who are not using the crosswalk.

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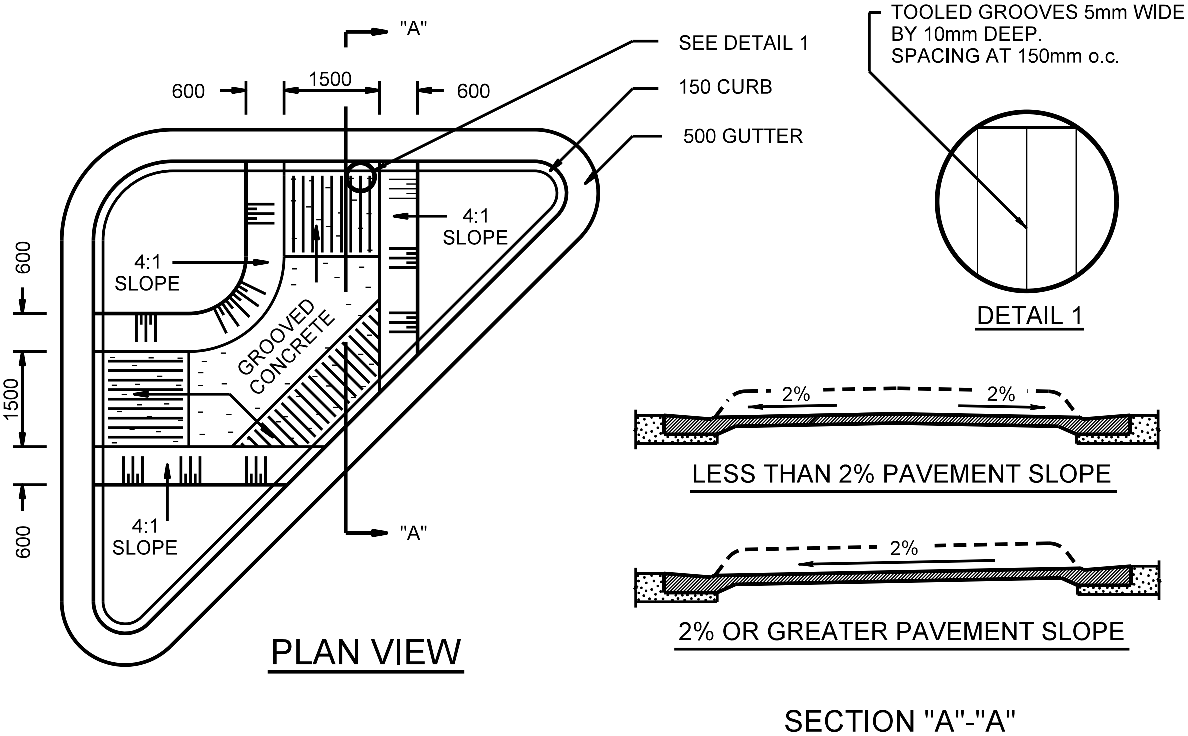
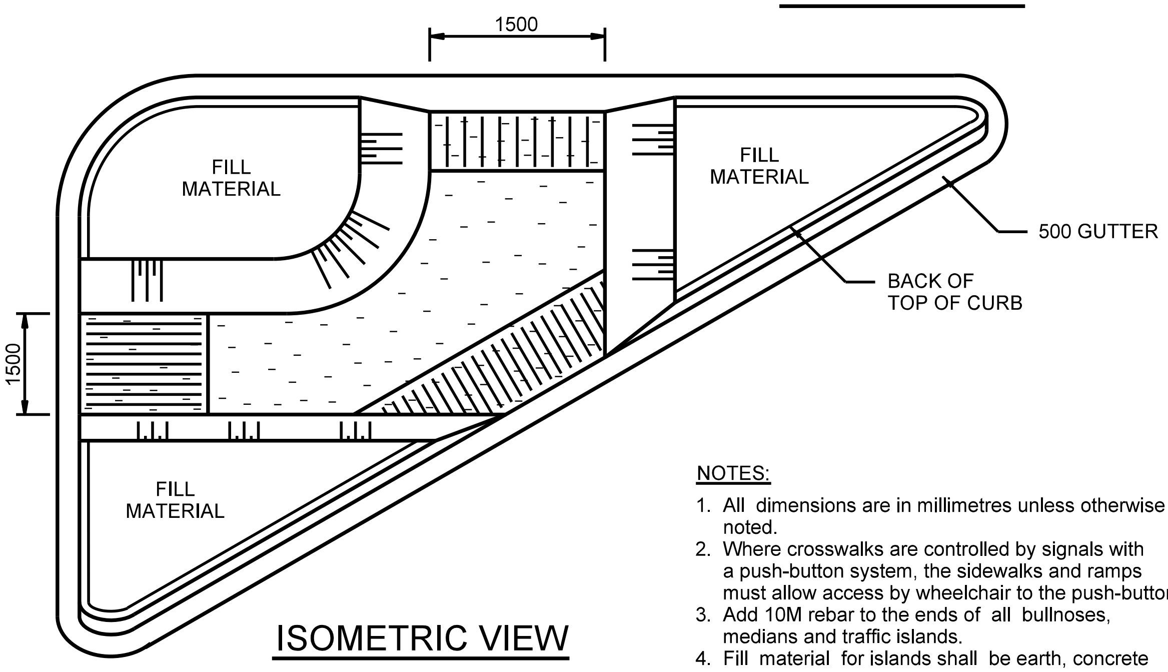
| Checked: HC | Scale: NTS | | | |

## Figure C-7-1d Typical Sidewalk and Ramp Layout on Smaller Islands and Medians




NOTES:

1. All dimensions are in millimetres unless otherwise noted.
2. Where crosswalks are controlled by signals with a push-button system, the sidewalks and ramps must allow access by wheelchair to the push-button.
3. Add 10M rebar to the ends of all bullnoses, medians and traffic islands.
4. Fill material for islands shall be earth, concrete or asphalt concrete as specified.
5. Sidewalk and ramps shall be concrete.

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| Prepared: SL | Date: February 2022 | | Typical Sidewalk and Ramp Layout on Smaller Islands and Medians | Figure C-7-1d |
| Checked: HC | Scale: NTS | | | |

## C.7.2 Curb and Gutter

A curb is a raised element running adjacent to the travel lane or shoulder whose function is to control drainage, provide delineation of the pavement edge, reduce right-of-way requirements, improve aesthetics, delineate between vehicular and pedestrian areas and assist in access management and roadway development control. Curb and gutter treatments are extensively used on urban roadways. On rural highways and many high-speed urban roadways, their function is primarily that of delineation since drainage channels usually accommodate drainage.

There are three types of curb and gutter treatments, as illustrated in Standard Drawing CB6-4.2M89 [7]:

- Barrier curb has a relatively steep face, with a near-vertical slope of 10V:1H, a height of 150 mm and a horizontal offset of 15 mm. It is intended primarily to control drainage as well as inhibit low-speed vehicles from leaving the roadway. When struck at high speeds, barrier curb is inadequate to prevent a vehicle from leaving the roadway, can cause drivers to lose control of their vehicle, and contributes to vehicle vaulting over many types of traffic barriers.

  Barrier curb is not used in combination with traffic barrier systems unless the operating speed of the roadway is 60 km/h or less. Refer to Table H4.1 of the Alberta Transportation, "Roadside Design Guide" [4].

  In general, a barrier curb should not be installed on roadways with a posted speed greater than 60 km/h. For curb installation in an area with a posted speed greater than 60 km/h, a semi-mountable or mountable curb is desirable.
- Semi-mountable curb is considered to be mountable under emergency conditions. The curb face has a slope of 0.625V:1H, with a height of 125 mm and a horizontal offset of 200 mm.

  Semi-mountable curb is sometimes used at channelized intersections that require raised islands or raised medians. It may also be used in combination with some semi-rigid barrier systems. It is not recommended for rigid barrier systems (concrete barriers).
- Mountable curb has a relatively flat sloping face (0.25V:1H) to permit vehicles to easily cross over it. The curb face has a height of 100 mm and a horizontal offset of 400 mm.

  Mountable curb may be used in conjunction with semi-rigid barrier systems. The combination of rigid (concrete) barrier and mountable curb is generally not required and is not desirable because the concrete barrier can be used to channel surface runoff to drainage outlets, eliminating the need to provide the mountable curb. Concrete barriers may be provided adjacent to mountable curb in special instances to deal with unique drainage issues.
- Generally, curbs should not be used in conjunction with concrete barriers. Improperly placed curbs may cause errant vehicles to vault the concrete barrier or to strike it, causing the vehicle to overturn.
- Acceptable combinations of curb and barrier systems are dependent on the operating speed of the roadway, the cross-section shape of the curb, the barrier type and the lateral offset of the curb from the barrier system. Refer to the "Alberta Transportation, "Roadside Design Guide" [4] for more information.

Gutters, which provide the principal drainage system for urban roadways, are located on the travel side of barrier, semi-mountable and mountable curbs. The use of 500 mm wide gutters has been adopted throughout the province to contain the majority of stormwater run-off and restrict the amount of overflow entering onto the outer travel lane. Because of the 500 mm wide gutter, the resultant offset of the curb face is 0.50 m from the edge of the travel lane (i.e., the gutter pan width is not considered to be part of the travel lane width). If a gutter is not required (e.g., the surface of the road slopes away from the curb), the curb face is still placed 500 mm from the edge of the travel lane. See Standard Drawing CB6-4.2M47 [7] for an example.

Curbs for medians, islands or where curb is introduced intermittently along roadways should be located at, or beyond, the outer edge of the shoulder. Where curb and gutter is placed at the outside edge of a paved shoulder, the shoulder width is measured between the edge of the travelled way and the lip of the gutter. For medians and islands, a sloping end treatment should be provided at the point where the island begins. For stand-alone curb, an additional 0.5 m wide tapered offset and sloping end treatment should be provided at the point where the curb begins.

### C.7.3 Boulevards

Boulevards on urban sections serve as a safety separation between pedestrians and vehicles as well as a location for surface and underground utilities, traffic signs and other control devices, and snow storage. The incorporation of boulevards is particularly important for streets with design speeds greater than 60 km/h.

The desirable width for a boulevard (offset between curb face and sidewalk) is 3.0 metres. Placement of street furniture and lighting poles within the boulevard is based on clear zone principles. The location of the lighting poles will affect the type of light pole base (breakaway or non-breakaway). Refer to the Alberta Transportation, “Roadside Design Guide” [4] and “Highway Lighting Guide” [15] for more information.

The width of the boulevard should allow for placement of other street furniture as well, while maintaining a minimum 800 mm offset from the curb to allow for vehicle door-openings.

Where property is limited, or where wider sidewalks are required, boulevards may be narrower than the desirable width. Examples are in business or commercial areas, where a shared multi-use path accommodating pedestrians and bicycles is required, or where a wider pathway is required to accommodate persons with disabilities.

For wide boulevards, a grass surface is used to provide a contrasting colour and texture. Narrow boulevards are normally paved.

## C.8 TYPICAL CROSS-SECTIONS

### C.8.1 Strategies to Retain Existing Pavement Width

In 1999, Alberta Transportation adopted a strategy to address narrow pavements. The strategy was intended to reduce the need to grade-widen existing paved roads. A policy was subsequently developed, and later refined, to address roadway width by means of distinct strategies for new construction, grade-widening and rehabilitation.

New construction projects involve building a new subgrade, base course and pavement on a new alignment, or involve full reconstruction (including removal of the existing pavement) on an existing alignment.

Grade-widening projects involve existing pavements being widened (i.e., where new subgrade, base course and ACP is placed to the side of an existing pavement). Grade-widening may also include an overlay of the entire roadway width.

Rehabilitation projects involve an overlay or other type of surface treatment, often without widening.

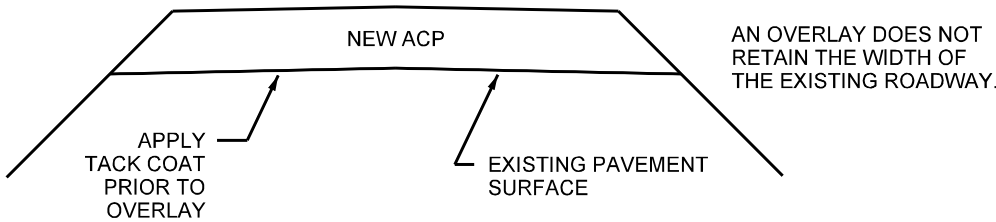
#### C.8.1.1 Rehabilitation

When pavement rehabilitation is being undertaken, all possible alternatives to minimize the loss of surface width are to be considered. Design choices are based on an analysis of the various options available on each project, taking into account the benefit cost effectiveness of the options. Desirably, this analysis is undertaken at the planning or preliminary engineering stage, however, some decisions involving surfacing and grading strategies occur at the detailed design stage. Refer to the latest version of the Alberta Transportation, “Benefit Cost Model and User Guide” [16].

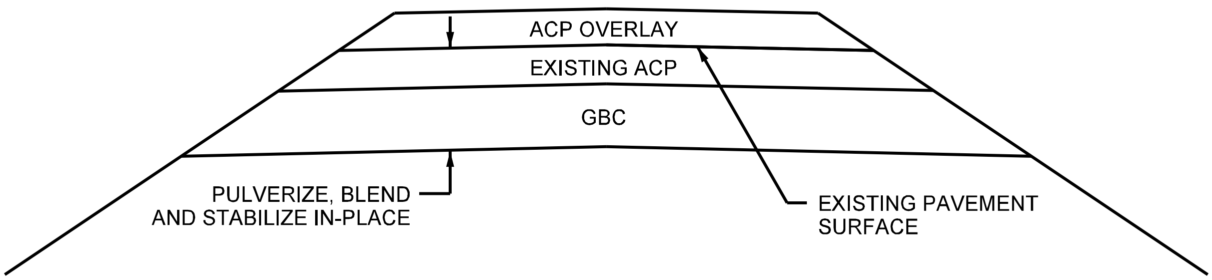
A pavement overlay reduces the width of an existing roadway. Figures C-8-1a and C-8-1b illustrate a number of alternatives that should be considered to retain, or minimize loss of, existing pavement widths. Although the objective is to minimize loss of pavement width on a network basis, preventing pavement loss on all projects is impractical. The suitability of various options will depend on structural needs, existing conditions and funding availability. Generally, the roadway design choice is based on a combination of geometric design and surfacing considerations.

Refer to the Alberta Transportation, “Guidelines for Assessing Pavement Preservation Treatments and Strategies” [17].

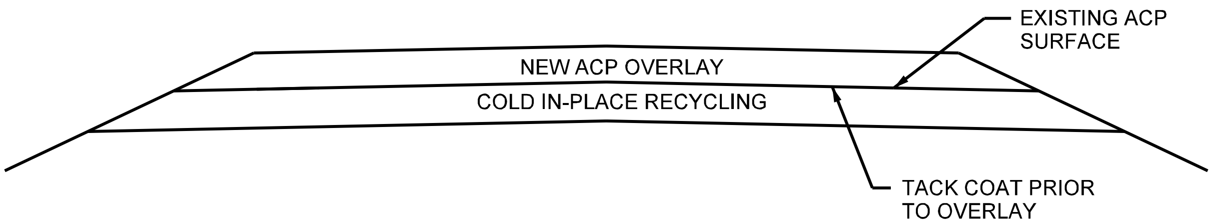
**Figure C-8-1a Strategies to Retain or Minimize Loss of Existing Pavement Width – Part 1**




OVERLAY




FULL-DEPTH RECLAMATION WITH STABILIZATION AND OVERLAY




COLD IN-PLACE RECYCLING WITH STABILIZATION AND OVERLAY

(FULL WIDTH OF EXISTING PAVEMENT)

NOTES:

1. FOR TYPICAL SERVICE LIFE, REFER TO THE ALBERTA TRANSPORTATION "GUIDELINES FOR ASSESSING PAVEMENT PRESERVATION TREATMENTS AND STRATEGIES".
2. DEPENDING ON THE STRUCTURAL AND SURFACE CONDITION OF THE EXISTING PAVEMENT, DEPTH OR THICKNESS OF THESE TREATMENTS MAY VARY.

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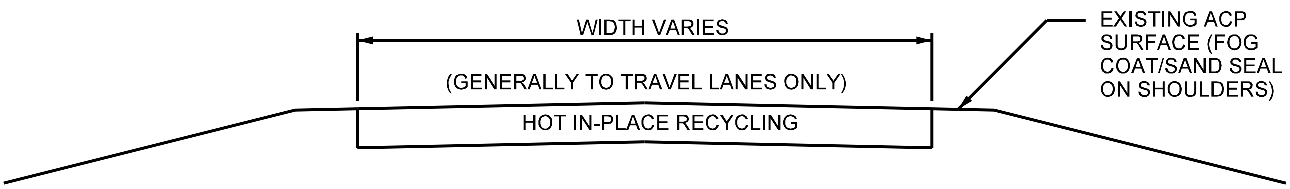
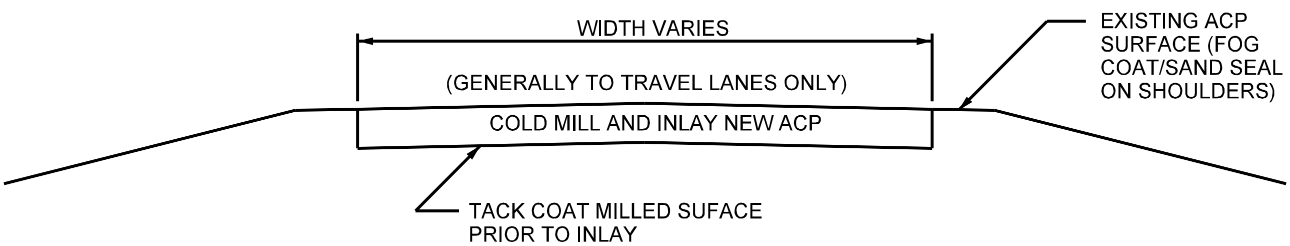
| Checked: HC | Scale: NTS | | | |

**Figure C-8-1b Strategies to Retain or Minimize Loss of Existing Pavement Width – Part 2**



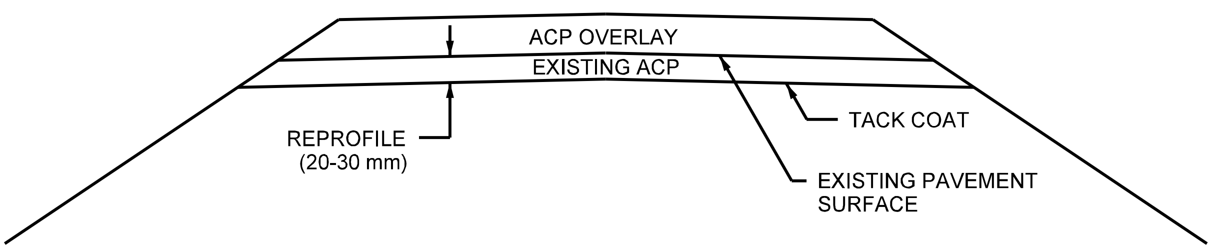

HOT IN-PLACE RECYCLING

(MAY INCLUDE AN OVERLAY)




COLD MILL AND INLAY

(MAY INCLUDE AN OVERLAY)




REPROFILE BY COLD MILLING AND OVERLAY

NOTES:

1. FOR TYPICAL SERVICE LIFE, REFER TO THE ALBERTA TRANSPORTATION "GUIDELINES FOR ASSESSING PAVEMENT PRESERVATION TREATMENTS AND STRATEGIES".
2. DEPENDING ON THE STRUCTURAL AND SURFACE CONDITION OF THE EXISTING PAVEMENT, DEPTH OR THICKNESS OF THESE TREATMENTS MAY VARY.
3. THE WIDTH OF THE HOT IN-PLACE AND COLD MILL AND INLAY TREATMENTS MAY VARY DEPENDING ON THE TOTAL WIDTH OF THE EXISTING PAVEMENT,PRESENCE OF RUMBLE STRIPS, AND OTHER FACTORS. REFER TO THE ALBERTA TRANSPORTATION "GUIDELINES FOR ASSESSING PAVEMENT PRESERVATION TREATMENTS AND STRATEGIES".

| | | | | |
|---|---|---|---|---|
| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Strategies to Retain or Minimize Loss of Existing Pavement Width - Part 2 | Figure C-8-1b |
| Checked: HC | Scale: NTS | | | |



Classification: Public

### C.8.1.2 New Construction and Grade-Widening (to Accommodate Two Future Overlays)

New construction and grade-widening projects include roadway twinning, the addition of an auxiliary lane, intersection and interchange improvement, and converting a non-paved road to a paved road.

Alberta Transportation has been constructing wide subgrades, base courses and ACP surfaces on new construction and grade-widening projects for many years. The main purpose of this strategy is to extend the service life of the roadway (despite periodic pavement rehabilitation, such as an overlay) by ensuring sufficiently wide shoulders are available. This defers the need for grade-widening.

The policy/practice of Alberta Transportation is to provide a wide subgrade, base course and ACP surface to allow two future ACP overlays to be placed without the surface width being reduced to less than the width of the design designation. Under normal practices, accommodating for two, future 80 mm overlays (a total depth of 160 mm) will maintain the designated surface width for a period of over 50 years after the pavement is originally built or widened (based on a pavement design life of 20 years). The practice of providing for two future ACP overlays normally does not apply on bridge structures.

The pavement sideslope includes the ACP and base course layers above the subgrade. A pavement sideslope of 5:1 is typically used at all stages on divided highways, and on undivided highways with a design designation width greater than 10 metres. A pavement sideslope of 4:1 is typically used at all stages on undivided highways with a design designation width of 10 metres or less.

Because of the allowance for two, future ACP overlays, the overall surface width at the time of new construction or grade-widening is greater than the width indicated by the design designation. Refer to Table C-8-1-2a.

**Table C-8-1-2a New Construction Width to Accommodate two Future ACP Overlays**

| Design Designation Width (m) | Pavement Sideslope | Thickness, Two Future Overlays (m) | Overlay Allowance per Side (m) | Initial Width of New Construction | |
|---|---|---|---|---|---|
| | | | | Roadway Surface Width (m) | Lane / Shoulder Width (m) (See Section C.2) |
| UED 410.4 | 5:1 | 0.16 | 0.80 | 11.20 (Note 1) | 3.70 / 0.00 (Lt), 3.80 (Rt) |
| UED 614.1 | 5:1 | 0.16 | 0.80 | 14.90 (Note 1) | 3.70 / 0.00 (Lt), 3.80 (Rt) |
| UFD 617.1 | 5:1 | 0.16 | 0.80 | 17.90 (Note 1) | 3.70 / 3.00 (Lt), 3.80 (Rt) |
| UED 617.1 | 5:1 | 0.16 | 0.80 | 17.90 (Note 1) | 3.70 / 3.00 (Lt), 3.80 (Rt) |
| UFD 820.8 | 5:1 | 0.16 | 0.80 | 21.60 (Note 1) | 3.70 / 3.00 (Lt), 3.80 (Rt) |
| RFD 820.8 | 5:1 | 0.16 | 0.80 | 22.40 | 3.70 / 3.80 (Lt), 3.80 (Rt) |
| 16.6 | 5:1 | 0.16 | 0.80 | 18.20 | 3.70 / 3.30 (Lt), 3.80 (Rt) |
| 12.4 | 5:1 | 0.16 | 0.80 | 14.00 | 3.70 / 2.80 (Lt), 3.80 (Rt) |
| 12.0 | 5:1 | 0.16 | 0.80 | 13.60 | 3.70 / 3.10 |
| 11.0 | 5:1 | 0.16 | 0.80 | 12.60 | 3.70 / 2.60 |
| 10.0 | 4:1 | 0.16 | 0.64 | 11.28 | 3.70 / 1.94 |
| 9.0 | 4:1 | 0.16 | 0.64 | 10.28 | 3.70 / 1.44 |
| 8.0 | 4:1 | 0.16 | 0.64 | 9.28 | 3.50 / 1.14 |
| 7.0 | 4:1 | 0.16 | 0.64 | 8.28 | 3.50 / 0.64 |

Notes:

1. Next to flush medians and raised medians, no allowance for future overlays is provided. A long-life pavement design is often used in these locations. The overlay allowance is only provided on the right side (outside) of the roadway.

