MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 10 for Chapter 10

Interchanges

~~October~~ ~~TBD~~July 202~~3~~6

MTO Design Supplement
Appendix 10 for Chapter 10
Interchanges

The following Design Supplements are Applicable to *Chapter 10 – Interchanges of the TAC Geometric Design Guide for Canadian Roads - June 2017*:

Section 10.1.1 – General

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following ~~**additional Guidance**~~**additional guidance**:

  When designing an interchange, consider the environmental footprint of the infrastructure. The land requirements associated with interchanges can be large and may result in additional habitat destruction to accommodate the space. ~~The D~~Ddesigners should also be cognizant of the amount of excavation required, as disrupting the earth releases greenhouse gases sequestered in the ground beneath.- Additionally, construction of interchanges requires substantial amounts of building materials which have their own carbon footprint to consider.

  Other considerations for efficient interchange design include:
  - Stormwater management / bioretention cells to manage drainage~~.~~
  - Commuter parking lots to encourage carpooling~~.~~
  - Accelerated Bridge Construction staging areas for future construction and decommissioning of infrastructure~~.~~
  - Ensuring bridge spans are wide enough to accommodate future lane widening as traffic capacity increases over time~~.~~

While interchanges are predominantly constructed on highways with a freeway functional classification of “Freeway”, there are instances where interchanges are constructed on high-speed divided, and occasionally undivided, highways with other functional classification. The guidance in Chapter 10 of the TAC GDG and the Design Supplement applies to all interchanges constructed on provincial highways, regardless of functional classification. The term “”freeway” used throughout this Appendix is intended to denote a high-speed, high-volume roadway, rather than a strict reference to a functional classification.

Section 10.1.2 - Pedestrians and Bicycles

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  Interchange on and off ramps are high-risk locations for pedestrians and cyclists to cross due to the high-speed free-flowing environment.~~ ~~When designing an interchange, it is important to consider active transportation in the initial design, as retrofitting active transportation into existing ~~structures ~~configurations can be ~~ much more ~~prohibitively difficult~~ after the fact~~.
  Interchanges possess unique characteristics and functions that present challenges when designing for the integration of pedestrians and cyclists.~~ ~~Balancing the needs of traffic volumes and cyclists is ~~difficult~~often challenging.~~,~~ A~~a~~ change that could make a crossing easier for pedestrians and cyclists could ~~cause widespread gridlock~~have adverse impacts on vehicular traffic.~~ Transitioning ~~Moving active transportation through interchanges ~~is difficult and takes~~in an ideal manner requires ~~room~~space that is not always available and trade-offs and engineering judg~~e~~ment is frequently required.

  When balancing the needs of pedestrians and cyclists, designers must take into consideration the requirements of the *Accessibility for Ontarians with Disabilities Act* (AODA), the ministry's *Bikeways Design Manual* and *Provincial Engineering Memorandum # 2018-07* dated Oct 22, 2018.

Section 10.1.3.3 – Loop Ramps

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  ~~Usually l~~Loop ramps exiting a~~off the ~~ freeway (parclo B or buttonhook configuration) typically have low visibility, require significant braking, and may not meet driver~~'~~s' expectations. In this situation, use of minimum values for sight distance ~~visibility ~~to the bullnose should be avoided~~ enhanced~~.

Section 10.1.3.5 – Over Versus Under

- ~~This Section~~This section ~~is Applicable~~is **applicable** with the following ~~**additional Guidance**~~**additional guidance**:

    - The Manual of Uniform Traffic Control Devices for Canada (MUTCDC) ~~should be~~is replaced with the *Ontario Traffic Manual Books*.
    - The TAC Guide for the Design of Roadway Lighting ~~should be~~is replaced with the ministry *"Policy for Highway Illumination", Directive # PLNG-B-05* Dated May 8, 2002.
    - There are drainage ~~challenges~~ considerations with both advantages and disadvantages when selecting over versus under. Climate change is a factor to be considered for flooding and snow accumulation/icing when ~~looking at~~considering over versus under.
    - In flood-prone areas ~~more prone to flooding~~, it can be advantageous to have the ~~primary~~ major road go over the ~~secondary~~ minor road.
    - Consider the amount of excavation required - disrupting the earth releases greenhouse gases sequestered in the ground beneath.
    - It is generally cost-effective ~~advantageous~~ when selecting an underpass where topography is such that the existing ground level is close to the major roadway.
    - Traffic volume to and from the freeway should be considered.
    - There may be a need for longer stopping distances on downgrades in icy conditions.

Section 10.1.4.8 – Task and Risks: Merging and Mental Workload

- ~~This Section~~This section ~~is Applicable~~is **applicable** with the following **correction**:

  Reference to "Section 10.1.3.7" ~~should be read~~is corrected to "Section 10.1.4.7".

  Section 10.1.4.11 ~~with the correct reference of *"OTM Books" instead*~~ *"TAC Manual of Uniform Control Devices for Canada"* is replaced with *"OTM Books"*.~~.~~

Section 10.1.4.11 – Task and Risks: Reading Guide Signs Prior To Exit

- ~~This Section~~This section ~~is Applicable~~is **applicable** with the following ~~**correction**~~**revision**:

Reference to the TAC *Manual of Uniform Traffic Control Devices for Canada* is replaced with the *"Ontario Traffic Manual (OTM)"* books.