A long-life pavement design is often used so future pavement maintenance and rehabilitation can occur without adding pavement thickness. This is important in areas where it would be impossible, impractical or costly to raise the elevation of the existing pavement (e.g., at railway crossings and bridge approaches, at a bridge underpass, or adjacent to curb and gutter).

Often, the long-life pavement consists of a thicker pavement structure that provides sufficient structural capacity for a 40-year design period. Milling and replacing the surface layer is the expected pavement rehabilitation treatment. Providing an additional shoulder width to accommodate two future overlays may not be required. Refer to the Alberta Transportation, “Pavement Design Manual” [2] as well as the associated design bulletins (13, 15 and 77) on the Alberta Transportation website, “Design Bulletins” [18].

For locations beneath a bridge structure, consultation with highway network planners at Alberta Transportation is required to determine if the under-passing road is (or will be) designated as part of the High Load Corridor. The under-passing pavement design should reflect this.

The designer uses the design pavement structure to determine the project-specific pavement cross-section details. Based on the type of construction, these project-specific cross-sections are developed by the consultant and included in the contract/tender documents. For new construction projects, the ACP is normally placed in two stages (1$^{st}$ stage paving and final paving). On grade-widening projects, the ACP is usually placed in one stage (but, perhaps, more than one lift, depending on the total ACP thickness).

Figures C-8-1c through C-8-1f indicate pavement sideslope details, including accommodation of future overlays, for various design designations and types of construction.

Figure C-8-1g also indicates offset crowns that are typically used on four-lane divided highways. By offsetting the crowns of the subgrade, base course and ACP, a thicker overall pavement structure can be placed on the outside lane where, typically, heavier vehicles travel.

On roadways which require grade-widening, different strategies may be considered to achieve grade-widening in a cost-effective way while still achieving acceptable quality. These strategies include grade-widening on one side or both sides of the roadway. Widening on both sides is often more beneficial than widening on one side. Grade-widening often results in flatter sideslopes for the widened roadway than on the existing roadway. Where one-side widening is being considered, designers should carefully assess the additional cost for crown shift, especially related to the additional pavement thickness. The location of the wheel paths on the proposed cross-section must also be considered. A cross-section that results in a wheel path on or near the joint is undesirable.

The options available for grade-widening or reconstruction of existing paved highways may be influenced or restricted by the nature or proximity of existing developments, right-of-way constraints or physical constraints. Widening on one side or horizontal realignment may be the most practical solution.

In all cases (including the addition of an auxiliary lane or widening for an intersection improvement) the design objective is to construct a roadway with a surface width that will not require further widening for a period of 50 years, by accommodating for two, future 80 mm overlays.

**Figure C-8-1c Pavement Sideslope, New Construction - Design Designations > 10 m Wide**

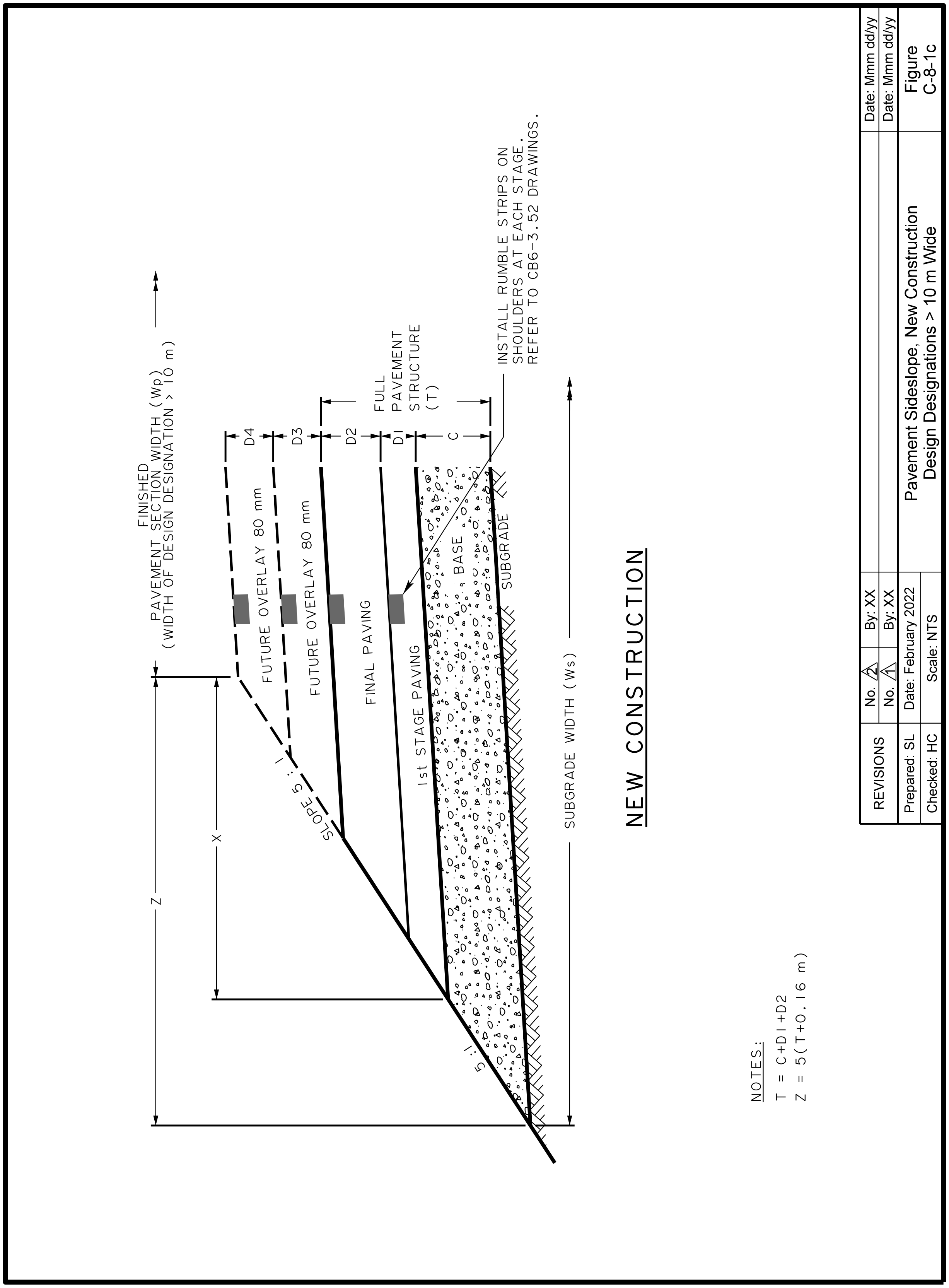


**Figure C-8-1d Pavement Sideslope, Widening – Design Designations > 10 m Wide**

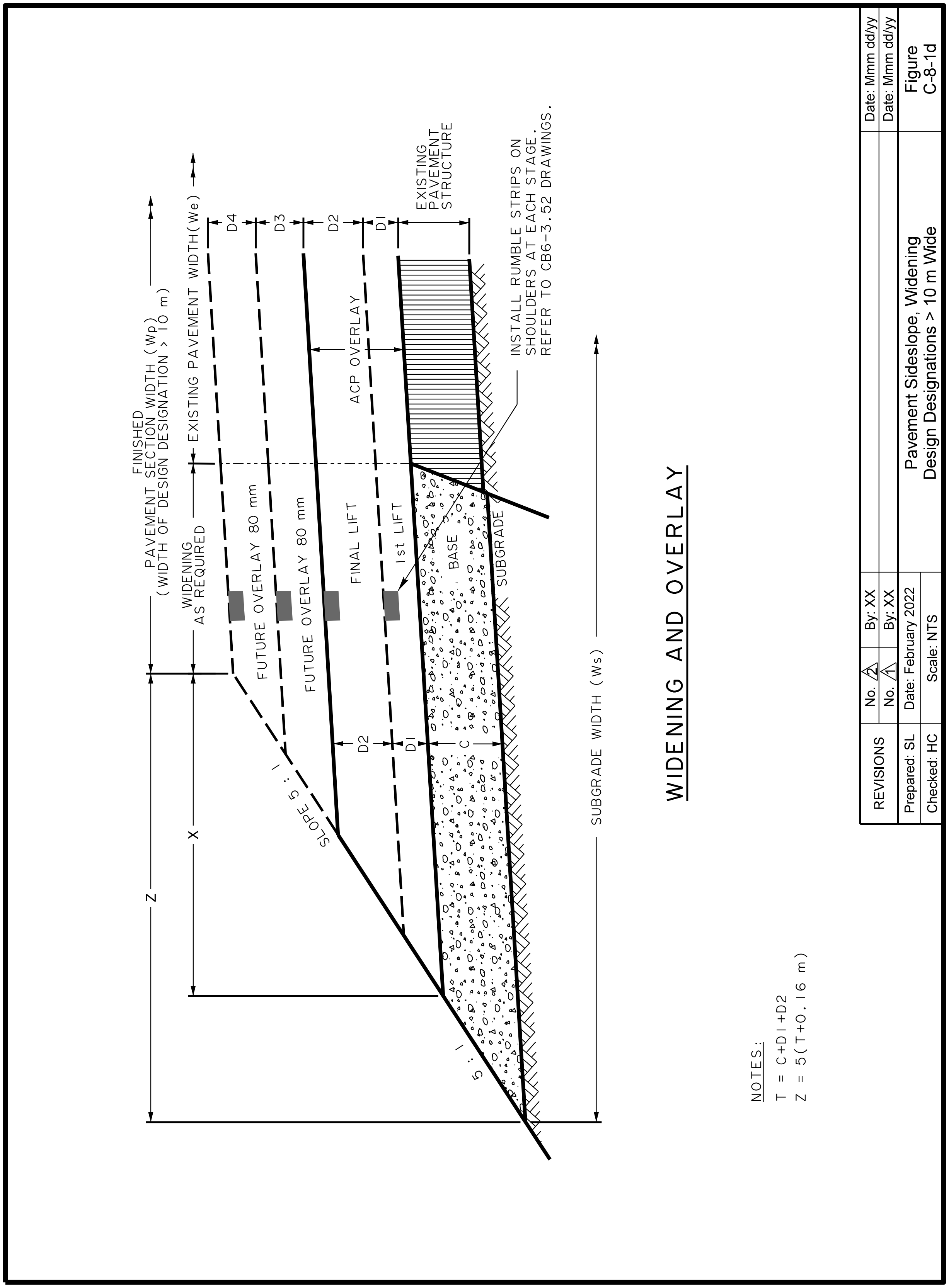


**Figure C-8-1e Pavement Sideslope, New Construction - Design Designations ≤ 10 m Wide**

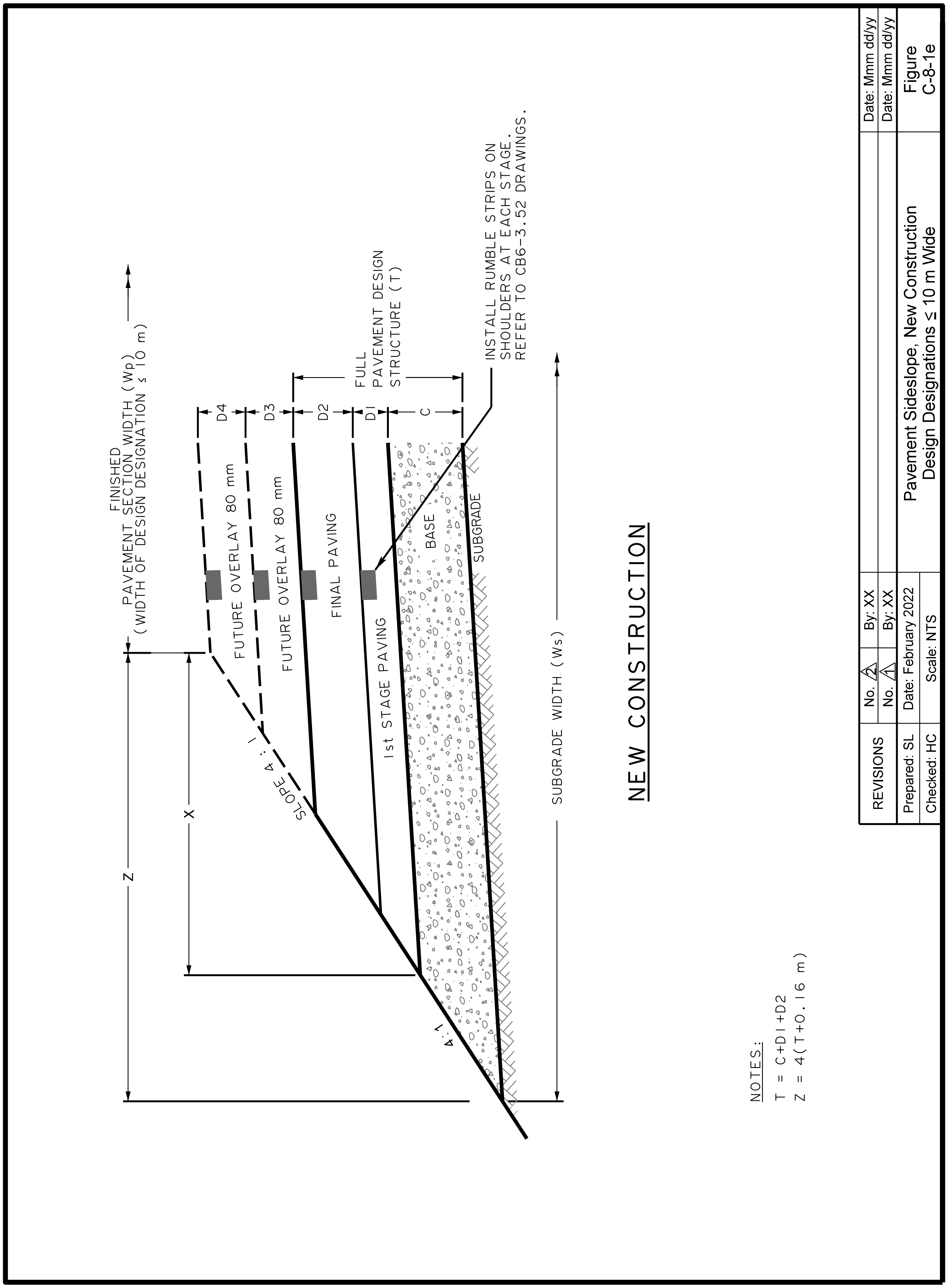
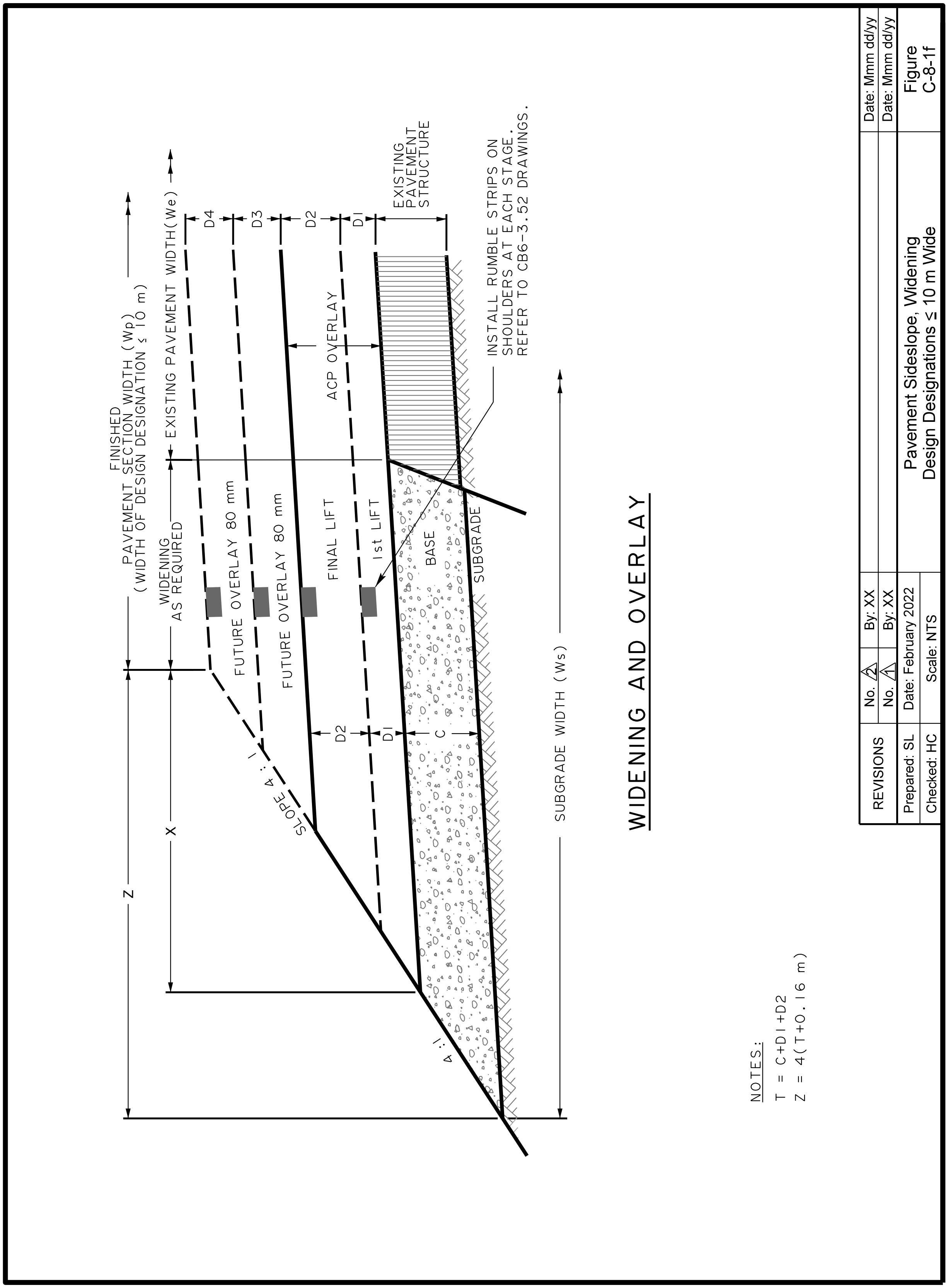
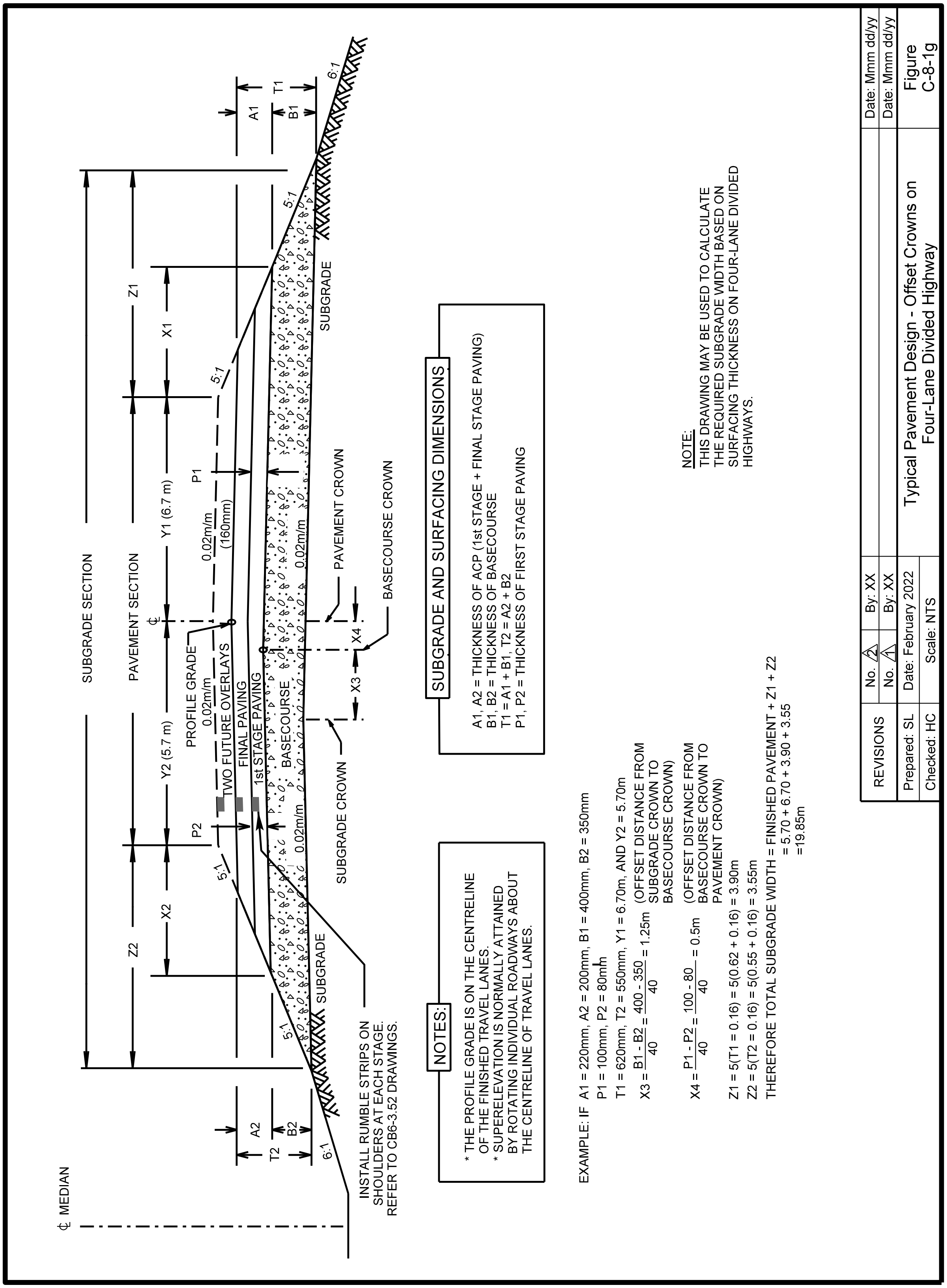


**Figure C-8-1f Pavement Sideslope, Widening – Design Designations ≤ 10 m Wide**



## Figure C-8-1g Typical Pavement Design – Offset Crowns on Four-lane Divided Highway



## C.8.2 Typical Cross-sections for Design Designations

The figures in this section illustrate the typical cross-sections for each of the commonly used design designations. Guidelines for selecting the appropriate design designation are contained in Chapter A, Basic Design Principles. Rural cross-sections are in Section C.8.2.1. Urban cross-sections are in Section C.8.2.2.