Section 10.2 – Interchange Warrants

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following ~~**additional Guidance**~~**additional guidance**:

Active ~~Modes~~Transportation

Impacts to active modes of transportation should be carefully evaluated in the warrant analysis of interchanges. Interchanges may be considered at existing intersections with high pedestrian and cyclist volumes to improve the operation and safety ~~to~~ for all road users.

Major Transit Corridor

More major transit corridors have been developed ~~in the past~~over recent decades due to the reliable and convenient mobility choices provided to the public. An i~~I~~nterchange may be considered at the junction of a roadway~~s~~ and major transit corridor to minimize impacts to operations on both corridors.

Table 10.2.1 – Selection of Interchanges, Grade Separations, and Intersection Based on Classification

- This Table is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -10A:**

Exhibit -10A

~~**SELECTION OF INTERCHANGES, GRADE SEPARATIONS AND INTERSECTIONS BASED ON HIGHWAY FUNCTIONAL CLASSIFICATION**~~**Selection of Interchanges, Grade Separations and Intersections Based on Highway Functional Classification**

	Classification	Freeway	Arterial	Collector/Local
Rural	Freeway	1	2	4
	Arterial		6	7
	Collector/Local			8
Urban	Freeway	1	3	5
	Arterial		6	6 or 7
	Collector/Local			8

Notes:

1. Interchange in all cases.
2. Normally interchange, but grade separation where traffic volume is light.
3. Normally interchange, but grade separation where interchange spacing is too close.
4. Normally grade separation or alternatively the collector/local may be closed.
5. Normally separation, but an interchange may be justified to:
   - relieve congestion
   - serve high density traffic generators
6. Normally intersection, but an interchange may be justified where:
   - capacity limitation causes serious delay
   - injury and fatality rates are high
   - cost would be lower than an intersection
7. Normally intersection, or alternatively the collector/local may be closed.
8. Normally intersection, or alternatively one road may be closed.

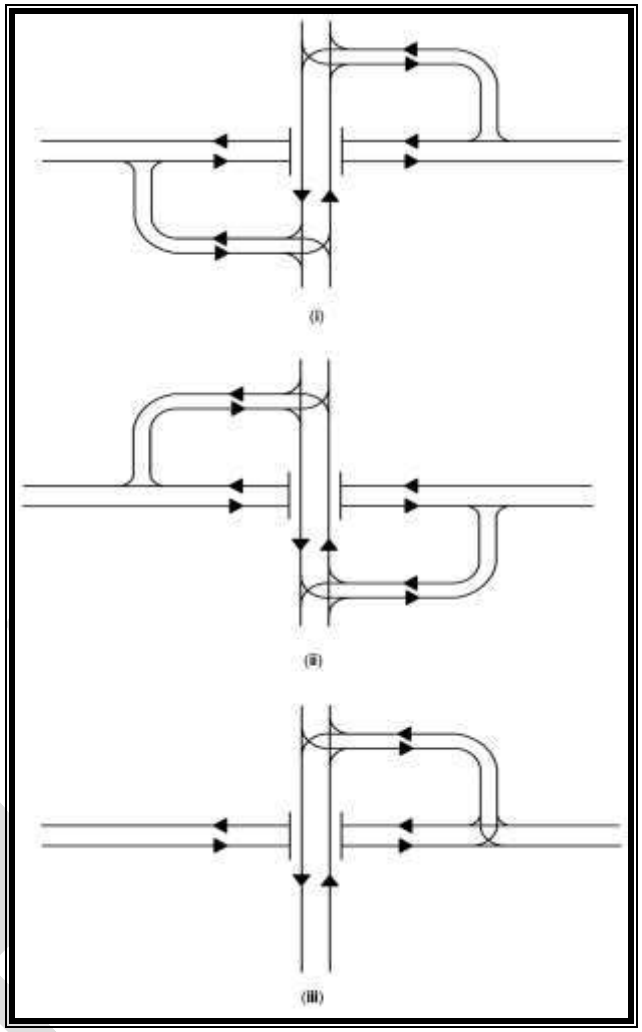
Section 10.5.4 – Interchanges between Roads other than Freeways

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following ~~**additional Guidance**~~**additional guidance**:

  Exhibit -10B shows interchanges ~~suitable for~~between roads other than freeways ~~that are not applicable to freeways~~. Illustrations (i) and (ii) of **Exhibit -10B** are similar in configuration to Parclos A-2 and B-2 respectively but have lower quality geometric features. They ~~have applications~~are typically applied on rural arterial roads where it is desirable to introduce a median barrier or otherwise eliminate left-turning traffic on the ~~arterial~~major road. Illustration (iii) of **Exhibit -10B** confines all turning movements to one quadrant and ~~has application~~are appropriate where turning volumes are very low yet it is desirable to separate through traffic movements.

Exhibit -10B

~~**INTERCHANGES BETWEEN ROADS OTHER THAN FREEWAYS**~~**Interchanges Between Roads**



Other Than Freeways

Section 10.6.1 – General

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  ~~Usually r~~Ramps are generally fully access-controlled, and no access is permitted to other roadways or development. The t~~T~~hree elements of ramp design ~~i~~are~~s~~ illustrated in **Exhibit -10C**. The locations of the two bullnoses ~~is~~ are dependent on the geometric features of the two roadways and the desired characteristics of the ramp.

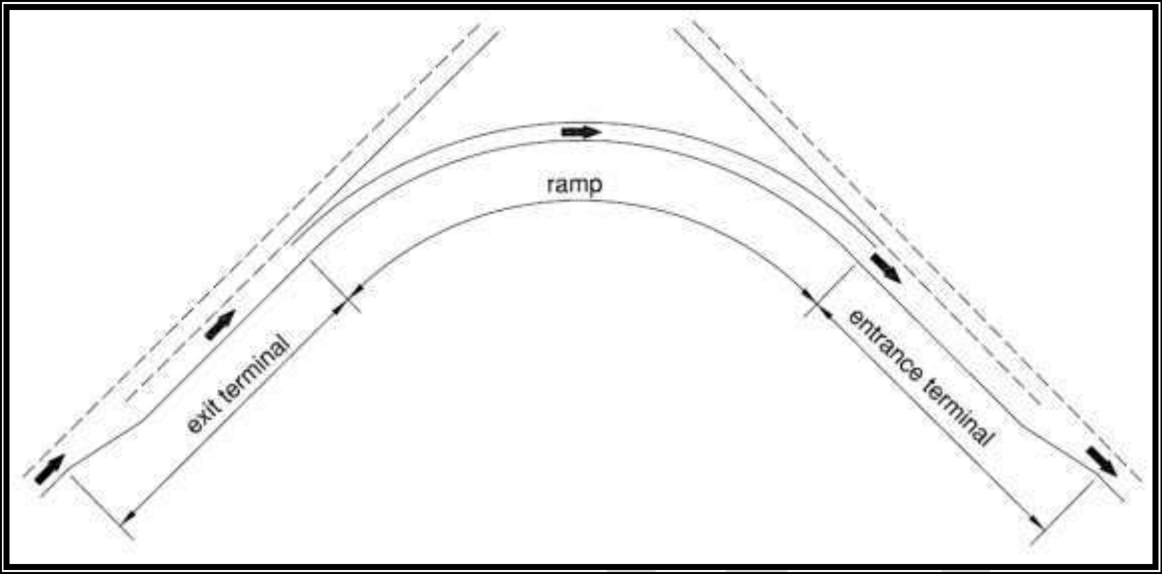
  Ramps may have one, two or three lanes. Ramps on rural interchanges normally have one lane. Ramps for traffic entering freeways in urban areas normally have one lane and ramps for traffic exiting freeways in urban areas normally have two lanes and on occasions, three lanes, where there is a change in the number of basic lanes of the freeway.

In ramp capacity analysis, the three components are ~~examined~~ evaluated separately and the lowest of the three is regarded as the capacity or service volume. Normally this is at an exit or entrance terminal on the freeway or in the case of an intersection terminal, at the intersection. Procedures for ramp capacity analysis are provided in *Provincial Engineering Memorandum, HSBM DCSO # 2016-05 dated March 31, 2016 for Capacity Analysis Manual – January 2016*.

~~Based on human factors point of view~~In a human factors context, drivers generally ~~are~~ expect~~ing~~ to exit and enter freeways on the right-hand side. ~~However,~~ This configuration~~it~~ may not be possible at every location~~in every case~~. If a left-hand exit or entry is required~~that expectation is violated~~, ~~then~~ additional advance guidance ~~needed~~is required for traffic safety and operation.

Exhibit -10C

~~RAMP DESIGN ELEMENTS~~Ramp Design Elements



Section 10.6.2 – Ramp Design

- This section is **applicable**, including the~~e~~ following ~~**general**~~**additional** **g~~G~~uidance** for “Ramp Design Types”~~ added to this Section~~:

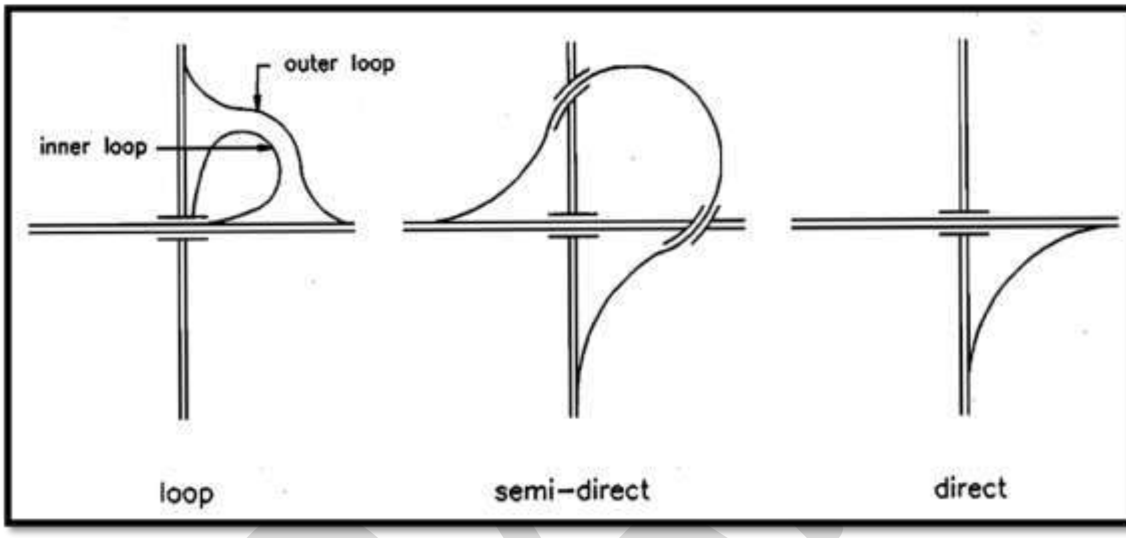
  Ramps fall into one of three general categories, illustrated in **Exhibit -10D**~~, reflecting their overall configuration~~. Direct ramps are those ~~having~~ with a~~n overall~~ deflection angle to the right of approximately 90°~~ more or less~~. Semi-direct ramps ~~in general refer to ramps~~typically ~~to~~ accommodate a left turn, with~~having~~ ~~overall~~ deflection angles ~~in the order o~~of approximately 90° to the left~~o the left~~. Inner loop ramps ~~refer to those whose configuration resembles a loop and~~ accommodate left-turning traffic, ~~having an overall~~with a deflection angle of approximately 270° to the right. Outer loop ramps are direct ramps which match~~following~~ the configuration of an~~the~~ inner loop.