Where grade-widening is involved, the life cycle cost effectiveness of various options should be considered. Refer to Chapter G, 3R/4R Geometric Design Guidelines, for more information.

Right-of-way is that area of property established to accommodate a road and its accompanying features and elements. Right-of-way width is determined by establishing dimensions for each roadway element including roadway surface width, median width, ditch width, requirements for cut and fill slopes, as well as a provision for landscaping, roadside devices and infrastructure. Added together, each of these elements establish a basic right-of-way width. A long-term view must be taken to ensure that enough land is set aside to accommodate the ultimate roadway configuration so that costly right-of-way acquisition can be minimized or avoided in subsequent stages of development.

Basic right-of-way widths are indicated in Chapter A, Basic Design Principals. Table A-2-3-2a indicates a general range of right-of-way based on functional classification. Table A-10-1a and Table A-10-1b indicate more specific right-of-way based on design designation. Each of the typical cross-sections, following, show a basic right-of-way width. In some cases, this is shown as a desirable and/or minimum width.

### C.8.2.1 Rural Cross-sections

Figures C-8-2a through C-8-2k, which follow, illustrate the typical cross-sections for each of the commonly used rural design designations.

Figures C-8-2L through C-8-2q illustrate typical cross-sections for unique situations such as log haul resource roads; highways within a provincial park; sections through muskeg, adjacent to open water and through rock; modified cross-sections for staged construction of nine and ten metre roadways.

The designer is required to use the design pavement structure, and the geometric information contained in these typical cross-sections, to develop project-specific cross-sections that are included in the contract/tender documents. Refer to Section C.8.1.2 for information regarding the accommodation of two future overlays.

Figures C-8-1c through C-8-1f indicate pavement sideslope details, including accommodation of future overlays, for various design designations and types of construction.

**Figure C-8-2a Typical Cross-section for RFD-616.6-130/110 and RAD-616.6-120**

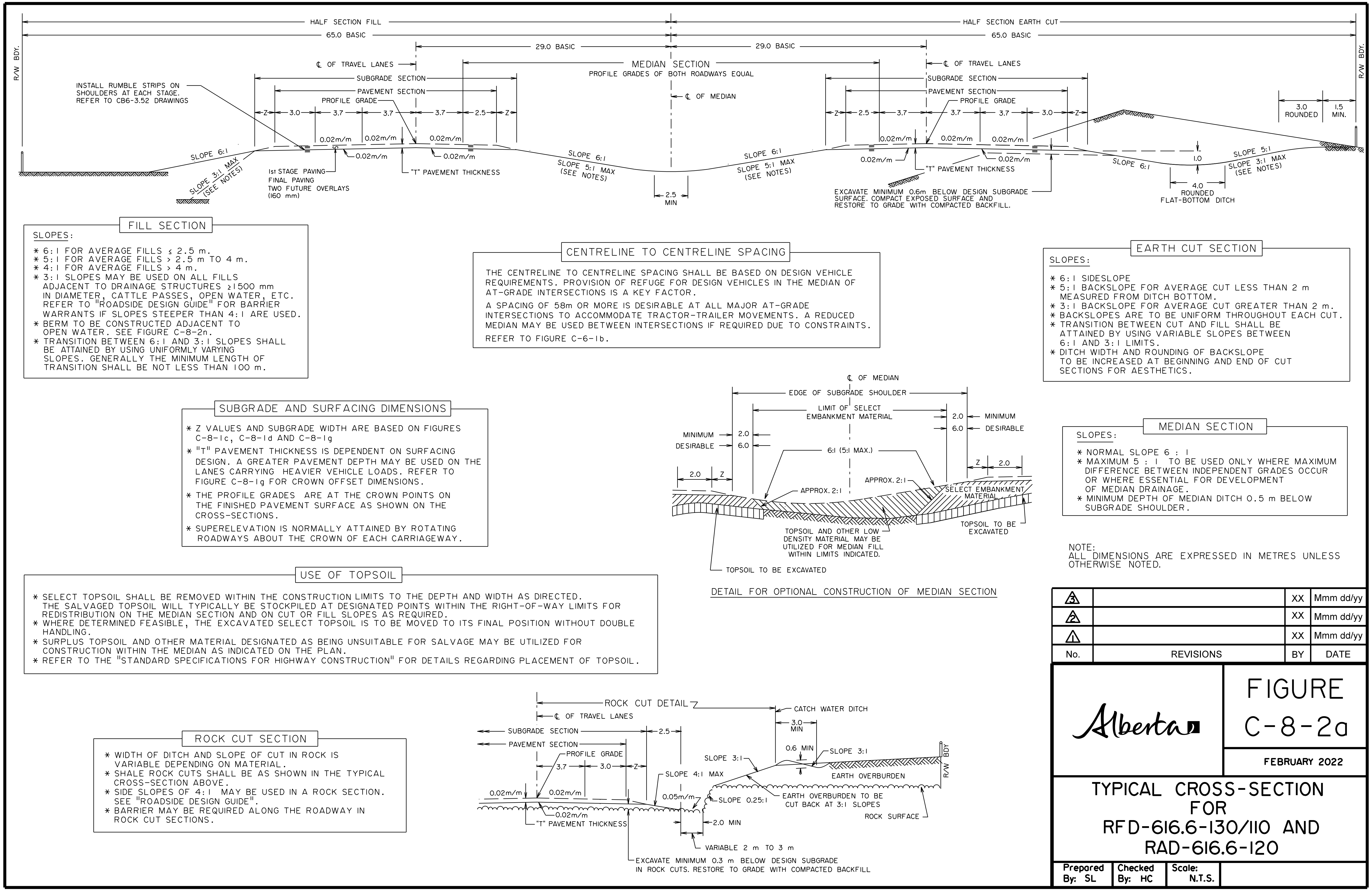


**Figure C-8-2b Typical Cross-section for RFD-412.4-130/110 and RAD-412.4-120**

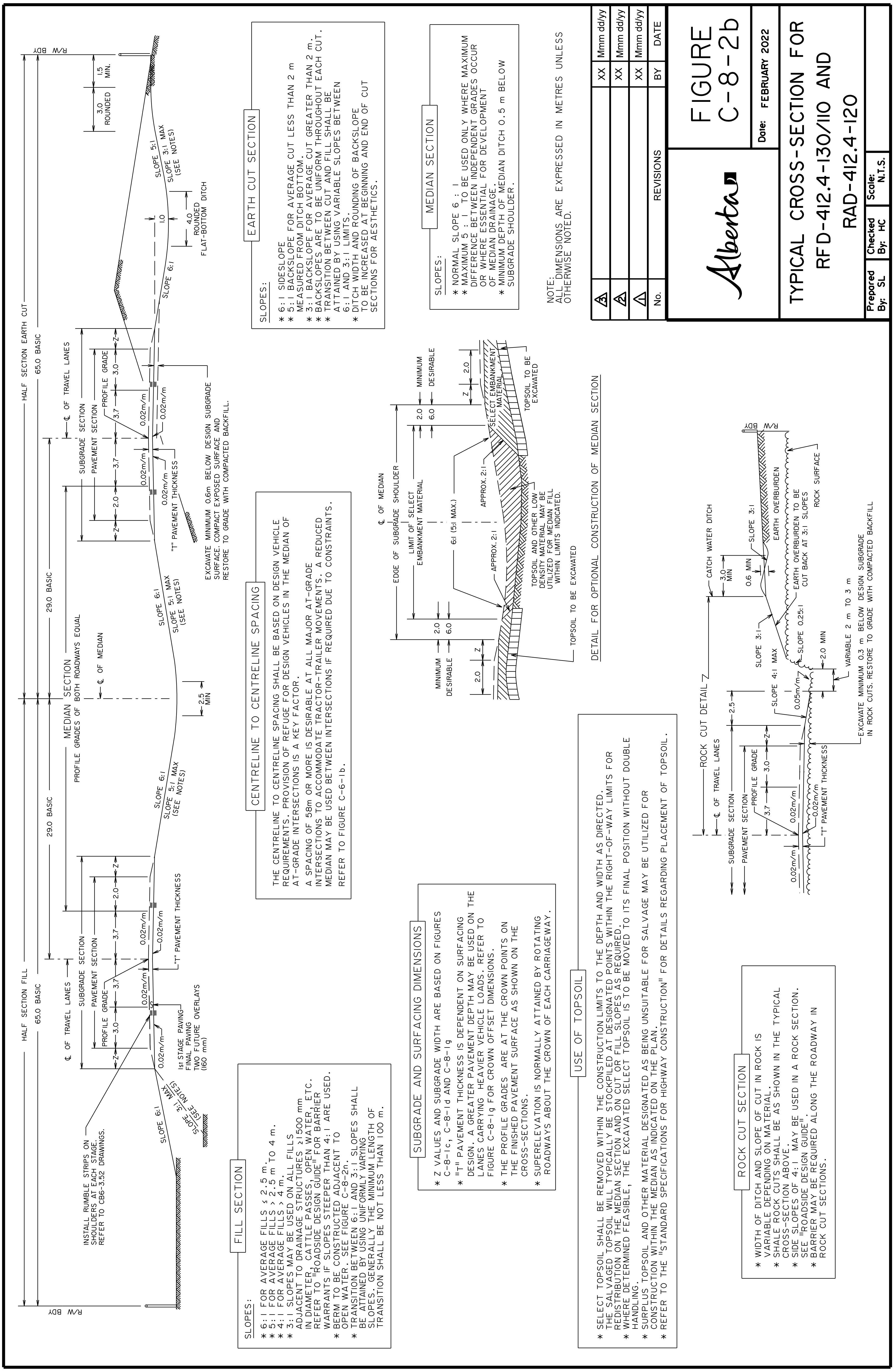
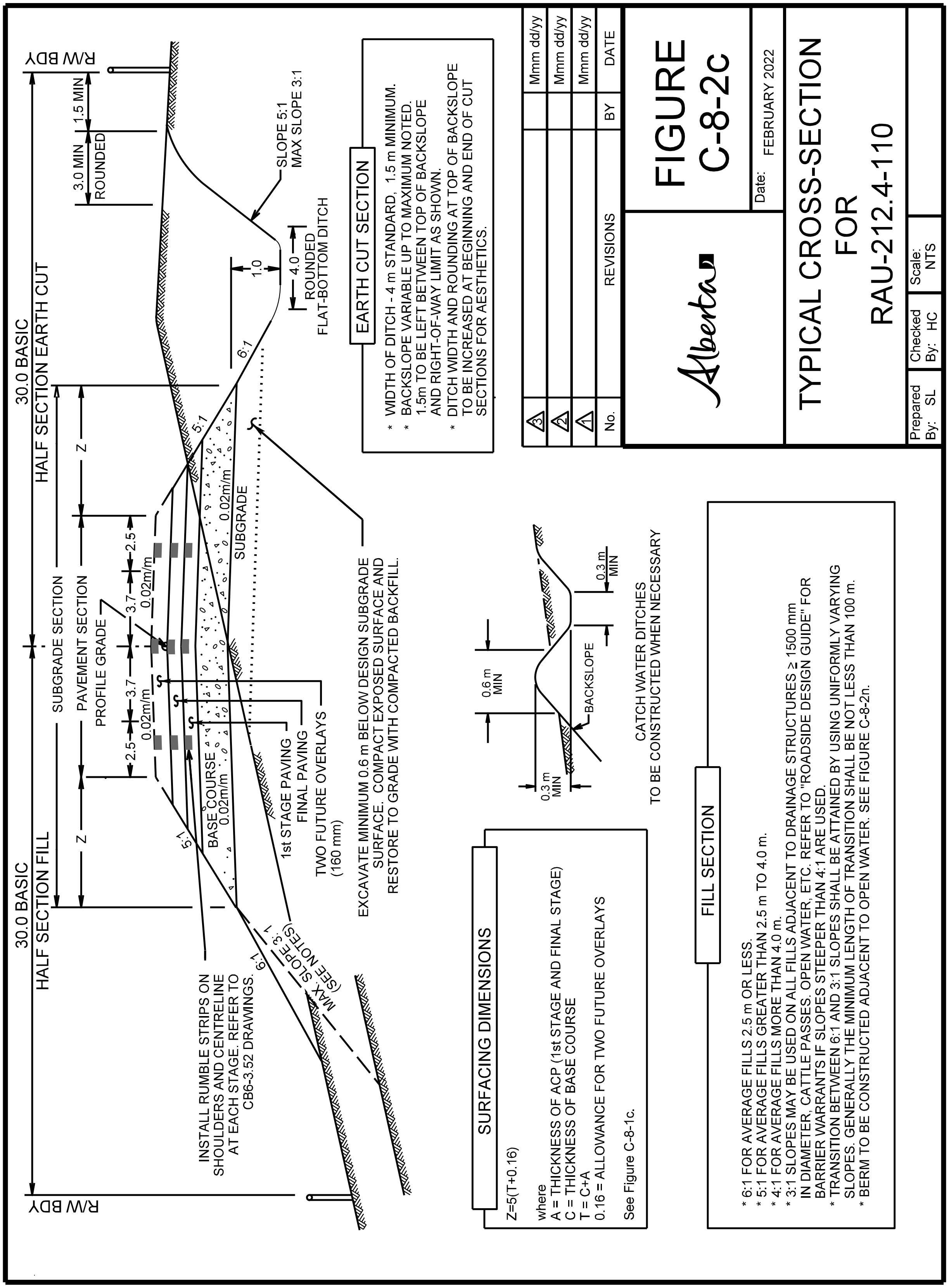
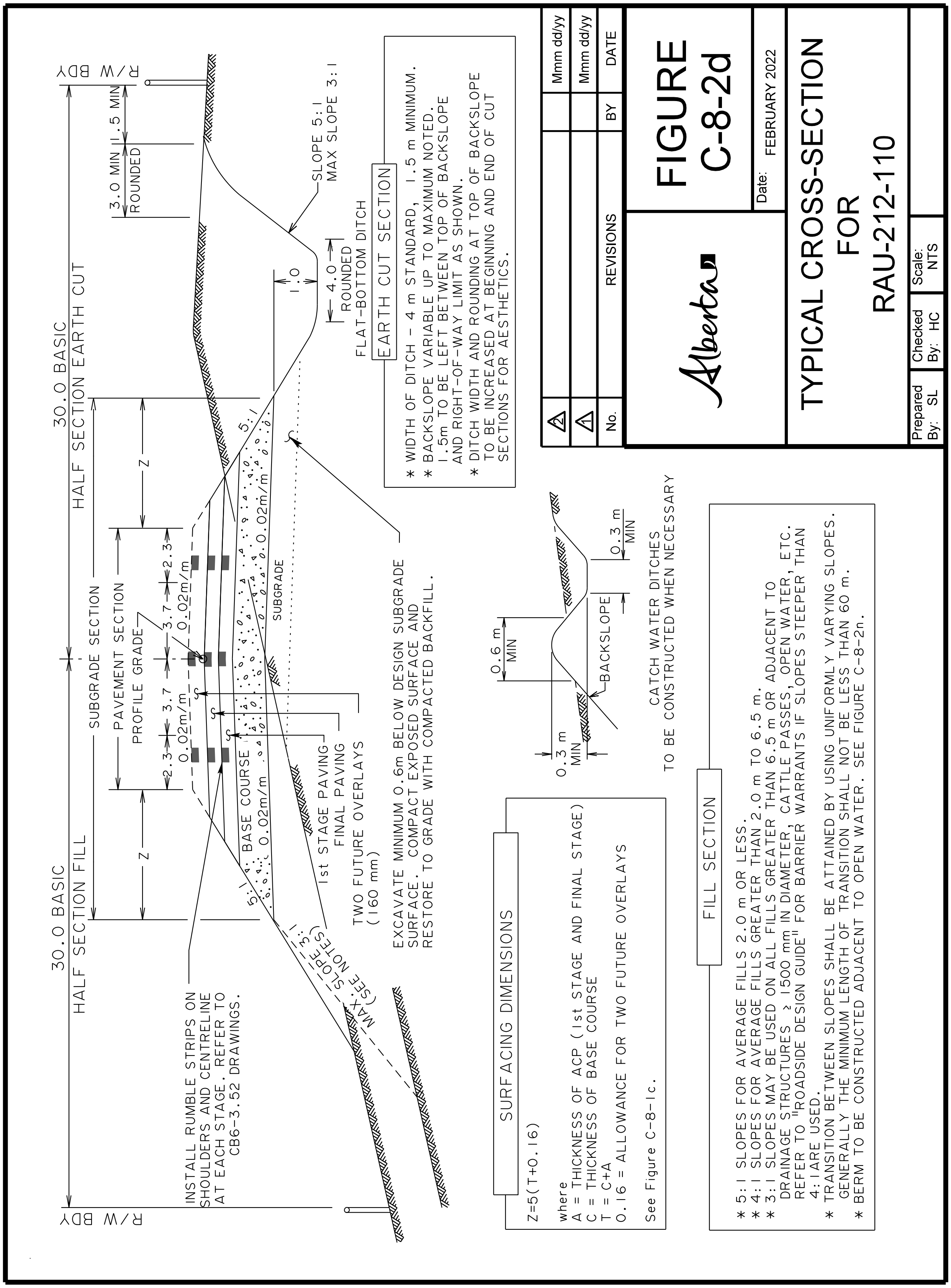


**Figure C-8-2c Typical Cross-section for RAU-212.4-110**



## Figure C-8-2d Typical Cross-section for RAU-212-110



## Figure C-8-2e Typical Cross-section for RAU-211-110

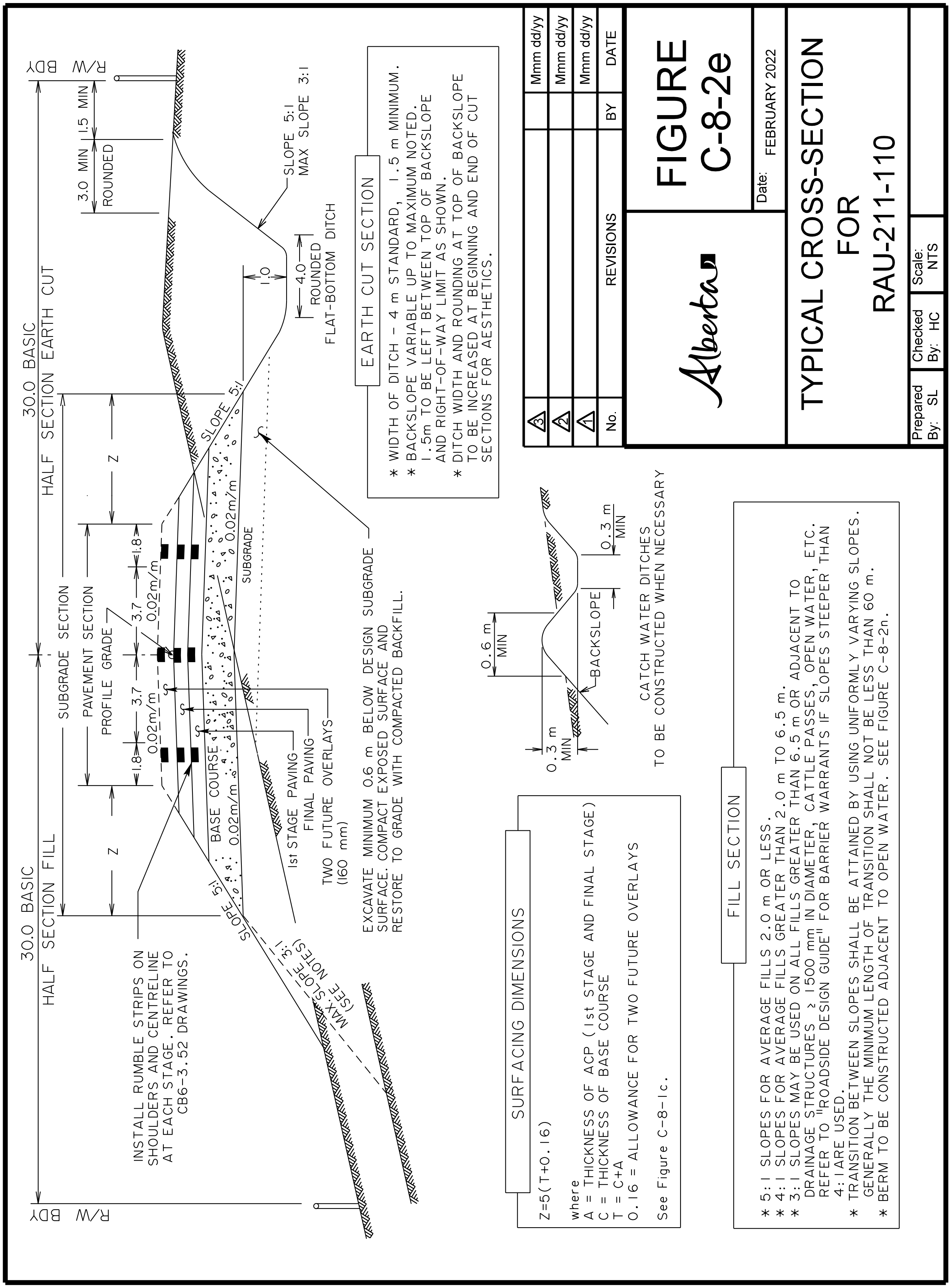
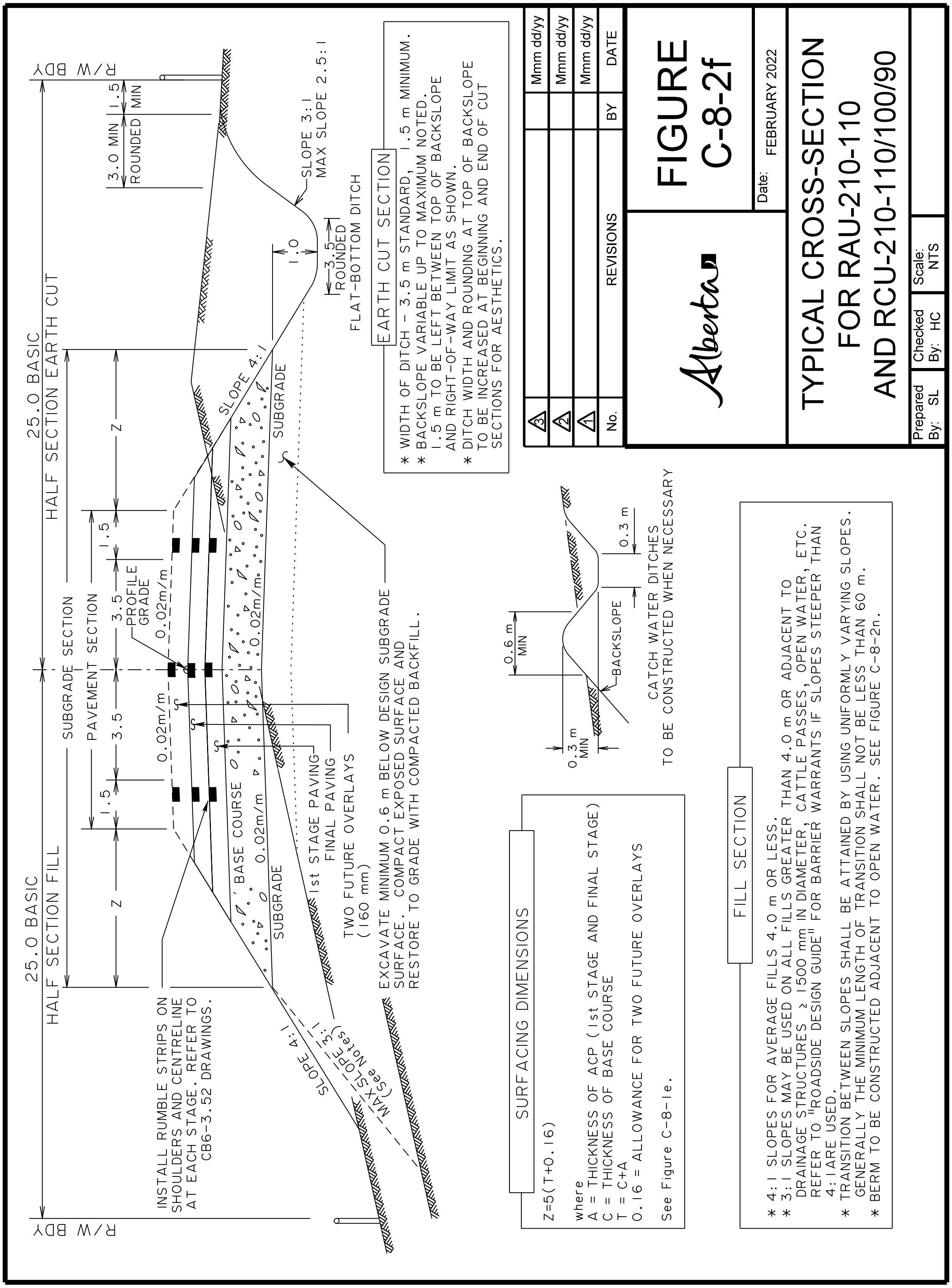


**Figure C-8-2f Typical Cross-section for RAU-210-110 and RCU-210-110/100/90**



## Figure C-8-2g Typical Cross-section for RAU-209-110 and RCU-209-110/100/90

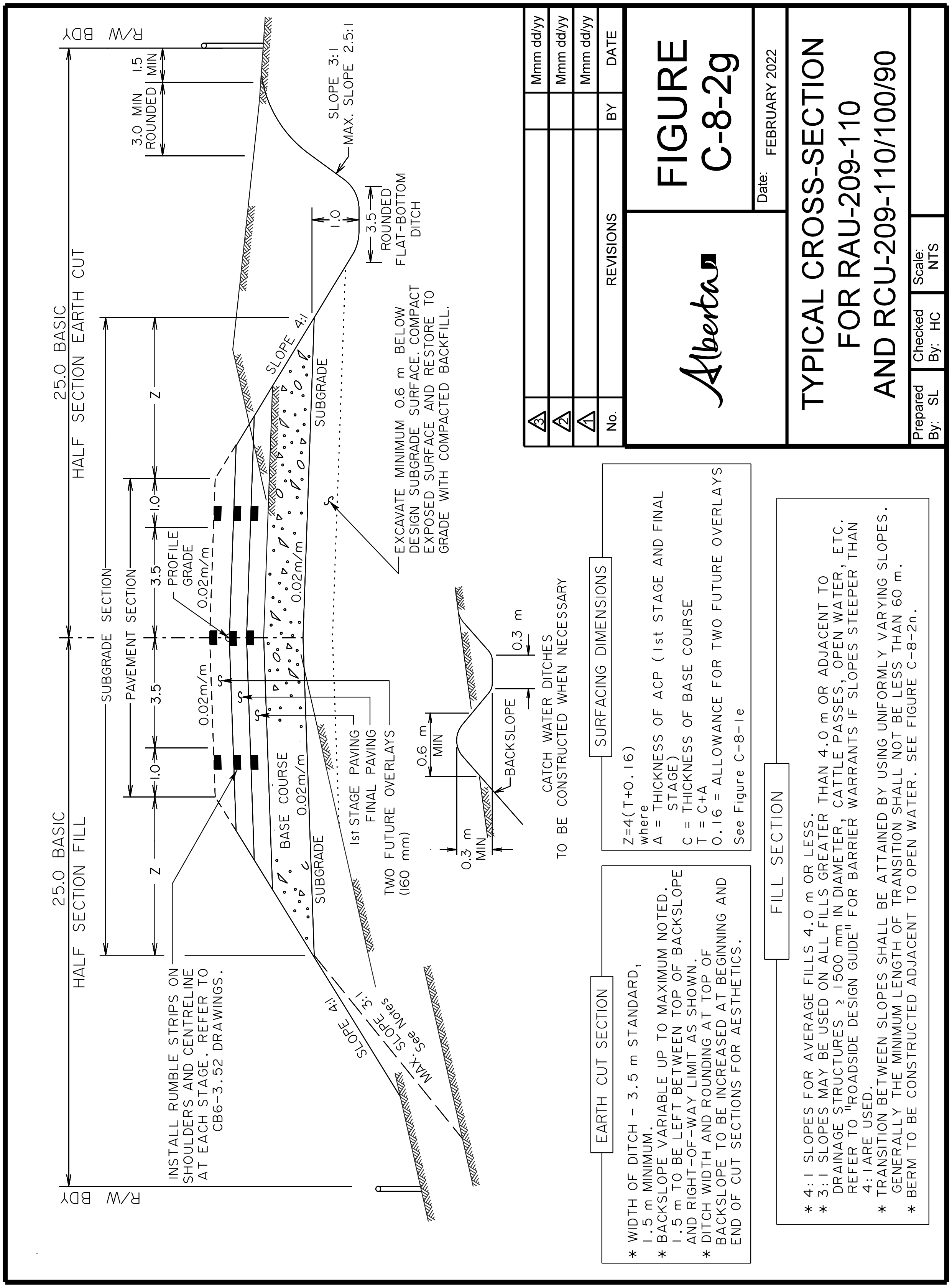


**Figure C-8-2h Left Blank Intentionally**

Figure C-8-2h is not in use.