  The design and speed selected for a ramp design is ~~related to~~dependent on the design speed of the through roadway upstream of the ramp and the configuration of the inner ramp. ~~Guide v~~Values for ramp design speed for a range of highway design speeds are ~~given~~ provided in **Exhibit -10E.**

  Horizontal and vertical alignment geometry should meet the standards and guidelines ~~set out~~ in **Chapter 3**, using the design speed shown in **Exhibit -10E** as a guide. Profile design should always provide ~~at least~~ minimum stopping sight distance and normally this constraint will be more stringent than limiting values for gradient.

Exhibit -10D

~~RAMP DESIGN TYPES – GENERAL~~Ramp Design Types - General



Section 10.6.2.1 – Design Speed

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  ~~The~~ For outer loops and direct ramps from crossing roads, ~~the standard~~design speed values ~~of design speed given~~ in **Exhibit -10E** should be used.

  For inner loops, ~~standard values of~~ design speed values ~~given~~ in **Exhibit -10E** may not be attainable~~,~~ ~~because of~~due to large property requirements. For inner loops from a crossing road exit terminal the minimum values are:

  - Parclo A inner loop – urban condition:
    - Crossing road design speed 60 – 80 km/h
    - Ramp design speed 40 km/h
    - Minimum radius 50 m
  - Parclo A inner loop – rural condition:
    - Crossing road design speed 60 – 100 km/h
    - Ramp design speed 40 km/h

- Minimum radius 55 m

For inner loops from a highway exit terminal the minimum values are:

- Parclo B inner loop – urban condition
  - Highway design speed 100 km/h
  - Ramp design speed 50 km/h
  - Minimum radius 80 m

Two-Lane Inner Loop Ramp

~~There is direct relationship between the growth of population, land development, economic activities, and generation of traffic on highways including freeways. The need for two-lane loop ramp has increased~~Where traffic volumes warrant, two-lane inner loops are permissible. ~~The two-lane loop configuration should not be immediately preceded or followed by a loop ramp.~~ The radius of the inner edge of the traveled way of ~~the~~ a two-lane inner loop ramp ~~normally~~ should not be less than 55 to 60 m. Turn simulation software should be used to verify that the appropriate design vehicles may traverse either lane of a two-lane inner loop ramp without off-tracking into the adjacent lane. A two-lane inner loop configuration should not be immediately preceded or followed by another loop ramp.

Parclo B Loop and Button Hook Ramps

Parclo B loop and button hook exit ramps are not recommended for highways ~~of~~ with design speeds ≥ 110 km/h. ~~However, I~~If these types of ramps are the only options, ~~then the designer should use~~ first principles for design elements should be used, considering all site-specific constraints, including road safety and~~,~~ traffic operations, and ~~should consult with~~ Highway Design Office should be consulted with.

Table 10.6.1 – Ramp Design Speed

- This Table is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -10E**.

Exhibit 10E

~~RAMP DESIGN SPEED, RADIUS, AND SUPERELEVATION~~Ramp Design Speed, Radius, and Superelevation

Highway Design Speed km/h	50	60	70	80	90	100	110	≥120	~~130~~
Ramp Design Speed, km/h									
Desirable	40	50	50	60	70	70	80	80	~~90~~
Minimum	30	40	40	40	50	50	60	60	~~70~~

1) Minimum allowable radii shall accord with ramp design speeds per TAC GDG Section 3.2.2.6. A maximum superelevation (e_{max}) of 0.06 m/m applies to all ramp designs.

~~Spiral parameter (A) values required to establish appropriate speed reduction zones shall be obtained from TAC GDG Table 10.6.4 based on mainline and ramp design speeds.~~

Section 10.6.2.2 – Speed Change Lane

- ~~This Section~~ The first two paragraphs of this section are **applicable.** Subsequent paragraphs, including Table 10.6.2 and Figure 10.6.1 are **not applicable** and replaced with the following **replacement guidance**:~~This section~~ is Applicable~~is **applicable**~~ ~~including the following **additional Guidance**~~**additional guidance**~~:~~

  The length of a speed-change lane is based on the running speed of the through lane. This is the speed at which drivers maneuver into the deceleration lane or merge with through traffic after leaving an acceleration lane.

  Speed change lanes are designed in one of two possible configurations: the "direct taper" and the "parallel" types. The direct taper type works on the principle of a direct entry or exit at a flat angle, whereas the parallel type has an added lane for speed change. Direct taper exits are permitted for crossing roads with design speeds up to 100 km/h. Parallel lane exits should be used on all mainline freeways and crossing roads with design speeds exceeding 100 km/h.

  Exhibits 10F~~?~~ and **10G**~~?~~ provides design parameters for direct taper exit ramps for crossing roads. Speed change lane and gore area lengths may be increased and deflection angle may be reduced according to engineering judgement.

Exhibit 10F

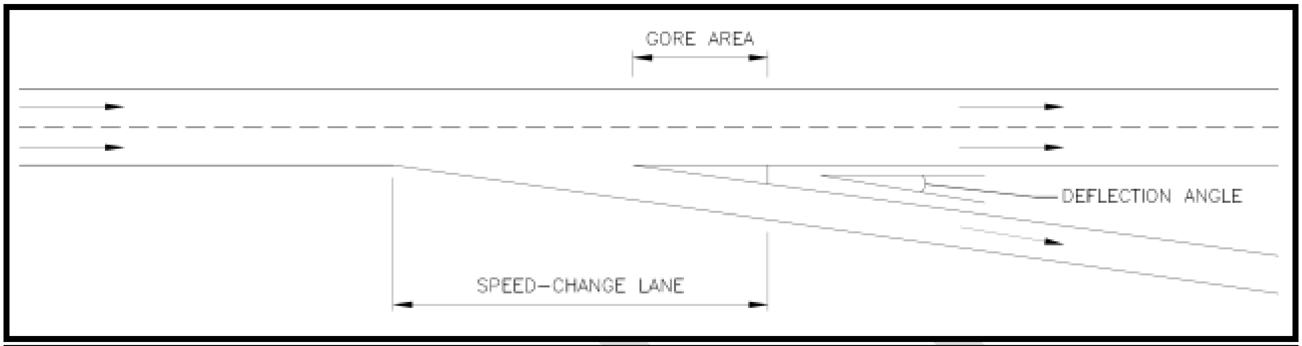
~~?~~ Direct Taper Exit Design Dimensions

Design Speed of Crossing Road (km/h)	Speed Change Lane Length (m)	Gore Area Length (m)	Deflection Angle (degrees)
60	60	15	8
70	85	25	6
80	110	35	5
90	150	50	3

100	180	65	3

Exhibit 10G~~?~~

Direct Taper Exit Design Parameters



Exhibits 10H~~?~~ and 10I~~?~~ provides minimum design parameters for parallel deceleration lanes. Length of speed change lane, gore areas and curves and curve radius may be increased and deflection angle may be decreased using engineering judgment as applicable. At diamond interchanges where the first downstream curve has a high design speed or is nonexistent, the length of the speed change lane may be reduced provided adequate sight distance is provided and potential queuing onto the freeway is not a concern.

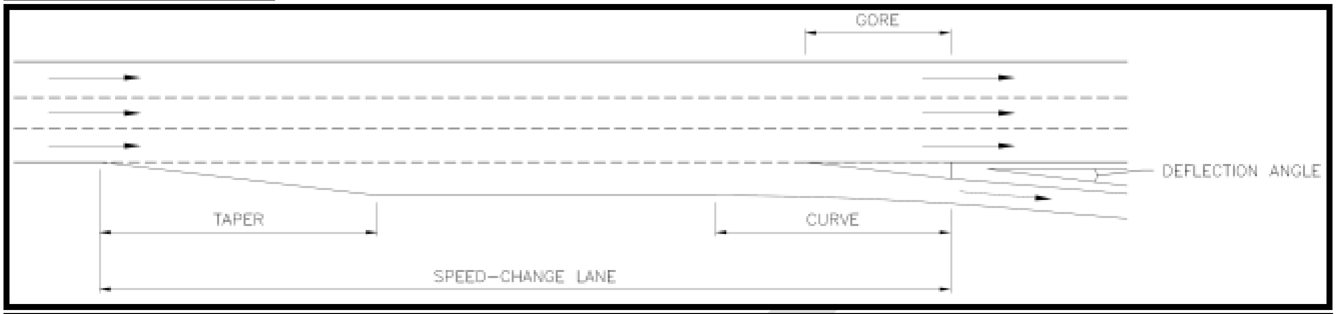
Exhibit 10H~~?~~

-Parallel Lane Exit Design Dimensions

Design Speed of Freeway (km/h)	Total Length of (S.C.L) Including Taper (m)	To Inner Loop				To Outer Loop				Taper Length (m)
		Exit Curve		Length of		Exit Curve		Length of		
		Radius (m)	Deflection Angle (degrees)	Gore Area (m)	Curve (m)	Radius (m)	Deflection Angle (degrees)	Gore Area (m)	Curve (m)	
100	290	1000	7	50	120	1800	5	65	160	80
110	315	1250	6	55	135	2000	5	70	170	85
≥120	345	1500	5	60	145	3000	4	85	210	90

Exhibit 10I~~?~~

Parallel Lane Exit Design Parameters



For two-lane freeway exit terminals, the speed change length is based on a different concept, ~~whereby~~ where the distance of the exit curve to the bullnose ~~is considered to~~ governs the manoeuvre of ~~the~~ vehicles exiting into the left-hand ~~of the two lanes~~exit lane. This lane configuration ~~has been~~is based on deceleration in gear for 3 seconds at the assumed speed followed by comfortable braking to 50 km/h at the bullnose, with deceleration commencing at the point where a half lane width is available to the vehicle exiting to the left lane. For two-lane freeway exit terminals the total length is based on the vehicle exiting to the right lane of the two lanes, utilizing a 3 second lane shift taper at the assumed speed plus deceleration in gear to a speed of 50 km/h at the bull-nose. The design values for length of two-lane deceleration lanes are provided in **Exhibit -10J~~F~~**, and their method of measurement are shown in **Exhibit -10K~~G~~**.