**Figure C-8-2i Typical Cross-section for RCU-208-110/100/90**

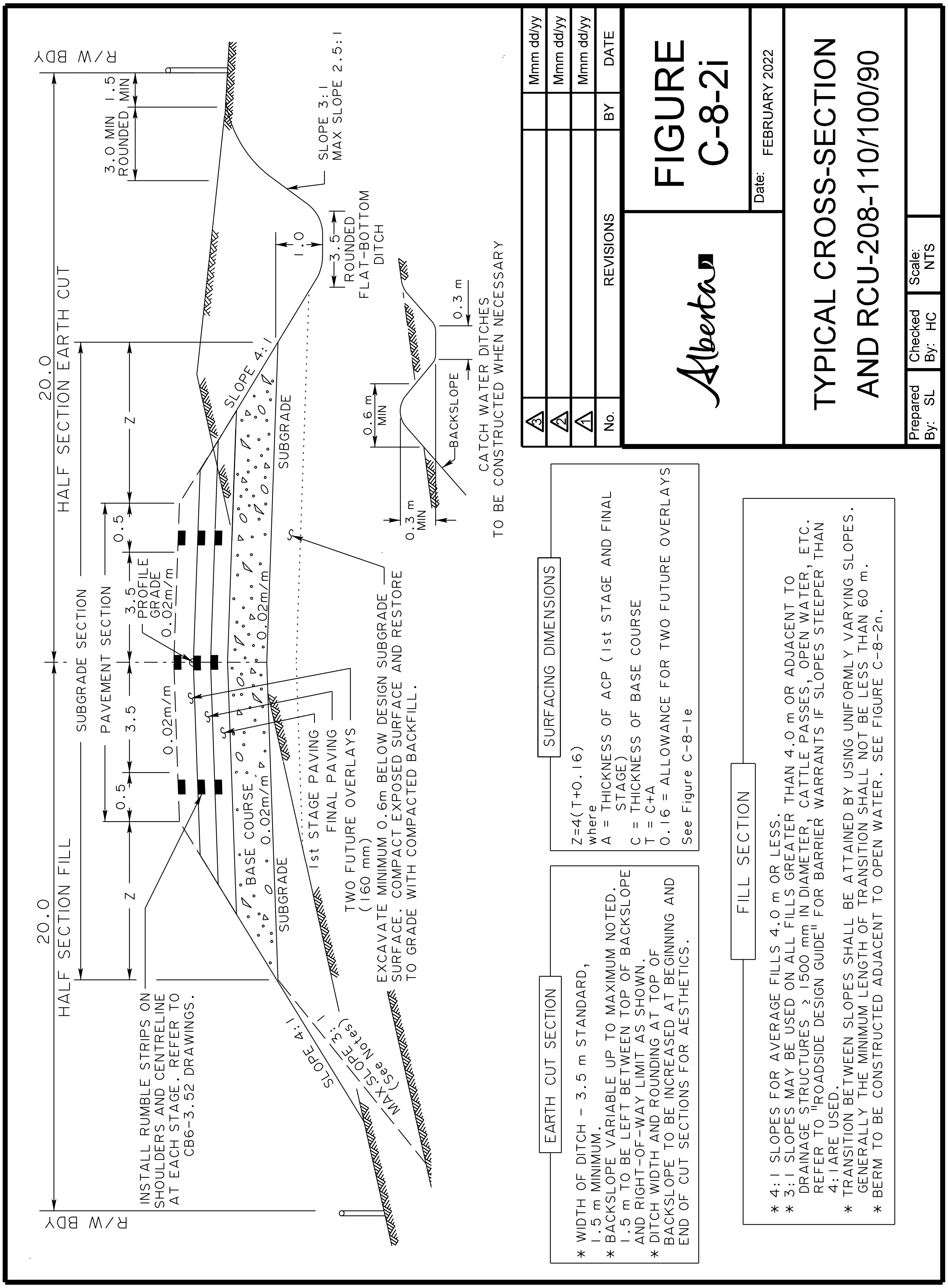


**Figure C-8-2j Typical Cross-section for RLU-210-90, RLU-209-90 and RLU-208-90**

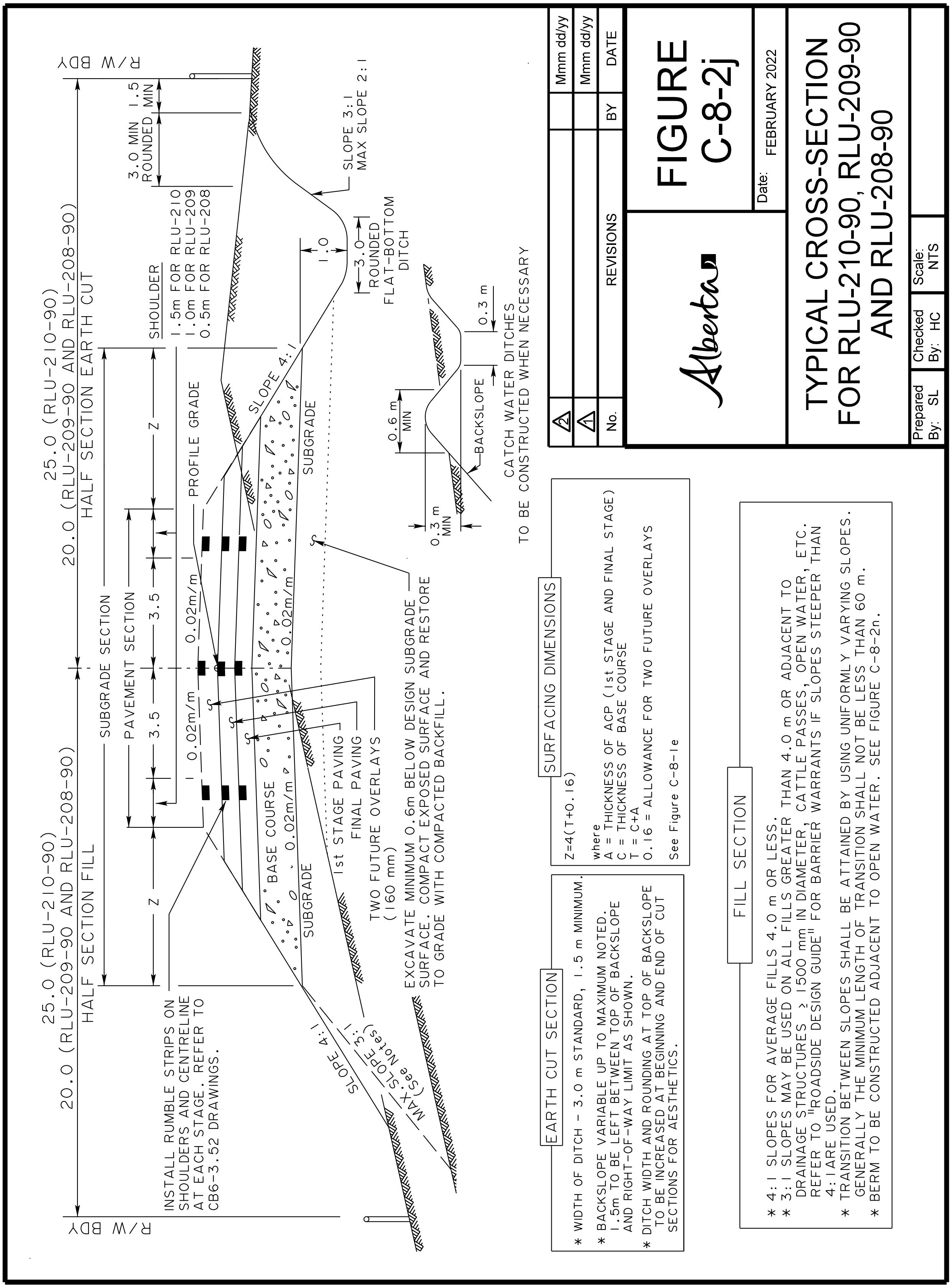


**Figure C-8-2k Typical Cross-section for RLU-208-60 and RLU-207-60**

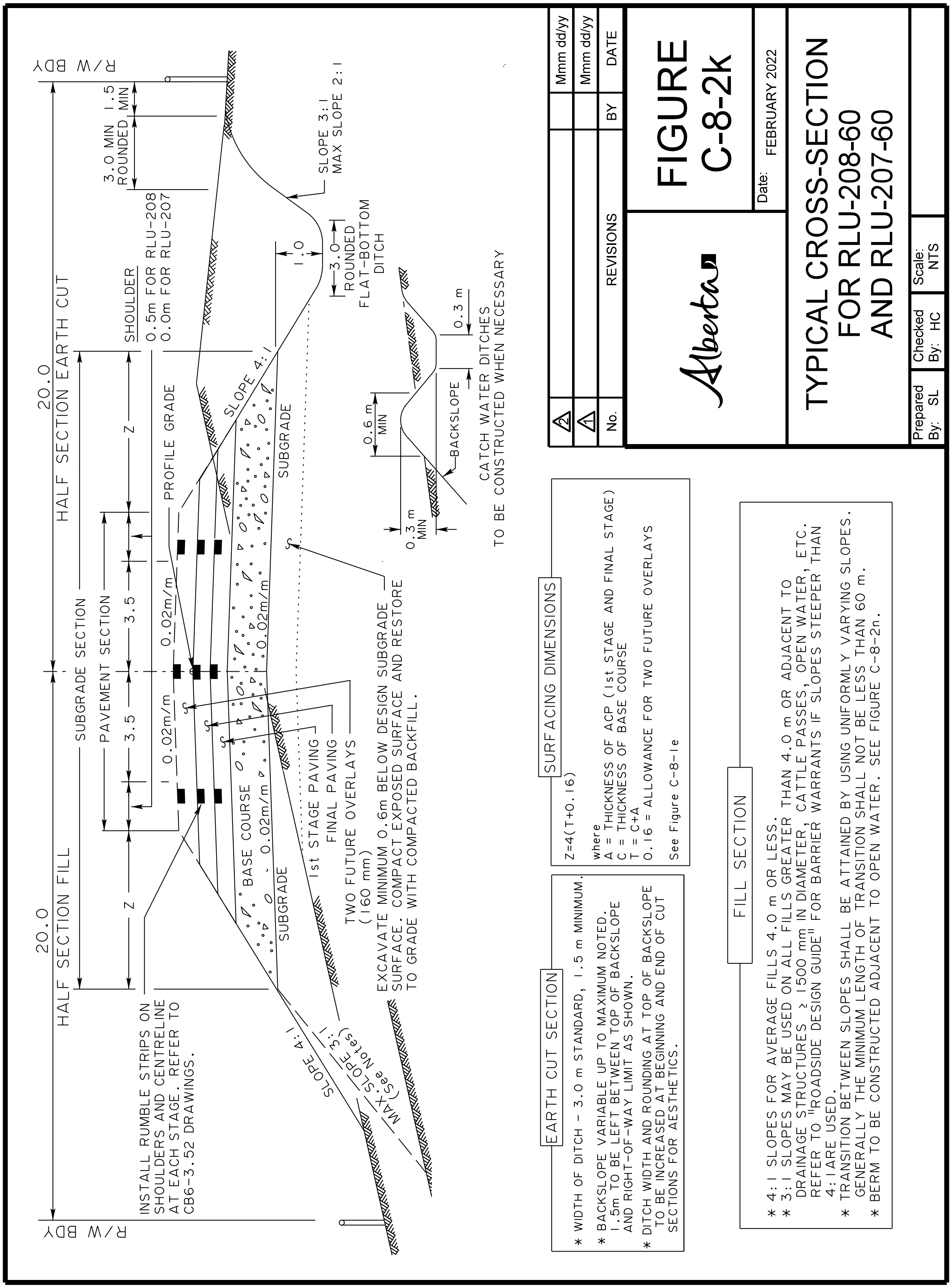


**Figure C-8-2L Typical Cross-section for RCU-211L-90 (Log Haul Road)**

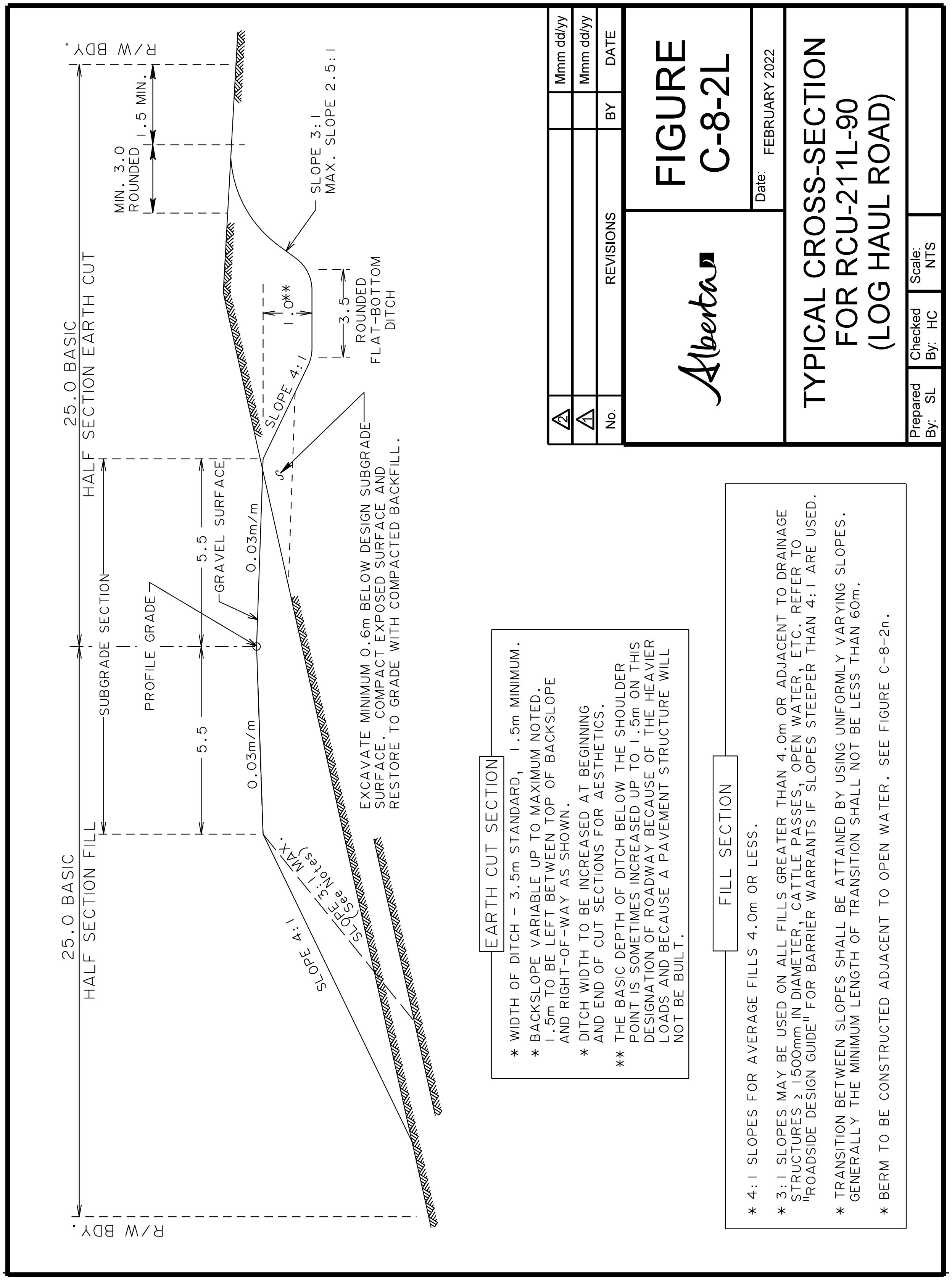
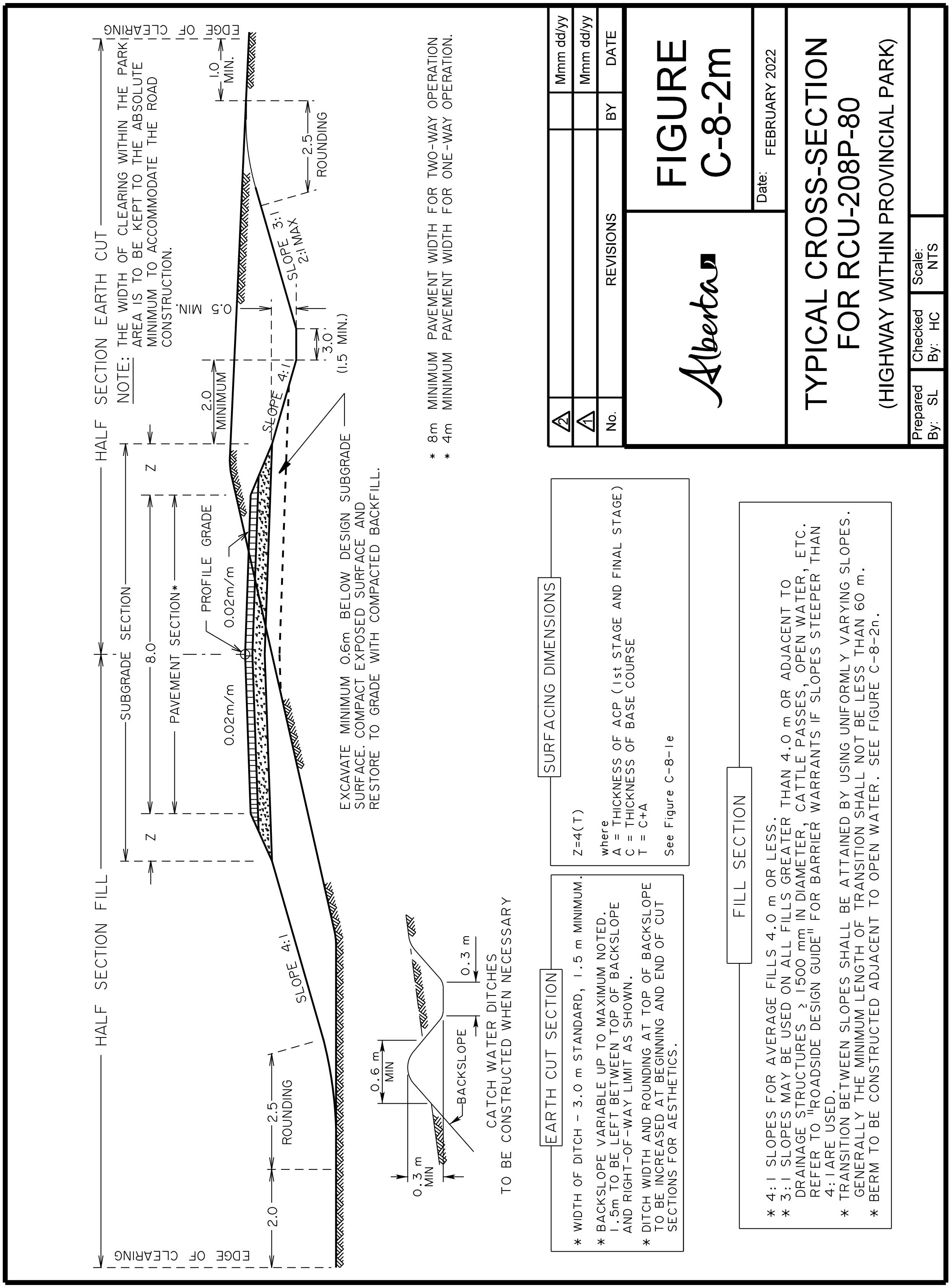
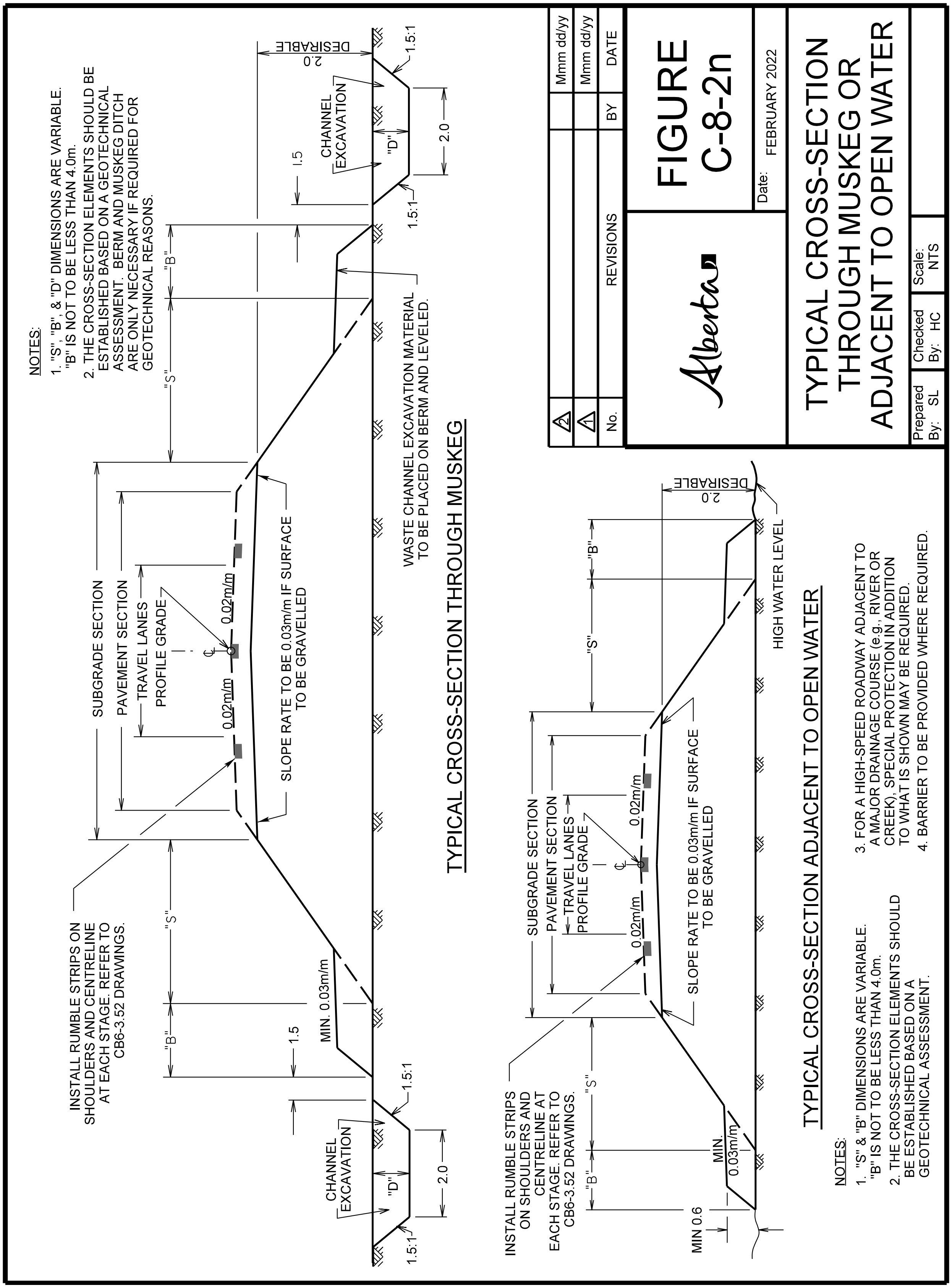


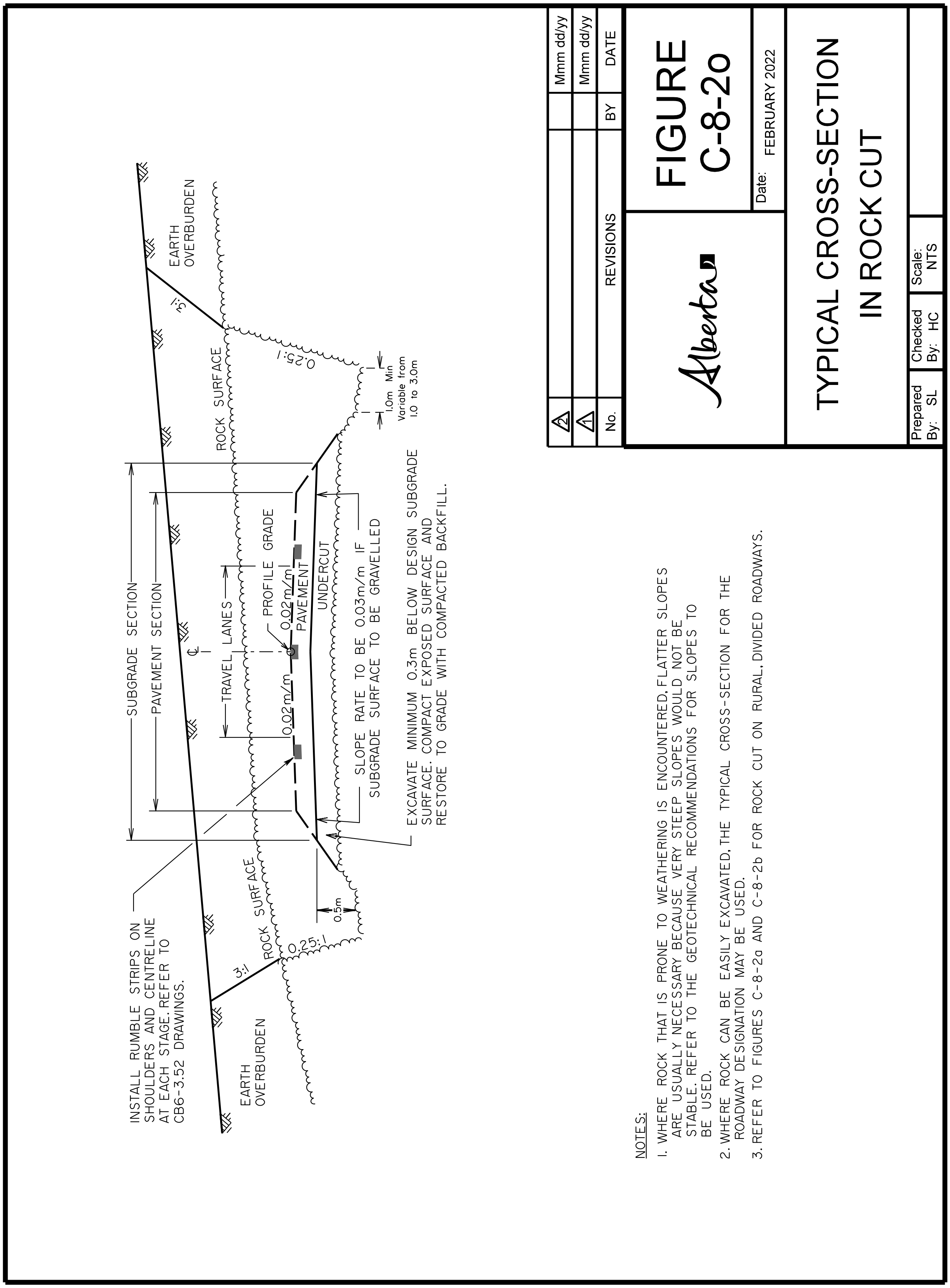
**Figure C-8-2m Typical Cross-section for RCU-208P-80 (Highway within Provincial Park)**



## Figure C-8-2n Typical Cross-section Through Muskeg or Adjacent to Open Water



## Figure C-8-2o Typical Cross-section in Rock Cut



## Figure C-8-2p Typical Cross-section – Modified Subgrade for RAU-210 and RCU-210

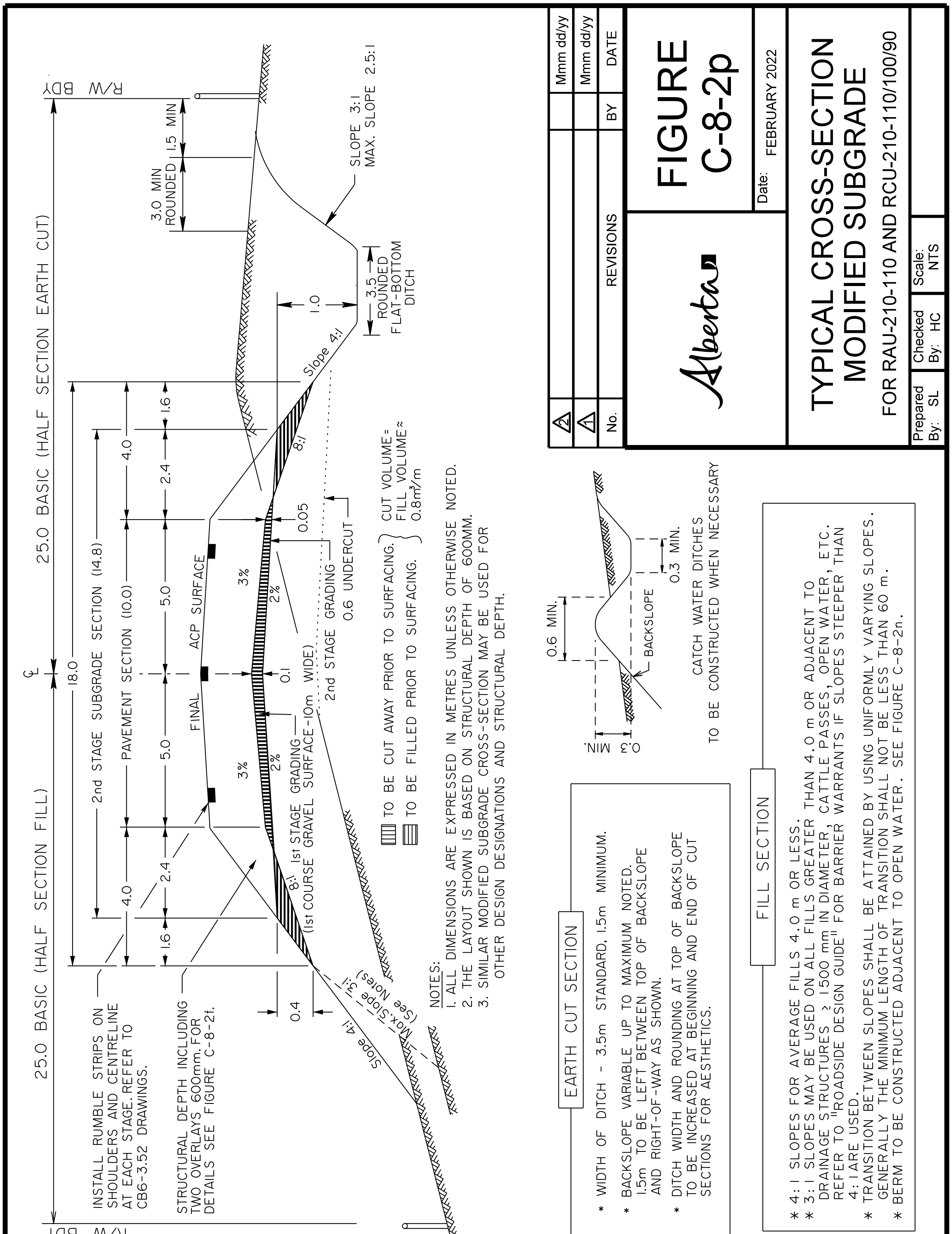
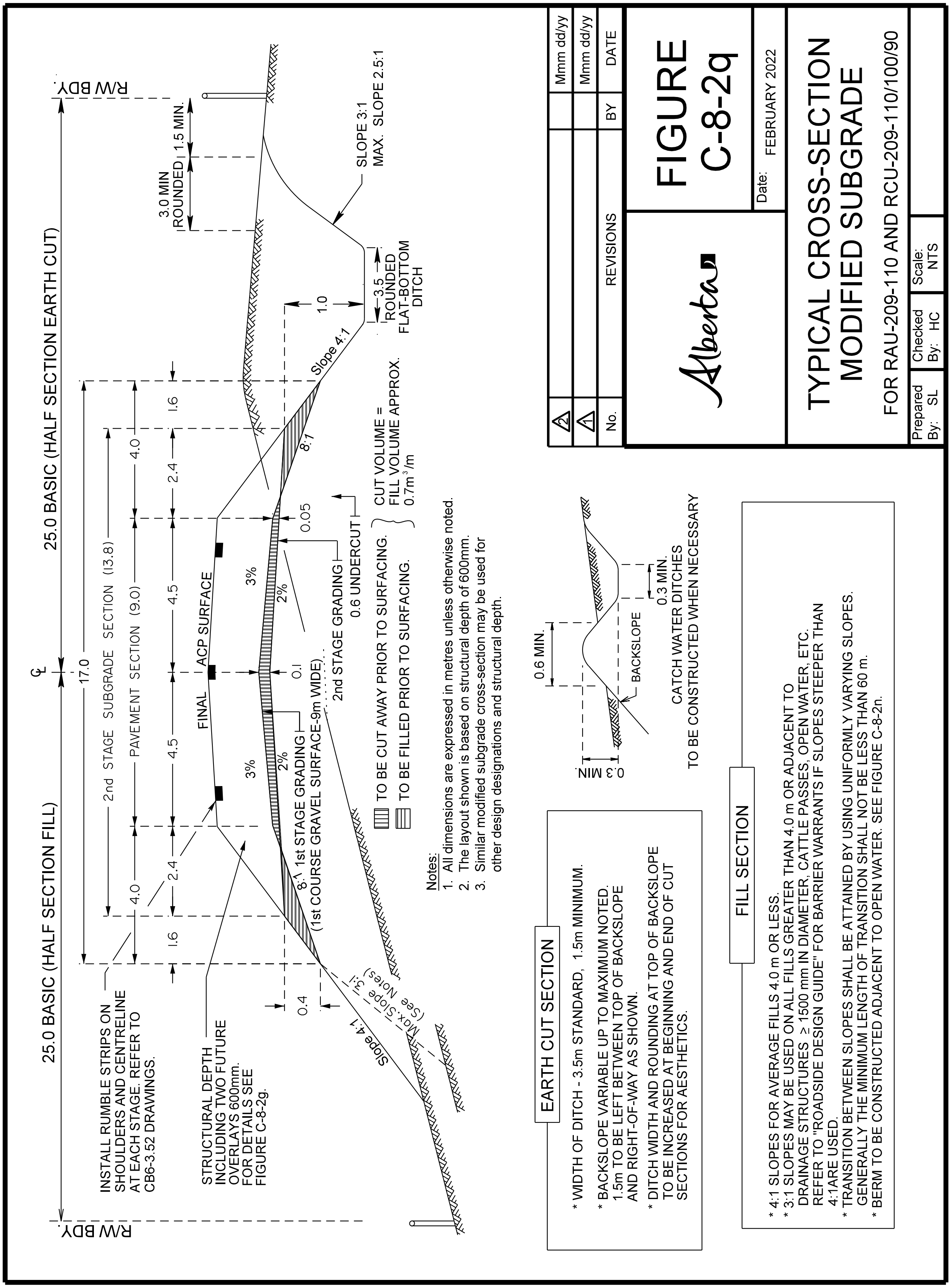


**Figure C-8-2q Typical Cross-section – Modified Subgrade for RAU-209 and RCU-209**



### C.8.2.2 Urban Cross-sections

Figures C-8-2Ua through C-8-2Uc illustrate various typical cross-sections for higher-speed (80 km/h through 110 km/h) urban, multi-lane divided roadways with an open ditch (UED and UFD). These urban freeways and expressways typically have shoulder widths the same as rural divided highways. The cross-sections are designed to allow conversion to six or eight lanes in the future. A shift of crown line may be desirable at the six-lane or eight-lane stage to enhance roadway surface drainage. This may be achieved through cold-milling and overlay. In all cases, consultation with Alberta Transportation is required to determine if the crown shift is acceptable and the manner to achieve the crown shift.

Figures C-8-2Ud through C-8-2Uh show various typical cross-sections for lower-speed (60 km/h through 80 km/h) urban roadways with curb and gutter on both sides of the roadway (ULU, UCU, UAU and UAD). These roadways may initially be built as a rural cross-section and converted to an urban cross-section later, as the need arises.

Provision of shoulder width is not normally considered for urban roads which have curb and gutter. Under certain site-specific conditions, additional pavement width may be provided as an offset from the edge of travel lane to the gutter lip. This offset is chosen based on allowance/prohibition of parking (see Section C.2.1, Parking Lane Width) and whether vulnerable road users such as cyclists are being accommodated.

For new, urban, arterial, divided construction projects where the design speed is less than 80 km/h (UAD-408-70 and UAD-611.7-70), a wider right-hand curb lane may be used to accommodate motor vehicles and cyclists operating side-by-side. The width of the shared lane is typically 4.3 m minimum. If there is a demonstrated need (i.e., the number of potential cyclists is relatively high) and where there is adequate width, a delineated bike lane (typically 1.8 to 2.1 metres wide) may be considered. If the design speed is 80 km/h or greater, cyclists must be accommodated on a separate bike path or shared multi-use path (UAD-407.4-80 and UAD-611.1-80). Refer to Figures C-8-2Ug and C-8-2Uh.

The typical width of a bidirectional bike path or a shared multi-use path is 3.00 metres. Refer to Chapter 5 of the 2017 Transportation Association of Canada, "Geometric Design Guide for Canadian Roads" [11].

The boulevard and sidewalk width and location, as well as the location of trees, signal poles, illumination poles, utilities, lights, fire hydrants and other roadside furniture located within the right of way, may vary based on site specifics. The designer should adhere to the clear zone requirements indicated in the Alberta Transportation, "Roadside Design Guide" [4]. Refer also to Section C.7, Safe Accessible Pedestrian Environments.

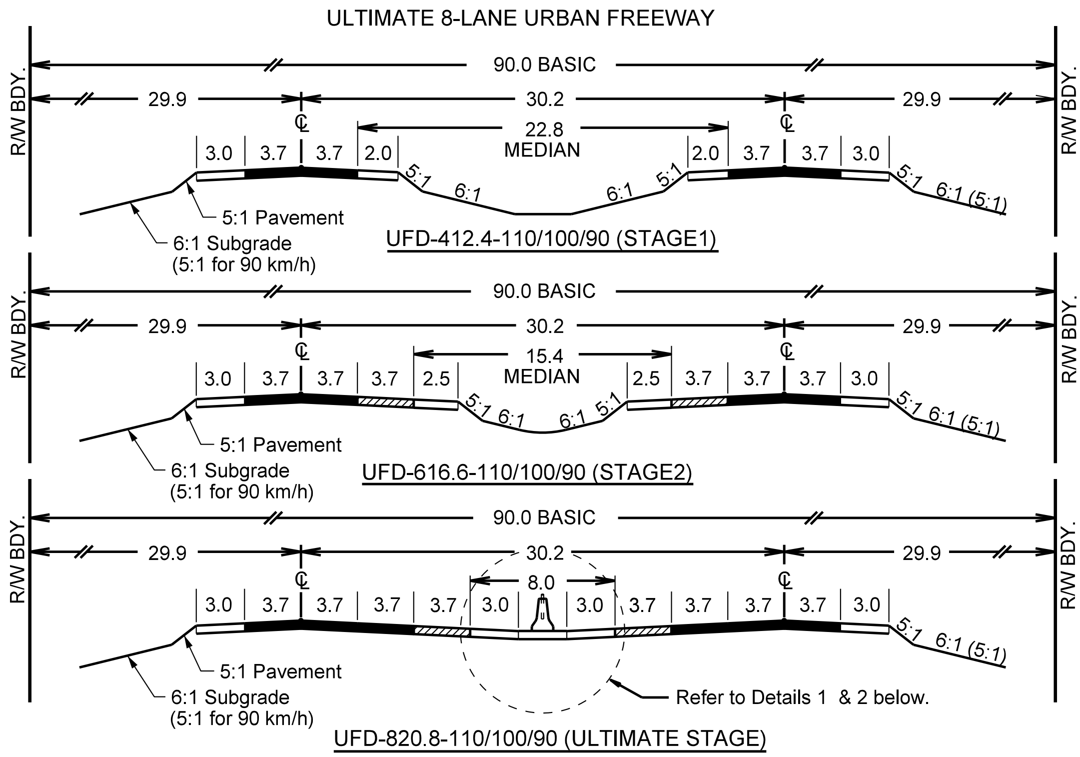
Most urban streets, with the exception of freeways and expressways, accommodate pedestrian traffic through the use of sidewalks or pathways. The typical sidewalk width is 1.80 metres. A wider sidewalk may be warranted depending on the need to accommodate the requirements of expected users (e.g., high pedestrian use, cyclists, people with disabilities). Sidewalks may be placed adjacent to the highway, with a boulevard, when the design speed is less than or equal to 80 km/h. Where the design speed is less than or equal to 70 km/h and where a barrier curb and illumination exists, the sidewalk may be placed adjacent to the highway without a boulevard or landscaped separation. Refer to Standard Drawing CB6-4.2M88 [7].

Use of semi-mountable or mountable curb is required when the design speed exceeds 70 km/h. Refer to the Alberta Transportation, "Roadside Design Guide" [4] and Section C.7.2, Curb and Gutter, for more information.

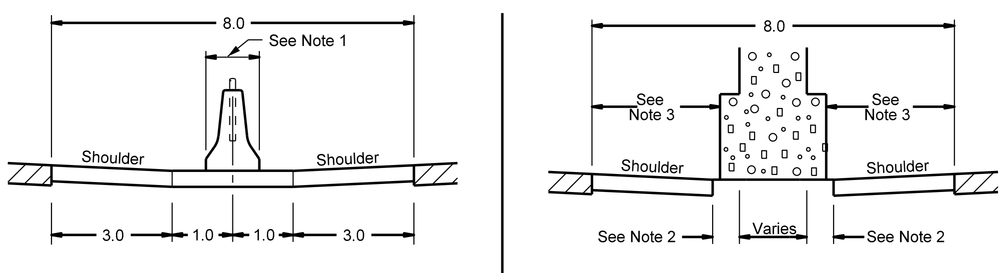
For type of light pole base (breakaway or non-breakaway), refer to the Alberta Transportation, "Roadside Design Guide" [4] and "Highway Lighting Guide" [15].

The designer is required to use the design pavement structure, and the geometric information contained in these typical cross-sections, to develop project-specific cross-sections that are included in the contract/tender documents. Refer to Section C.8.1.2 regarding the accommodation of two future overlays.

## Figure C-8-2Ua Typical Urban Cross-sections for UFD-412.4, UFD-616.6 and UFD-820.8




NOTES:
1. Refer to Section C.8.1.2 for pavement details.
2. Refer to Figure C-8-2b for sideslope, ditch and backslope details. For this 90 km/h design speed, the sideslope is 5:1 (not 6:1) and the backslope is 4:1 (not 5:1).




Detail 1 Flush median with concrete barrier

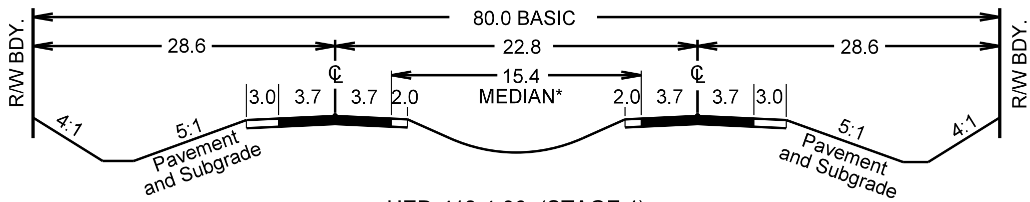
Detail 2 Flush median with pier and concrete barrier

NOTES:
1. F-Shape Barrier is shown. Base width is 670mm. Refer to Standard Drawing CB6-4.3M3. Base width of Single Slope Barrier is 600mm. Refer to Standard Drawing RDG-B6.1. To accommodate median light standard, refer to Standard Drawings RDG-B7.2 and B7.3.
2. Width is 675mm for transition around existing bridge pier. Refer to Standard Drawings RDG-B6.3 and B6.4. Width is 600mm for transition around new bridge pier. Refer to Standard Drawings RDG-B6.5, B6.6 and B6.7.
3. Resultant shoulder width may be narrower than 3.0m depending on the width of the bridge pier and the barrier.

| | | | | |
|---|---|---|---|---|
| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: FS | Date: February 2022 | | Typical Urban Cross-Sections for UFD-412.4, UFD-616.6 and UFD-820.8 | Figure C-8-2ua |
| Checked: HC | Scale: NTS | | | |

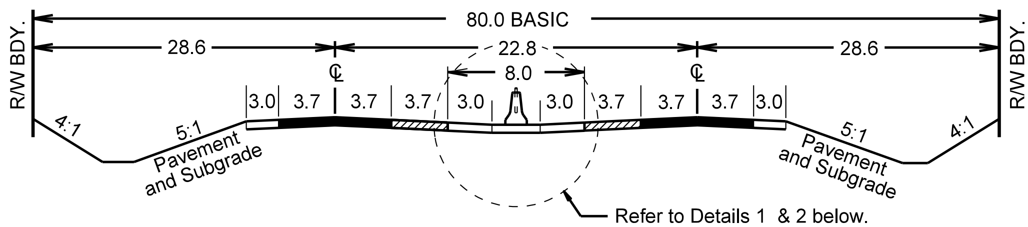
## Figure C-8-2Ub Typical Urban Cross-sections for UED-412.4, UED-617.1 and UFD-617.1

ULTIMATE 6-LANE URBAN FREEWAY OR EXPRESSWAY (DESIGN SPEED 90 km/h)




UED-412.4-90 (STAGE 1)

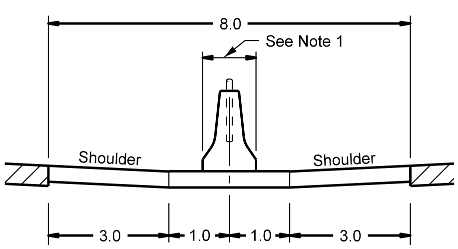
* The stage 1 median will accommodate slotted left turn bays.



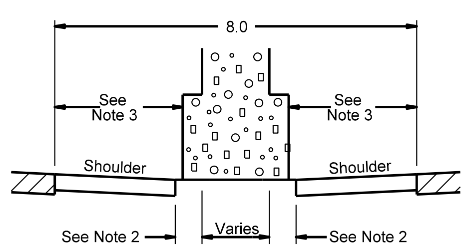

UFD-617.1-90 OR UED-617.1-90 (ULTIMATE STAGE)

NOTES:

1. Refer to Section C.8.1.2 for pavement details.
2. Refer to Figure C-8-2c for sideslope and ditch details. The backslope for these designations is 4:1, not 5:1.




Detail 1 Flush median with concrete barrier




Detail 2 Flush median with pier and concrete barrier

NOTES:

1. F-Shape Barrier is shown. Base width is 670mm. Refer to Standard Drawing CB6-4.3M3. Base width of Single Slope Barrier is 600mm. Refer to Standard Drawing RDG-B6.1. To accommodate median light standard, refer to Standard Drawings RDG-B7.2 and B7.3.
2. Width is 675mm for transition around existing bridge pier. Refer to Standard Drawings RDG-B6.3 and B6.4. Width is 600mm for transition around new bridge pier. Refer to Standard Drawings RDG-B6.5, B6.6 and B6.7.
3. Resultant shoulder width may be narrower than 3.0m depending on the width of the bridge pier and the barrier.

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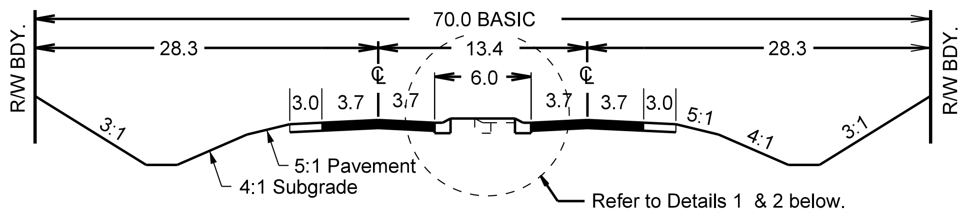
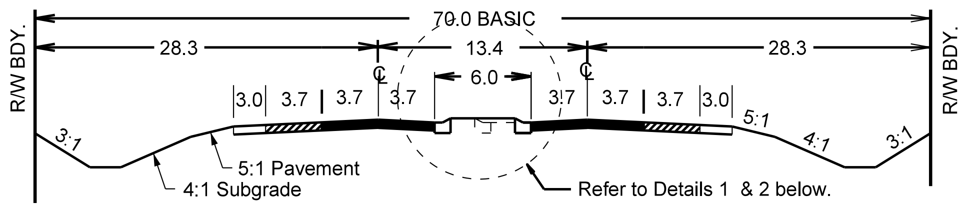
| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: FS | Date: February 2022 | | Typical Urban Cross-Sections for UED-412.4, UED-617.1 and UFD-617.1 | Figure C-8-2ub |
| Checked: HC | Scale: NTS | | | |

## Figure C-8-2Uc Typical Urban Cross-sections for UED-410.4 and UED-614.1

ULTIMATE 6-LANE URBAN EXPRESSWAY (DESIGN SPEED 80 km/h)

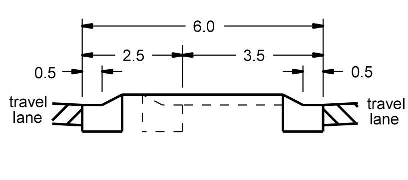



UED-410.4-80 (STAGE 1)

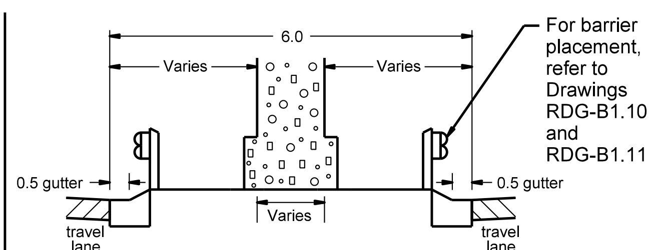



UED-614.1-80 (ULTIMATE STAGE)

NOTES:
1. Refer to Section C.8.1.2 for pavement details.
2. Refer to Figure C-8-2f for sideslope, ditch and backslope details.




Detail 1 Raised median with parallel left-turn lane




Detail 2 Raised median with pier and W-Beam barrier

NOTES:
1. Where the design speed exceeds 70 km/h, curbs are mountable or semi-mountable.
2. Where the design speed is 70 km/h or less, barrier curb may be used.

| | | | | |
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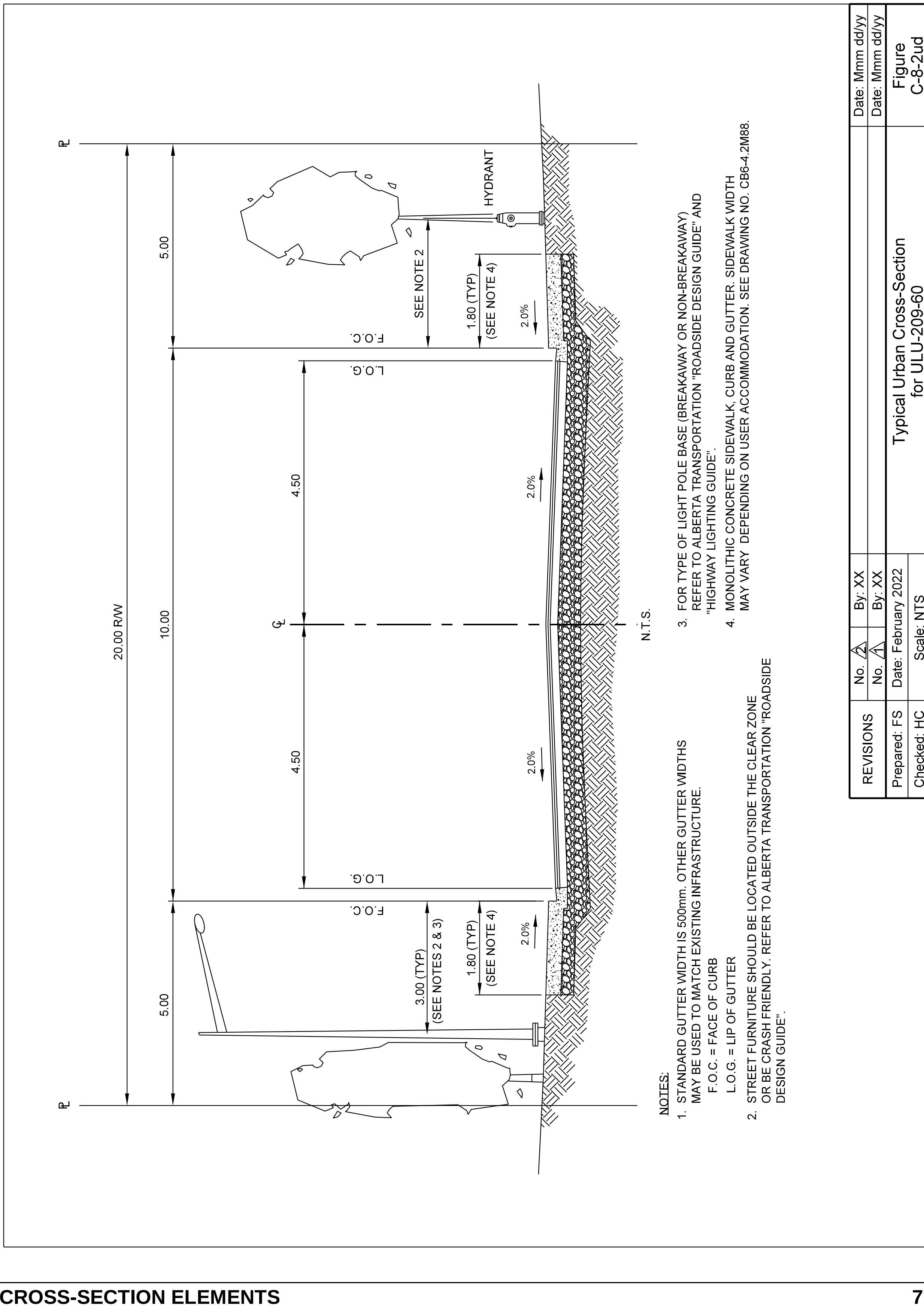
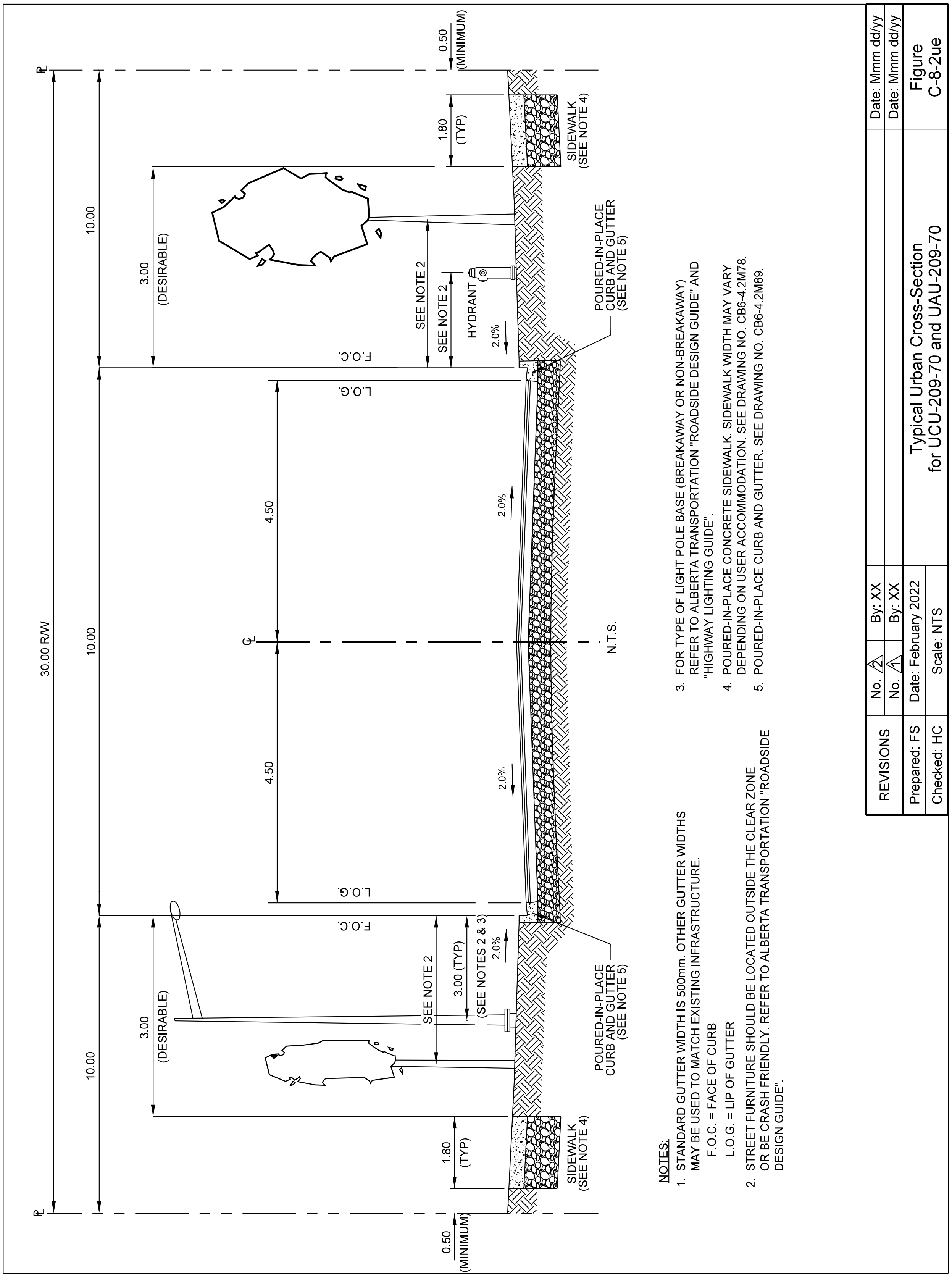
| REVISIONS | No. 2 | By: XX | | Date: Mmm dd/yy |
| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: FS | Date: February 2022 | | Typical Urban Cross-Sections for UED-410.4 and UED-614.1 | Figure C-8-2uc |
| Checked: HC | Scale: NTS | | | |

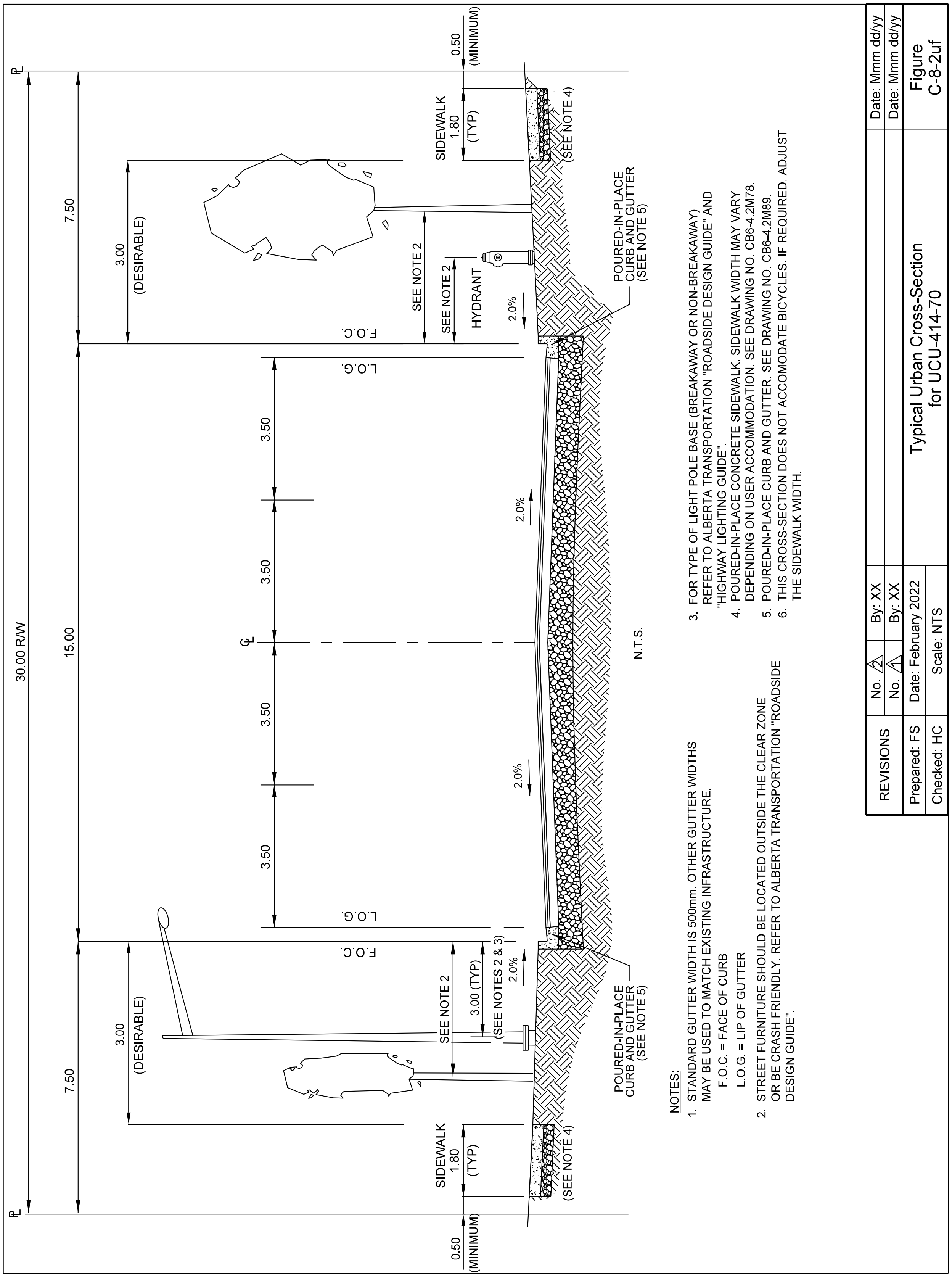
## Figure C-8-2Ud Typical Urban Cross-section for ULU-209-60