Exhibit 10-J~~F~~ lengths are intended to provide sufficient distance to accommodate the lateral transition of vehicles from the through-lane to the left-most exit lane, while providing necessary deceleration to reach the controlling ramp speed. Parameters for curve length, radius and deflection angle are the same as for single-lane ramps for equivalent design speeds.

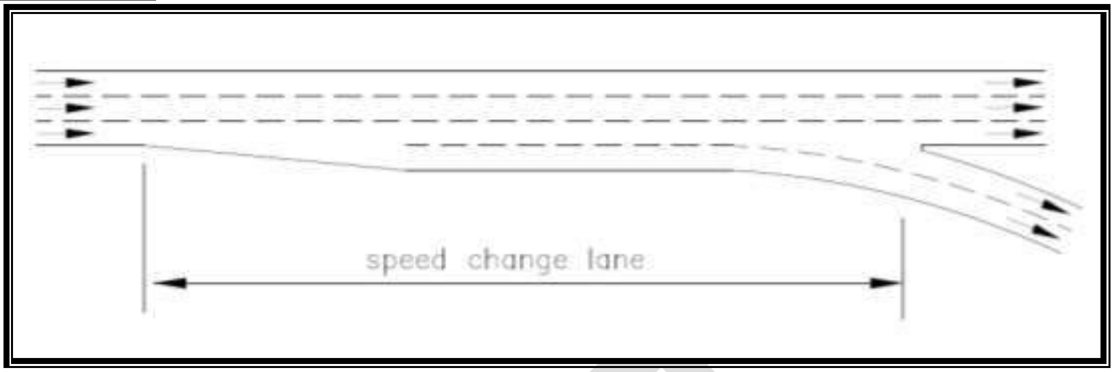
Exhibit -10~~F~~J

~~LENGTH OF SPEED-CHANGE LANES AT EXIT TERMINAL FOR TWO-LANE RAMP~~Length of Speed-Change Lanes at Exit Terminal for Two-Lane Ramp

Design Speed of Freeway, km/h	110	≥120
Length of Speed-Change Lane including Taper, m	480	535
Length of Taper, m	85	90

Exhibit 10K~~G~~

~~MEASUREMENT OF SPEED-CHANGE LANES AT EXIT TERMINAL FOR TWO-LANE RAMP~~Measurement of Speed-Change Lanes at Exit Terminal for Two-Lane Ramp



~~**Table 10.6.2 – Design Length for Deceleration**~~

~~This Table is Not Applicable and is replaced with **Exhibit -10H:**~~

~~Exhibit -10H~~

~~Design Length for Deceleration~~

~~Speed of Roadway (km/h)~~		~~Length of Taper (m) Lt~~	~~Length of Deceleration Lane Excluding Taper (m)~~ ~~L_d~~							
~~Design~~	~~Assumed Operating~~		~~Design Speed of Turning Roadway Curve (km/h)~~							
			~~Stop condition~~	~~20~~	~~30~~	~~40~~	~~50~~	~~60~~	~~70~~	~~80~~
~~60~~	~~55-60~~	~~55~~	~~115~~	~~110~~	~~105~~	~~90~~	~~60~~	~~-~~	~~-~~	~~-~~
~~70~~	~~63-70~~	~~65~~	~~145~~	~~140~~	~~130~~	~~120~~	~~105~~	~~70~~	~~-~~	~~-~~
~~80~~	~~70-80~~	~~70~~	~~170~~	~~165~~	~~160~~	~~150~~	~~130~~	~~105~~	~~-~~	~~-~~
~~90~~	~~77-90~~	~~80~~	~~195~~	~~185~~	~~180~~	~~170~~	~~160~~	~~135~~	~~110~~	~~-~~
~~100~~	~~85-100~~	~~85~~	~~215~~	~~210~~	~~205~~	~~200~~	~~180~~	~~165~~	~~145~~	~~-~~
~~110~~	~~91-110~~	~~90~~	~~250~~	~~245~~	~~240~~	~~230~~	~~220~~	~~205~~	~~190~~	~~165~~
~~120~~	~~98-120~~	~~95~~	~~320~~	~~315~~	~~310~~	~~305~~	~~300~~	~~280~~	~~270~~	~~240~~
~~130~~	~~105-130~~	~~100~~	~~335~~	~~335~~	~~330~~	~~325~~	~~320~~	~~300~~	~~285~~	~~270~~

~~The selection of ramp design speed as discussed in Exhibit 10E should be referred.~~

~~The values in the above table are based on deacceleration-distance curves in the *Geometric Design Standards for Ontario Highways*.~~

Section 10.6.2.4 – Sight Distance

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  ~~There should be a~~A clear view of the entire exit terminal should be provided, including the exit nose and a section of the ramp roadway beyond the gore. The sight distance on a freeway preceding the approach nose of an exit ramp should exceed the minimum stopping sight distance for the through traffic design speed, desirably by 25 ~~percent~~% or more. Decision sight distance should be considered in complex situations and provided where practical. Sight distance for passing is not required.