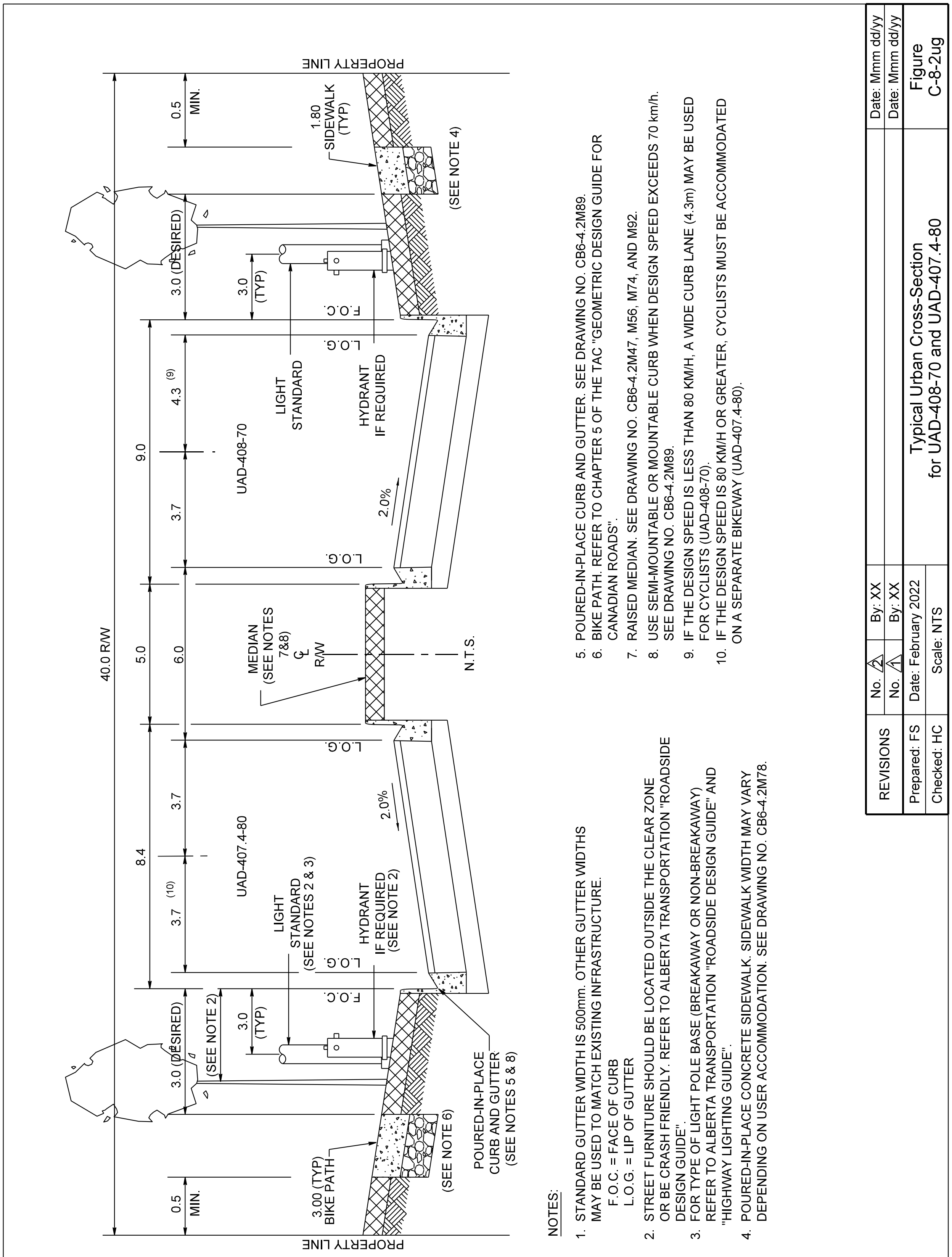
## Figure C-8-2Ue Typical Urban Cross-section for UCU-209-70 and UAU-209-70



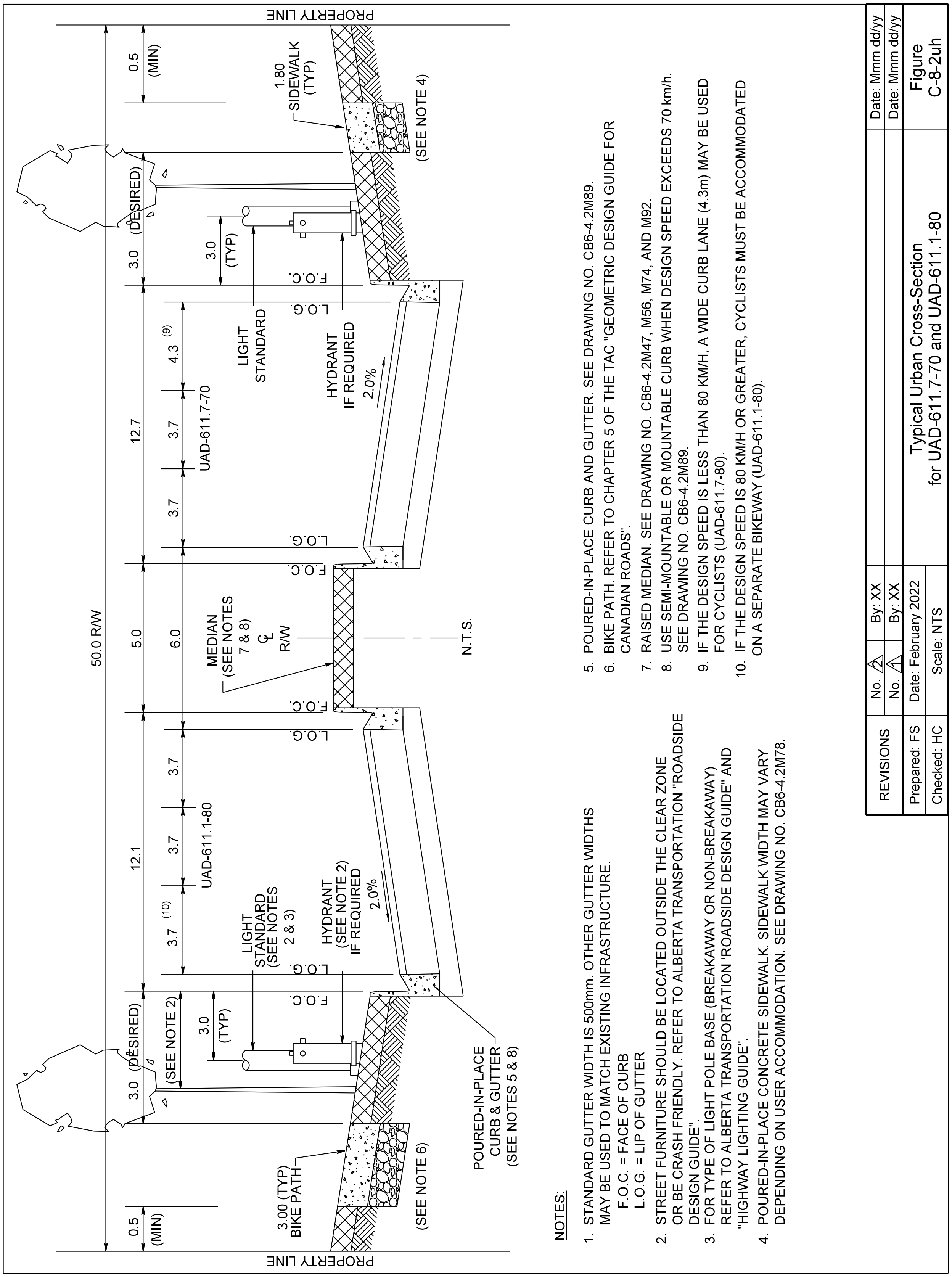
## Figure C-8-2Uf Typical Cross-section for UCU-414-70



## Figure C-8-2Ug Typical Urban Cross-section for UAD-408-70 and UAD 407.4-80



## Figure C-8-2Uh Typical Urban Cross-section for UAD-611.7-70 and UAD 611.1-80



# C.9 RAILWAY CROSSINGS

## C.9.1 General

When a railway intersects with a roadway, the crossing can either take the form of an at-grade crossing or a grade-separated crossing. At-grade crossings are covered in Section C.9.2 and grade-separated crossings are in Section C.9.3. Encroachment and drainage on railway property is in Section C.9.4.

## C.9.2 Railway At-Grade Crossings

### C.9.2.1 Introduction

The construction of a new railway at-grade crossing, or any modification of an existing one, requires a formal application to, and approval by, the Canadian Transportation Agency.

In November 2014, Transport Canada introduced the "Grade Crossings Regulations" [19] with the objective to increase safety at all federally regulated grade crossings by achieving consistency with respect to grade crossing design and maintenance. The "Grade Crossings Regulations" are expected to ensure that all new and existing grade crossings will meet required safety standards. They provide clarification of the roles and responsibilities of railway companies and road authorities regarding the design, construction and maintenance of crossing surfaces; sightlines; signs and traffic control devices; and the installation, inspection, testing and maintenance of grade crossing warning systems.

In January 2019, Transport Canada incorporated the "Grade Crossings Standards" [20] into the "Grade Crossings Regulations" [19]. Railway companies and road authorities are required to comply with all of the "Grade Crossings Standards" when constructing new grade crossings. In the event of a change at a grade crossing, railway companies and road authorities are required to comply with the "Grade Crossings Standards" safety standards that are applicable to that change.

The Forward of the Transport Canada, "Grade Crossing – Handbook" (October 30, 2019) [21] indicates in part:

> "This document is developed to provide guidance on the engineering best practices and requirements for safety at or around grade crossings, and is to be used as a complement to the requirements found in the *Grade Crossings Regulations*, and … *Grade Crossings Standards* made pursuant to *the Railway Safety Act*. Every party responsible for a road or a railway line involving a grade crossing should consult the legal requirements of these instruments."
>
> "Minimum safety standards are set out for the construction, alteration and maintenance of grade crossings, including the inspection and testing of grade crossing warning systems. It also included minimum safety standards for road approaches and other land adjoining the land on which the railway line is situated insofar as the safety of the grade crossings may be affected."

The "Grade Crossing – Handbook" (including a PDF version) is available at the Transport Canada website [21].

All new crossings must conform to these requirements unless the Minister of Transport for Canada grants an exemption.

The designer is responsible for obtaining approval from the Canadian Transportation Agency to construct or modify at-grade railway crossings.

### C.9.2.2 Roadway Geometry

Refer to the Transport Canada, “Grade Crossing – Handbook” [21] for design details regarding geometry for road approaches at railway crossings. These guidelines are applicable to all new grade crossings and to changes made at existing grade crossings.

The designer is responsible to consult the “Grade Crossing – Handbook” for all pertinent articles. Some applicable articles are:

- Article 5 Crossing Surface;
- Article 6 Road Geometry (Grade Crossings and Road Approaches);
- Article 10 Design Considerations; and
- Article 11 Location of Grade Crossings.

The horizontal and vertical alignment of the approach road and the crossing surface must be smooth and continuous. A smooth, level and continuous surface helps the safe and comfortable crossing by vehicles and cyclists. Horizontal gaps (such as at a flangeway) and the vertical difference between the rail and adjacent surfaces must be minimized.

Refer to Figure C-9-2-2a.

Desirably, the roadway should intersect the tracks at a right angle with no nearby intersections or driveways. This layout enhances the driver’s view of the crossing and tracks, and reduces conflicting vehicle movements from crossroads and driveways. When a grade crossing is not a 90-degree intersection, the problems caused by vertical differences between the railway and the crossing surface may be amplified. Skewed-angle grade crossings also increase the likelihood of cyclists losing control of their bicycles. On Alberta Transportation projects, the angle of crossing should not be less than 75 degrees. In no case may the angle of crossing be less than 70 degrees unless the crossing has a warning system.

Preferably, crossings should not be located on either roadway curves or railway curves. Roadway curvature may inhibit a driver’s view of the crossing ahead or a driver's attention may be directed toward negotiating the curve rather than looking for a train. Railway curvature may inhibit a driver's view along the tracks from both a stopped position at the crossing as well as on the approach to the crossing. In addition to having poor visibility for road traffic, crossings located on both roadway and railway curves may be less smooth for road traffic and present maintenance problems, due to conflicting superelevation.

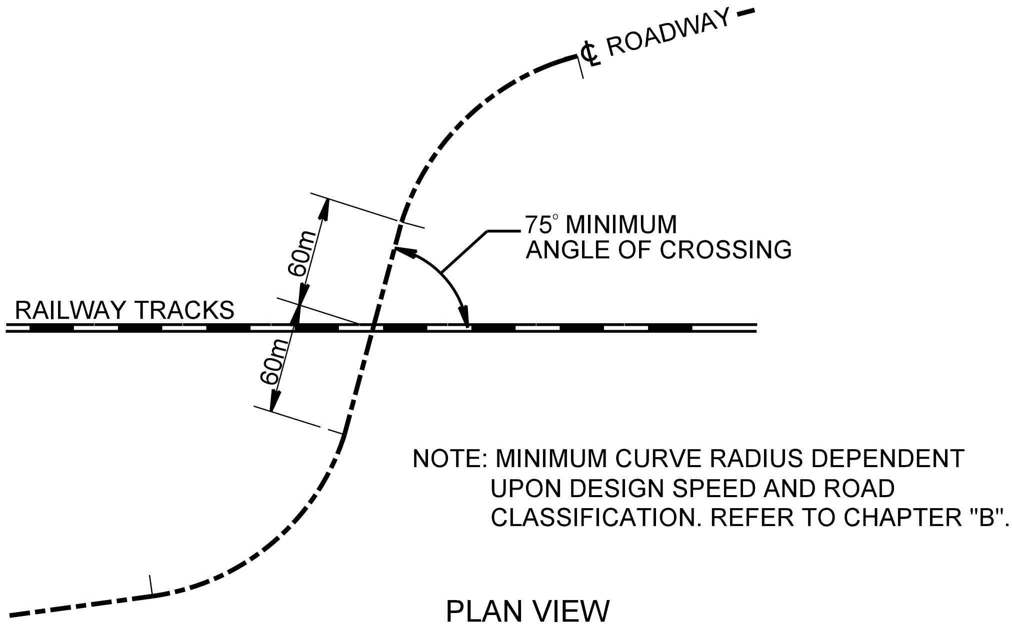
The horizontal alignment should be on tangent for at least 60 metres on each side of the railway crossing. In most cases, this provides sufficient length for the 30-metre tangent runout (the transition between where the adverse crown is removed and the normal crown) as well as length to adjust the cross-slope of the road to meet the grade of the railway. Refer to Chapter B.3.6, Development of Superelevation, for further information.

At the crossing, the grade of the highway is to match the cross-slope of the railway tracks as closely as possible. If the railway is on tangent (so both rails are at the same elevation due to no superelevation) it is desirable to provide a level portion of roadway for nine metres on each side of the center of the crossing (assuming a single rail line). Departure from this practice might cause vehicle occupants to experience discomfort. Such discomfort, however, should not be objectionable if the values shown in Table 1 of Figure C-9-2-2a are met. Table 1 is from the “Grade Crossing – Handbook” and indicates the allowable difference between the road approach gradient and railway cross-slope, or the railway gradient and the road approach cross-slope. Table 1 does not include the ECD or RCD classifications because Alberta Transportation does not use those classifications. The UED classification has been added to the table.

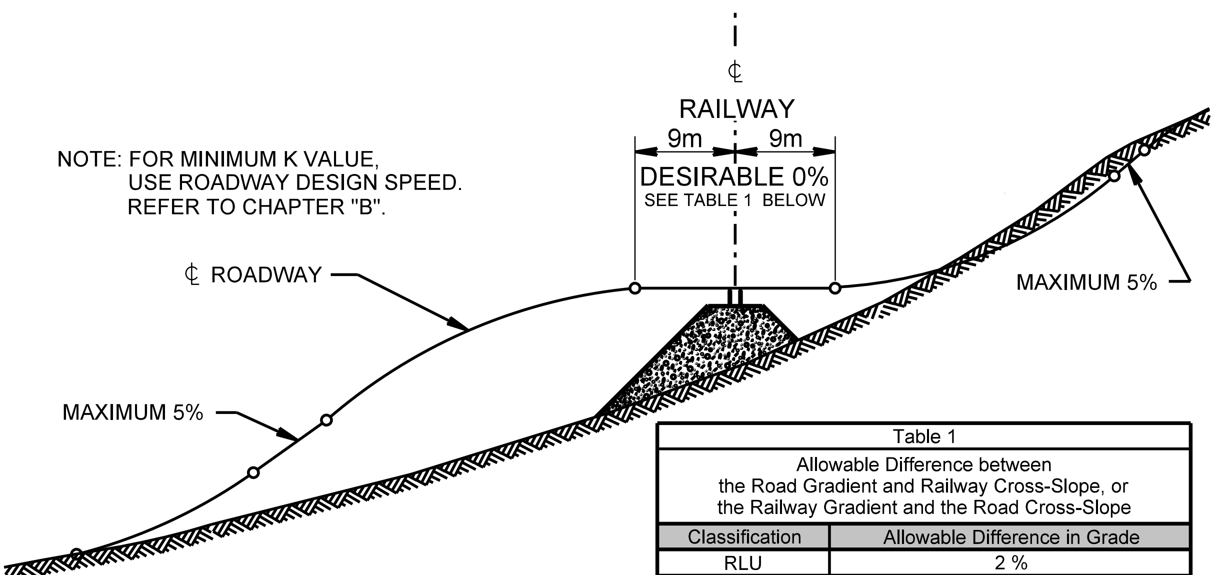
The K value for the vertical curves on the approaches to the crossing are selected based on the roadway design speed. As indicated in Figure C-9-2-2a, the maximum approach grade to a public crossing should be no greater than five percent.

Notwithstanding the above, the "Grade Crossing – Handbook" indicates the maximum grade for road approaches "must not exceed a ratio of 1:50 (2 per cent) within 8 m of the nearest rail and 1:20 (5 per cent) for 10 m beyond, at public grade crossings for vehicular use."

**Figure C-9-2-2a Railway Crossings – Horizontal Alignment and Profile Requirements**




PLAN VIEW
(DESIRABLE TANGENT AND MINIMUM ANGLE OF CROSSING)




ROADWAY PROFILE
ACROSS RAILWAY

Table 1
Allowable Difference between the Road Gradient and Railway Cross-Slope, or the Railway Gradient and the Road Cross-Slope

| Classification | Allowable Difference in Grade |
|---|---|
| RLU | 2 % |
| RCU | 1 % |
| RAU | 0 % |
| RAD | 0 % |
| RFD | No at-grade crossing allowed |
| ULU | 3 % |
| UCU | 2 % |
| UAU | 0 % |
| UAD | 0 % |
| UED | 0 % |
| UFD | No at-grade crossing allowed |

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| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Railway Crossings<br>Horizontal Alignment and Profile Requirements | Figure<br>C-9-2-2a |
| Checked: HC | Scale: NTS | | | |

### C.9.2.3 Sightline Requirements at Grade Crossings

Sightlines are a primary consideration at railway crossings. The establishment and maintenance of sightlines at a crossing allows a driver sufficient time to stop the vehicle if a train is approaching.

Refer to the Transport Canada, "Grade Crossing – Handbook" [21] for details regarding sightlines at grade crossings.

The designer is responsible to consult the "Grade Crossing – Handbook" for all pertinent articles. Some applicable articles are:

- Article 7 Sightlines;
- Article 10 Design Considerations; and
- Appendix E Guideline for Determining Minimum Sightlines at Grade Crossings. Appendix E is also available in the form of an online guide, "Determining Minimum Sightlines at Grade Crossings – A Guide for Road Authorities and Railway Companies" [22].

Appendix E "contains advice and technical guidance that stakeholders (road authorities, private authorities and railway companies) need to determine the minimum sightlines required at grade crossings."

The Government of Canada, "Grade Crossings Regulations" [19] and Transport Canada, "Grade Crossings Standards" [20] "require road authorities and railways to establish and maintain sightlines at grade crossings. These sightlines must, at minimum, provide crossing users with enough time to see and react to an oncoming train, from both the 'approach' and 'stop' positions." The sightline requirements are based on the regulations and standards and apply to all public and private grade crossings.

The minimum sightlines must be determined for all four quadrants of the crossing. Crossing users must be able to see an oncoming train from both road directions when approaching the crossing and when in the stopped position. The "Grade Crossing – Handbook" indicates, "sightlines are to be measured from a point 1.05 m above the road surface to a point 1.2 m above top of lowest rail." Providing sightlines that exceed the minimum requirements is encouraged.

In addition to establishing the sightlines, the sightlines must be kept clear to protect the visibility of the railway crossing, warning signs, signals and approaching trains. The highway traffic signs, utility poles and other roadside installations must not obstruct the view of the railway crossing signs, signals and warning systems.

### C.9.2.4 Traffic Control Devices and Warning Systems at Crossings

Transport Canada specifies a number of types of warning systems and traffic control devices at railway grade crossings. Refer to the Transport Canada, "Grade Crossing – Handbook" [21] for details regarding traffic control devices and warning systems at grade crossings.

The designer is responsible to consult the "Grade Crossing – Handbook" for all pertinent articles. Some applicable articles are:

- Article 8 Signs;
- Article 9 Warning Systems Specifications;
- Article 10 Design Considerations;
- Article 11 Location of Grade Crossings;
- Part D Warning System Design – General;
- Part E Interconnected Devices; and
- Part H

The need for at-grade railway crossing traffic control devices (e.g., signs) and warning systems is site-specific and is based on a number of factors outlined in the Transport Canada documents. The articles set out the criteria, specifications, minimum standards and placement for the various types of devices and systems including signs, pavement markings and warning systems (e.g., signal assemblies, gate assemblies and cantilever assemblies).

The placement of signs must not interfere with the visibility of other railway crossing traffic control devices or warning systems.

### C.9.2.5 Cost Sharing for At-Grade Crossing Improvement

Transport Canada often provides subsidies for approved crossing improvement projects, including signal installation and improvements.

The designer should always confirm the cost sharing arrangements for crossing projects at the conceptual design stage.

## C.9.3 Railway Grade-Separated Crossings

Grade separations are required at all railway/freeway crossings. It is also desirable to provide grade-separated crossings at all expressway and arterial highways planned for future upgrading to freeway standards. The warrant for a grade-separated crossing on other highways is to be evaluated individually.

When assessing a grade crossing for grade separation, the crossing should be assessed in the context of the corridor in which it is located. A site-specific study and analysis is also required to establish whether a grade separation is feasible.

Some criteria to consider when assessing a grade crossing for grade separation are:

- Traffic and safety-related criteria (with thresholds) such as the cross-product of the AADT and the average number of trains per day, the posted speed of the roadway; train speed; queuing issues, vehicle delay and level of service on the roadway; and
- Other criteria (without thresholds) include collision history, number of roadway lanes and railway tracks, type of railway traffic and roadway traffic, the roadway service classification and functional classification.

For criteria to consider when assessing grade crossings for grade separation, refer to the Transport Canada website, “Grade Separation Assessment Guidelines” [23].

Refer to the Alberta Transportation, “Bridge Conceptual Design Guidelines” [1] and “Bridge Structures Design Criteria” [14] for further information regarding railway grade separation.

The designer is responsible for obtaining approval from the Canadian Transportation Agency to construct railway grade-separated crossings.

### C.9.3.1 Overpass (Overhead Bridge)

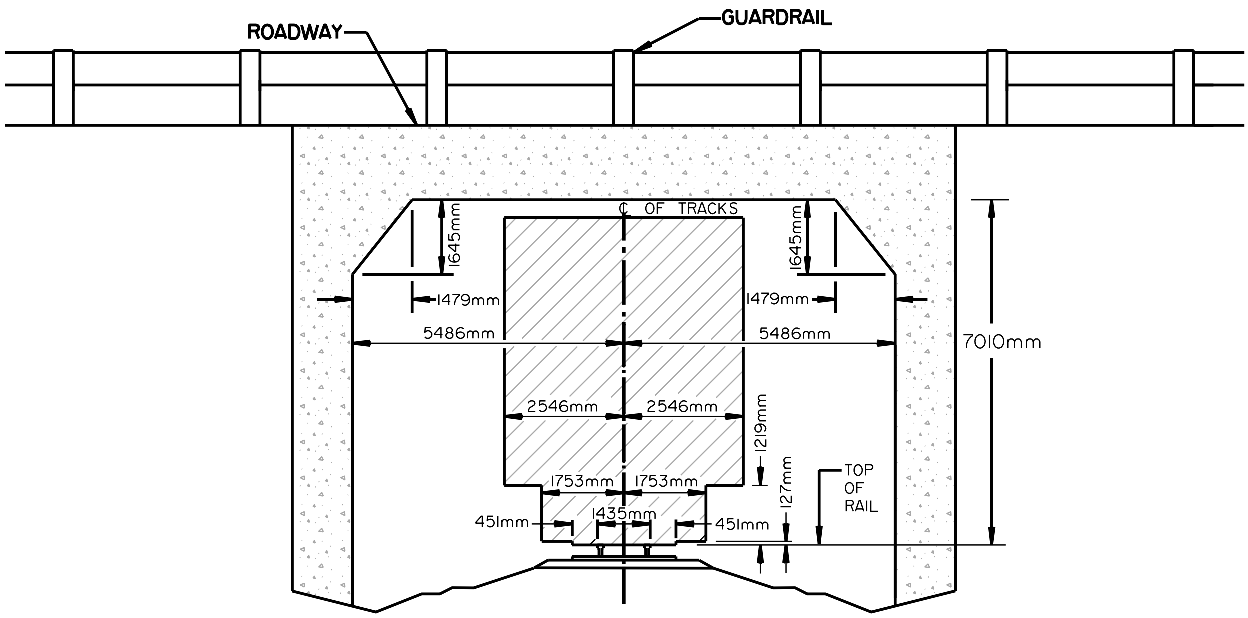
An overpass (overhead bridge) is a grade separation that carries a roadway across and over a railway. The standard clearances for a structure over a railway track are indicated in the Transport Canada, “Standards Respecting Railway Clearances” (May 14, 1992) [24].

Refer to Figure C-9-3-1a for the typical clearance requirements for a railway overpass. The following minimum clearances are to be used in conjunction with roadway design:

- The minimum vertical clearance from the top of the rail to the underside of the superstructure is 7010 mm, plus an additional 50 mm of construction tolerance;
- The critical vertical clearance is established along the outside limit of the horizontal clearance box;
- Unless otherwise authorized, all overpasses shall be designed to allow at least a minimum horizontal clearance of 5486 mm measured from the centreline of the tracks to both sides. The 5486 mm is a maximum dimension used for cost sharing between the roadway authority and the railway company. If either party requests a larger clearance, the additional cost is not shareable;
- Smaller horizontal clearances may be negotiated between the roadway authority and the railway company if required. The absolute minimum horizontal clearance is 2546 mm;
- The combination of the horizontal and vertical clearances form a clearance box. In some special cases, the clearance box may be modified to suit special structures such as tunnels. In some instances, the railway company may request clearances that exceed the minimum requirements. Minimum clearances must also take into consideration the possibility of future additional tracks.

In all cases, each grade separation is treated individually and the actual final vertical and horizontal clearances are to be submitted to Alberta Transportation for review.

**Figure C-9-3-1a Typical Clearance Requirements for a Railway Overpass**




NOTES:

1. 7010 mm and 5486 mm are the standard vertical and horizontal clearance dimensions, respectively, in the "basic grade separation" and apply to cost-share projects. A lateral clearance greater than 5486 mm is normally considered as an additional facility (concerning apportionment of costs). For non cost-share projects, smaller clearances may be negotiated with the railway. 2546 mm is the absolute minimum lateral clearance.

2. Refer to the Canadian Transportation Agency document, "Apportionment of Costs of Grade Separations: A Resource Tool" (November 2011).

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| Prepared: SL | Date: February 2022 | | Typical Clearance Requirements for a Railway Overpass | Figure C-9-3-1a |
| Checked: HC | Scale: NTS | | | |

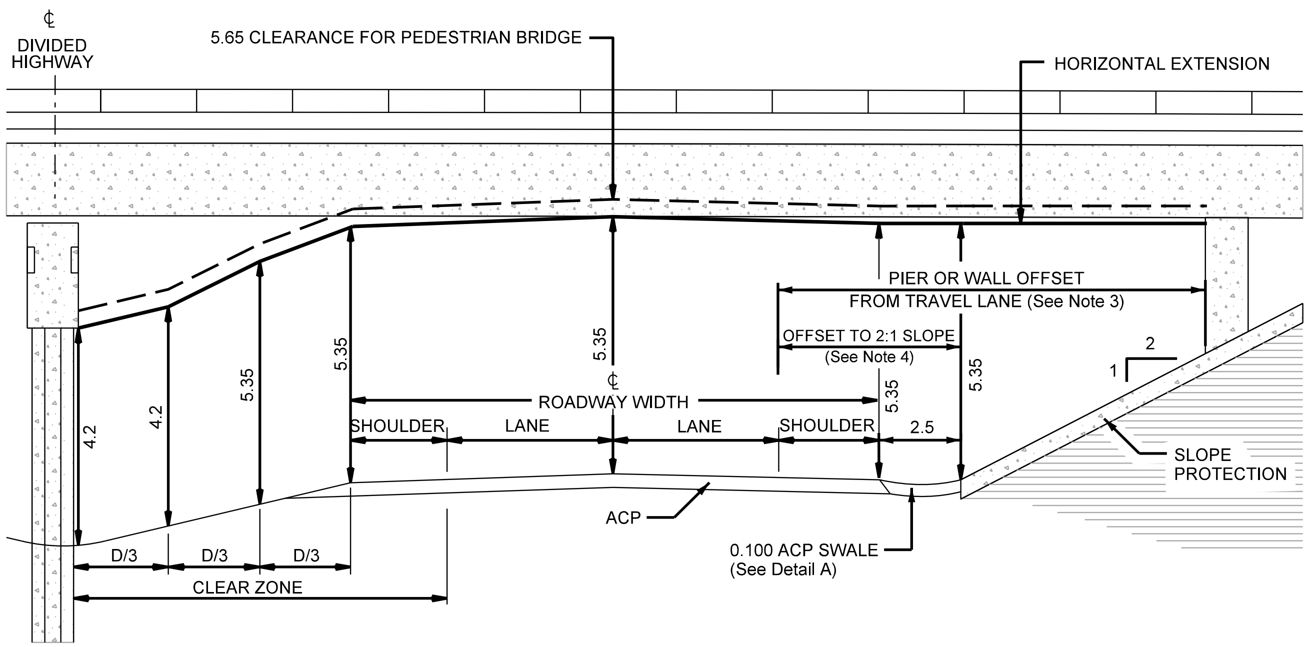
### C.9.3.2 Underpass (Subway)

An underpass (subway) is a grade separation where a roadway passes across and under a railway. The typical clearance requirements, with typical headslope details, for an underpass are shown in Figure C-9-3-2a. The following minimum clearances are to be used where a roadway passes under a railway or another roadway:

- A minimum vertical clearance of 5350 mm, measured from the finished roadway surface to the bottom of the structure, is required for subway structures occurring on highways. When designing the bridge, an additional vertical clearance of 50 mm is added to the required clearance for construction tolerance.
- The vertical clearance requirements on special routes may exceed 5350 mm. For example, on the High Load Corridor, vehicle loads that pass under a bridge may be up to 9.0 metres high and 9.0 metres wide. The clearance box is normally 9500 mm high and 9000 mm wide. Consultation with highway network planners at Alberta Transportation is required to determine if the under-passing road is (or will be) designated as part of the High Load Corridor. The 5350 mm vertical clearance accommodates the permitted load height on Log Haul Routes. Refer to Chapter A.2.5.1, High Load Corridor, and Chapter D.5, Design Vehicles, for more information.
- The standard vertical clearance for a pedestrian bridge is 5650 mm over the roadway surface. For the design vertical clearance, an additional 50 mm is added for construction tolerance.
- Where a sag vertical curve with a low K value is proposed at an underpass, the vertical clearance is to be checked for long-wheelbase truck configurations. Refer to Chapter B.4.4.4, Sight Distance at Underpasses.
- The full highway shoulder width shall be maintained through all subways. Where an auxiliary lane or taper is extended under the structure, the shoulder width, as established preceding the structure, shall be maintained through the subway.
- Alberta Transportation has a policy to maintain the posted vertical clearance of a bridge structure during the lifespan of the structure. A long-life pavement design is often used so future pavement maintenance and rehabilitation can occur without pavement overlay. Pavement maintenance and rehabilitation occurs by milling and replacing the surface layer beneath the bridge structure.
- The minimum horizontal distance from the edge of the finished shoulder to the face of the pier column shall be 2800 mm. This minimum value is normally used only for retrofit projects (e.g., grade-widening or the addition of a lane) or in constrained environments. Barrier protection is required. See Detail B of Figure C-9-3-2a.

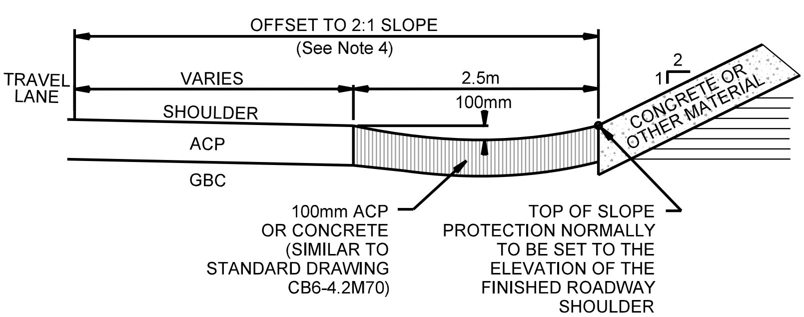
In all cases, each grade separation is treated individually and the actual final vertical and horizontal clearances are to be submitted to Alberta Transportation for review.

## Figure C-9-3-2a Typical Clearance Requirements for an Underpass (Railway or Roadway)

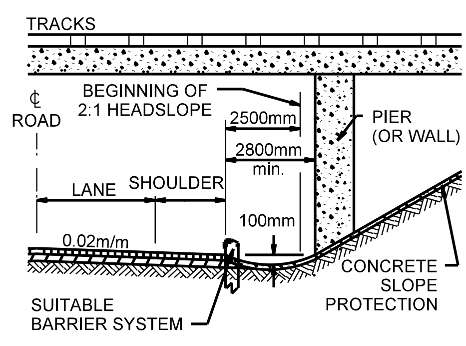



NOTES:

1. Abutment slopes are normally 2:1. Flatter slopes may be used for stability and/or roadside safety.
2. The minimum horizontal distance from the edge of the finished shoulder to the face of the pier column shall be 2800 mm. This minimum value is normally used only for retrofit projects (e.g., grade-widening or addition of a lane) or in constrained environments. Barrier protection is required. See Detail B.
3. On new construction or unconstrained projects, the indicated layout and dimensions in the main drawing are normally used. Barrier protection is required if a pier (including a median pier) or wall is located within the clear zone. Normally the bridge abutment will be located at the top of the headslope, which is outside the clear zone.
4. An unprotected 2:1 backslope within the clear zone is generally acceptable, especially if a suitable offset from the travel lane is provided. A suitable minimum offset for an unprotected 2:1 backslope, for any given speed, is one-half of the clear zone. Refer to Table H3.1, "Clear Zone Distances". Shoulder rumble strips are desirable.
5. D = (Clear Zone - shoulder width).
6. All dimensions in metres, unless otherwise noted.




Detail A - Swale




Detail B - Retrofit or Constrained Location

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| | No. 1 | By: XX | | Date: Mmm dd/yy |
| Prepared: SL | Date: February 2022 | | Typical Clearance Requirements for an Underpass (Railway or Roadway) | Figure C-9-3-2a |
| Checked: HC | Scale: NTS | | | |

### C.9.3.3 Cost Sharing for Grade-Separated Crossings

The Canadian Transportation Agency website, "Agreements: Apportionment of Costs of Grade Separations" [25] indicates how the construction and maintenance costs of a grade separation are apportioned between a road authority and a railway company.

The Canadian Transportation Agency website, "Apportionment of Costs of Grade Separations: A Resource Tool" [26] indicates how the Canadian Transportation Agency is responsible for making cost apportionment decisions when the parties involved in the project are unable to reach an agreement. The Agency uses this tool in its deliberations.

The designer should always confirm the cost sharing arrangements for grade-separation projects at the conceptual design stage.

## C.9.4 Encroachment and Drainage on Railway Property

In cases where the highway is located parallel to the railway and shares a common boundary, it is often necessary and desirable to encroach on the railway property. The encroachment may be required to accommodate large fills or to construct a common ditch for drainage and aesthetic purposes. Special precautions must be taken to ensure that railway ballast is protected from contamination by soil when highway construction work is undertaken immediately adjacent to the railway. Contamination could occur during construction of a common railway-highway ditch.

Prior to any form of construction within the railway right-of-way, it is necessary to request and receive permission from the railway company. The request for permission should provide some details and reasons for the encroachment. It is usually advantageous to support the reasons with sketches and typical cross-sections.

Particular attention must be given to the design of the drainage system in order to maintain the existing, established drainage. Generally, the highway centreline culverts should provide the same capacity as the existing railway facilities. If the railway drainage system must be revised, the necessary plan and profile information (both existing and proposed) should be prepared to show the revision. This information should be prepared during the detailed design so the submission can be made to obtain permission from the railway company.

# C.10 FENCING

## C.10.1 Introduction

Fencing along a highway is a means of preventing unwanted and likely intrusion of animals, people, vehicles, etc. from outside the right-of-way line, or access control line, into the vicinity of moving traffic or onto the operating right-of-way.

The fencing of highway right-of-way is a design consideration on most grading projects that involve a new alignment or upgrading of an existing alignment, which includes acquisition of new right-of-way. A designer requires the following information prior to determining the fencing quantities:

- locations where fencing is required along the right-of-way or elsewhere on the project (e.g., at borrow areas);
- the type of fencing that is required;
- for an existing fence, determine if the position and condition will be satisfactory throughout the design life of the highway;
- the need for gates or temporary openings; and

- who is responsible for the construction cost and maintenance of the fence.

## C.10.2 Requirement for Fencing

The basic purpose of fencing is to prevent farm animals, and possibly some wild animals, from gaining access to the highway right-of-way. The presence of animals in the highway right-of-way is a hazard to the road user, especially in high speed and poor lighting conditions. This condition is also deadly for animals.

The following criteria are used to establish the need to provide fencing on provincial highways. Generally, a fence is constructed as part of a grading project involving widening or a new alignment, where any of the following conditions exist (and subject to a Land Acquisition Agreement):

- there was an existing fence along the original right-of-way;
- the new alignment severs existing fenced enclosures;
- the land use is predominantly for livestock grazing; and
- where fencing is required during construction to protect livestock or people (e.g., at a borrow excavation). In this case, a temporary fence is typically installed. Temporary fencing is the responsibility of the contractor and must be maintained to prevent livestock from straying onto the highway.

All new right-of-way fencing shall connect to existing fences to form an enclosure. Fencing is not required where the land use adjacent to the right-of-way is predominantly grain farming. Similarly, fencing is not necessary along sections of highway that are constructed through undeveloped forested land (which is often owned by the Crown). Through Crown lands that have been leased for cattle grazing purposes, highway right-of-way should be fenced.

The criteria used to establish the need for fencing along municipal roads and roads through Indian Reserves is generally the same as along provincial highways.

## C.10.3 Types and Placement of Fencing

The purpose and type of typical fences are shown in Figure C-10-3a. The installation details of each fence, including corners and gate openings, are included in the Standard Drawings in Section 2.12 of the Alberta Transportation website, “CB6 Highway Standard Plates – Active Drawings” [7].

Fencing is classified as follows:

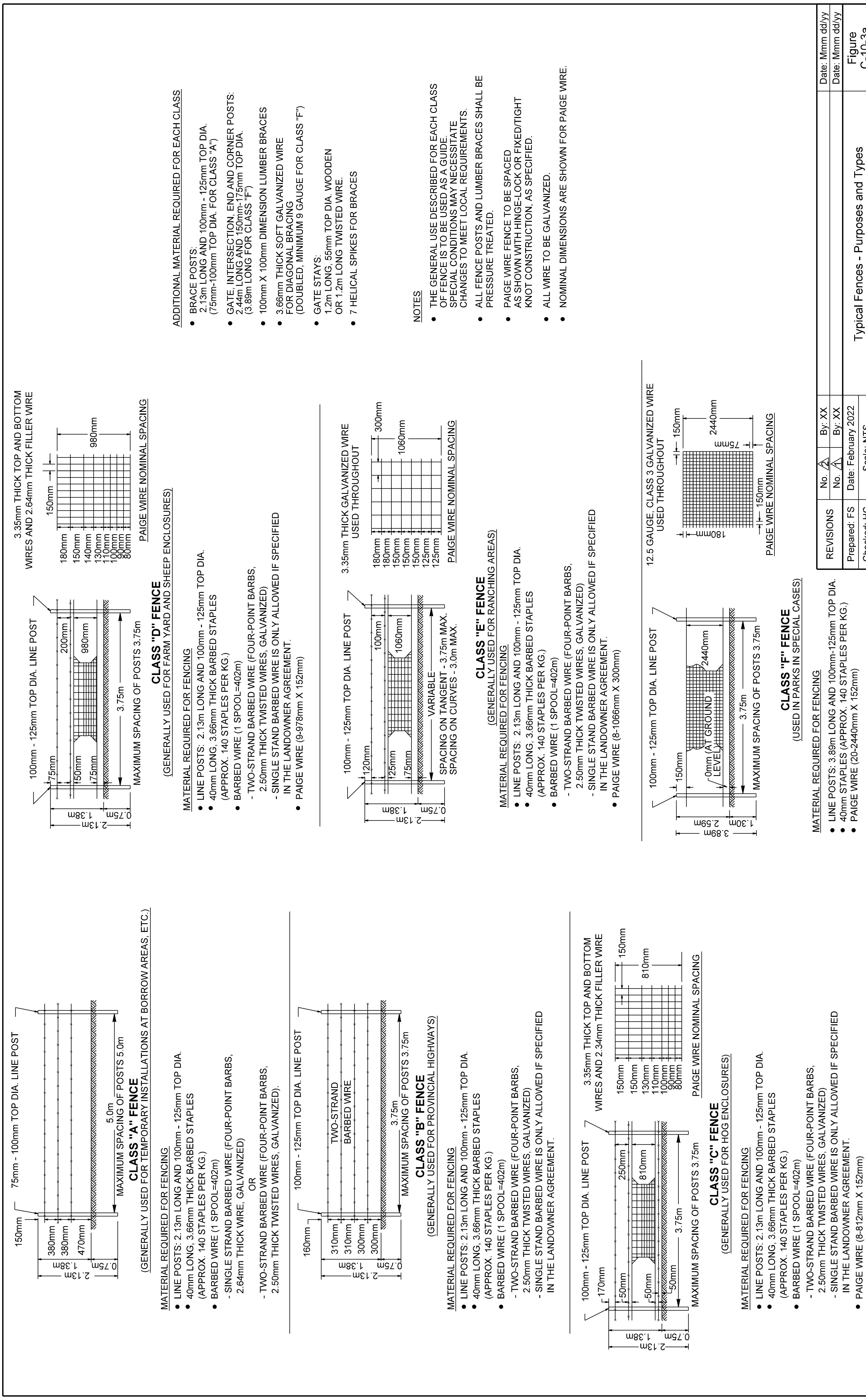
- Class A is three barbed wires with wooden posts at a five metre maximum spacing. It is generally used for temporary installations such as at borrow areas. See Standard Drawing CB6-2.12M1.
- Class B is four barbed wires with wooden posts at a 3.75 metre maximum spacing. It is generally used along provincial highways. See Standard Drawing CB6-2.12M2.
- Class B Modified. This alternative Class B system has a modified wire spacing and is only permitted when specified in the Land Acquisition Agreement and contract documents. See Standard Drawing CB6-2.12M2A.
- Class B with Metal Stays. The use of metal stays allows the wooden posts to be spread further apart, which reduces the number of posts. The metal stays produce a fully suspended fence that can be locked for permanent use. This system is often used between a highway and service road. The use of this alternative Class B fencing is only permitted when specified in the contract documents. See Standard Drawing CB6-2.12M11.
- Class C is three barbed wires with 812 mm graduated paige wire and wooden posts spaced at a maximum of 3.75 metres. It is generally used for hog enclosures. See Standard Drawing CB6-2.12M3.

- Class D is two barbed wires with 978 mm graduated paige wire and wooden posts spaced at a maximum of 3.75 metres. It is generally used for farmyard and sheep enclosures. See Standard Drawing CB6-2.12M4.
- Class E is two barbed wires with 1066 mm graduated paige wire and wooden posts spaced at a maximum of 3.75 metres. It is generally used in ranching areas. See Standard Drawing CB6-2.12M5.
- Class F is 2440 mm graduated paige wire with wooden posts spaced at a maximum of 3.75 metres. It may be used in parks in special cases. This extra tall fence may prevent ungulates from entering the highway right-of-way. See Standard Drawing CB6-2.12M7.
- Class G is a modified Class B fence. The maximum post spacing is five metres. See Standard Drawing CB6-2.12M8. The use of this modified fencing is only permitted when specified in the Land Acquisition Agreement and contract documents.
- Class H is chain link fence. No CB6 drawing is available. The fabric height is specified in the contract documents. Refer to Specifications 2.12 and 5.14 in the latest edition of the Alberta Transportation, “Standard Specifications for Highway Construction” [27] for construction and material requirements.
- Median Cable Fence is placed in the median between two roadways to discourage movement from one roadway to another through a depressed median. See Standard Drawing CB6-2.12M12.

Generally, Class B fencing is used along provincial highways, as well as along municipal roads and through Indian Reserves.

Fences other than Class “F” are generally ineffective in preventing most wildlife (such as deer or moose) from entering the right-of-way.

**Figure C-10-3a Typical Fences – Purposes and Types**



The number of gates should be kept to a minimum along controlled access highways. The gates are unique to the particular class of fence, as shown in the Standard Drawings in Section 2.12 of the Alberta Transportation website, “CB6 Highway Standard Plates – Active Drawings” [7]. Where fencing is installed for range control, it may be necessary to use livestock guards instead of gates (e.g., at interchanges or connecting roadways).

The placement of fencing is illustrated on Standard Drawing CB6-2.12.M6, Position of Fencing. Normally, fences used on Alberta highways are located as follows:

- on tangent, the wire is placed on the private property side of the post; and
- on a curve, the wire is placed on the side of the post away from the centre of the curve.

Fencing construction and material specifications are available in the latest edition of the Alberta Transportation, “Standard Specifications for Highway Construction” [27].

- Specification 2.12, Fencing; and
- Specification 5.14, Supply of Fence Material.

Livestock guard drawings are available in Section 2.13 of the Alberta Transportation website, “CB6 Highway Standard Plates – Active Drawings” [7]. Construction and material specifications are available in the latest edition of the Alberta Transportation, “Standard Specifications for Highway Construction” [27].

- Specification 2.13, Livestock Guards; and
- Specification 5.21, Supply of Livestock Guards.

## C.10.4 Construction and Maintenance Costs

Generally, Alberta Transportation is responsible for the cost of fence construction for all roads under the jurisdiction and control of Alberta Transportation. The landowner (or leasee, in the case of Crown grazing leases) is responsible for fence maintenance.

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