Section 10.6.2.5 – Ramp Width

- ~~This Section~~This section is **~~Not Applicable~~not applicable** and is **replaced** with the following g~~G~~uidance:

  Ramp traveled-way widths are governed by the type of operation, curvature, traffic volume and composition~~and volume and type of traffic~~. The roadway width for a turning roadway includes the traveled-way width plus the shoulder width or equivalent offset outside the edges of the traveled way. *Section 9.16.3 – Turning Roadway Widths in Chapter 9 – Intersections* should be referred to. The design width of ramp traveled ways for various considerations are provided in *Exhibit- 9O– Design Widths for Turning Roadways at Intersections* in *Appendix 9 – Intersections*. Width of pavement for turning roadways are classified for the following types of operation:

- Case I: one lane, one-way operation – no provision for passing.
- Case II: one lane, one-way operation – with provision for passing a stalled vehicle.
- Case III: two lane operation.

~~Types of operation~~Cases I, II, and III are described in broad terms. In general, ~~operation~~ Case I has a small volume of trucks or only an occasional large truck; ~~operation~~ Case II has a moderate volume of trucks (in the range of 5 to ten percent of total traffic); and ~~operation~~ Case III has more and large trucks.

Cross Slope

The cross slope on tangent~~ial~~ portions of ramps should normally be sloped one way at a practical rate ranging from 1.5 to 2 percent. The design control at the crossover crown line (not to be confused with the crown line normally provided at the centerlines of a roadway) is the algebraic difference in cross slope rates of the two adjacent lanes. Where both roadways slope down and away from the crossover crown line, the algebraic difference is the sum of their cross-slope rates; where they slope in the same direction, it is the difference of their cross-slope rates. A desirable maximum algebraic difference at a crossover crown line is 4 or 5 percent, but it may be as high as 8 percent at low speeds and where there are very few trucks. The suggested maximum differences in cross slope rates at a crown line, related to the speed of turning traffic, are given in **Exhibit 10L~~IH~~.**

Exhibit -10L~~IH~~

~~MAXIMUM ALGEBRAIC DIFFERENCE IN CROSS SLOPE AT RAMPS~~Maximum Algebraic Difference in Cross Slope at Ramps

Design Speed of Exit or Entrance Curve	Maximum Algebraic Difference in Cross Slope at Crossover Crown Line

(km/h)	(%)
30 and under	5.0 to 8.0
40 and 50	5.0 to 6.0
60 and over	4.0 to 5.0

Shoulders and Curbs

Shoulders should be provided on ramps and ramp terminals in interchange areas to provide a space that is clear of the traveled way for emergency stopping, to minimize the effect of breakdown, and to aid drivers who may be confused (human factors). Ramps at interchanges should be designed without curbs. Curbs should be considered only to facilitate ~~in difficult~~ drainage ~~locations~~where required, such as in urban areas ~~where~~ with restricted rights-of-way ~~favors~~ ~~enclosed drainage~~where ditches are impractical. In some cases, curbs are used at the ramp terminals to tie ~~in to~~into municipal infrastructure but are omitted along the ~~central~~ ramp ~~portions~~.

Profile and Grade

The profile of a typical ramp ~~usually~~ consists of a central ~~portion~~ section on a~~n~~ ~~appreciable~~ grade, coupled with terminal vertical curves and connections to the profiles of the intersection legs. Profiles at the terminals are mostly determined by through-road profiles and are seldom ~~tangent~~ flat grades.

Ramp grades should be as flat as practical to minimize the driving effort needed in maneuvering from one road to another. For any ramp, the gradient to be used is dependent on number of site-specific factors ~~unique to that site~~. The flatter the gradient on a ramp, the longer it will be, but the effect of gradient on ramp length is not substantial.

In general, adequate sight distance is more ~~important~~ critical than a specific gradient control and should be favoured in design. ~~Usually, t~~These two controls are generally compatible.

Superelevation

The following should be considered for development of superelevation on ramps:

- Superelevation rates, as related to curvature and design speed on ramps, are provided in *Chapter 3* of *TAC GDG*~~.~~
- The maximum superelevation on ramps should not be greater than 6 percent~~.~~

~~o~~

The method of developing superelevation at ramp terminals is illustrated in the following Exhibits:

- **Exhibits -10M~~JJ~~** – Development of Superelevation on Tangent Road with Direct Taper

- **Exhibits -10N~~KJ~~** – Development of Superelevation on Tangent Road with Taper and Parallel
- **Exhibits -10O~~LK~~** – Development of Superelevation on Same Direction Curved Road
- **Exhibits -10P~~ML~~** – Development of Superelevation on Opposite Direction Curved Road

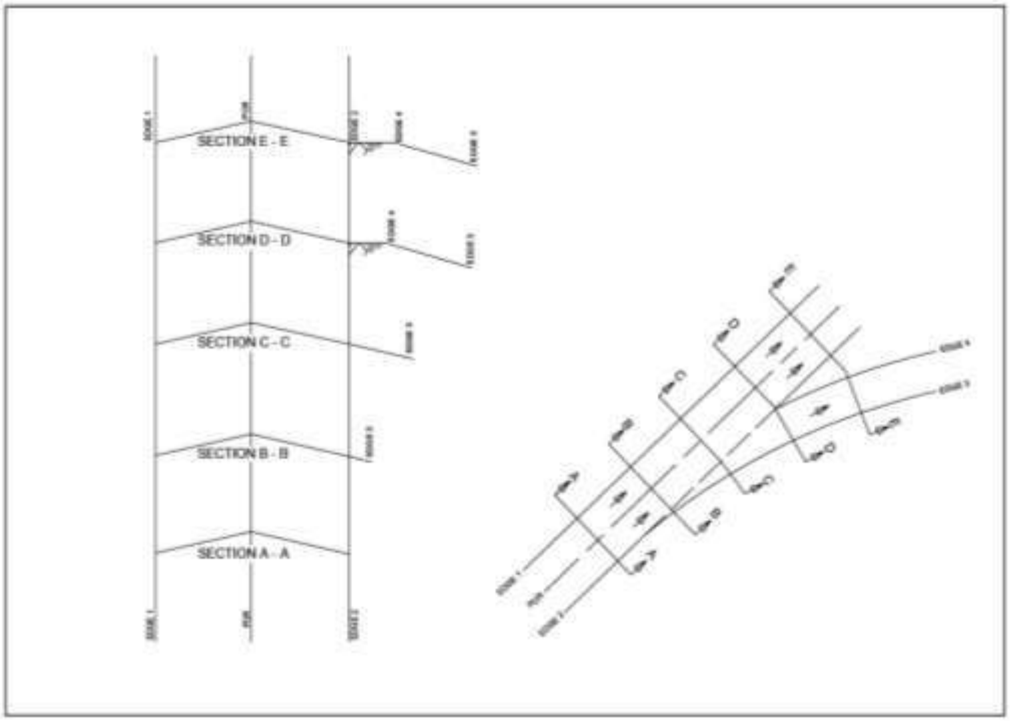
The guidance and arrangement illustrated in **Exhibit -10M~~JI~~** to **Exhibit -10P~~ML~~** for exit terminals are also ~~directly~~ applicable to entrance terminals, except that the details at the merging end are different from those of a~~n approach~~diverging nose. The merging end of an entrance terminal ~~would~~ is typically ~~be l~~located ~~in proximity of D~~around Section D-D in each Exhibit.

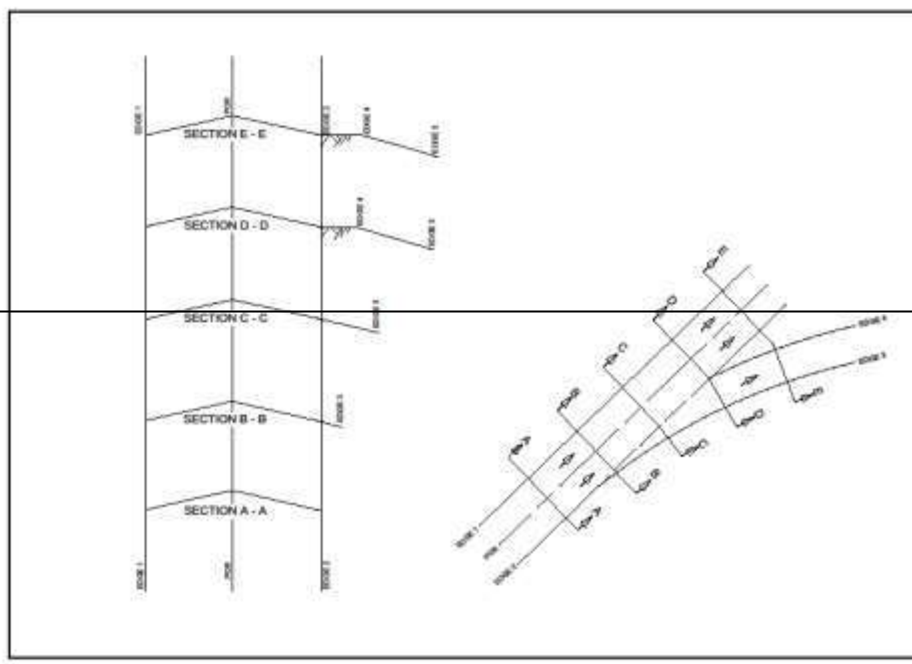
Superelevation Runoff

The principles of superelevation runoff design discussed in *Chapter 3* of *TAC GDG* and generally apply to free-~~-~~flow turning roadways. In general, the rate of change in cross slope in the runoff section should be based on the maximum relative gradients. ~~Usually~~Typically, the profile of one edge of the traveled way is established first, and the profile on the other edge is developed by stepping up or down from the first edge by the amount of desired superelevation at that location. This step is done by plotting a few control points on the second edge by using the maximum relative gradients and then plotting a smooth profile for the second edge of traveled way. Drainage may be an additional control, particularly for curbed roadways.

Exhibit -10M~~JI~~

~~DEVELOPMENT OF SUPERELEVATION ON TANGENT ROAD WITH DIRECT TAPER~~Development of Superelevation on Tangent Road With Direct Taper


SECTION E - E
SECTION D - D
SECTION C - C
SECTION B - B
SECTION A - A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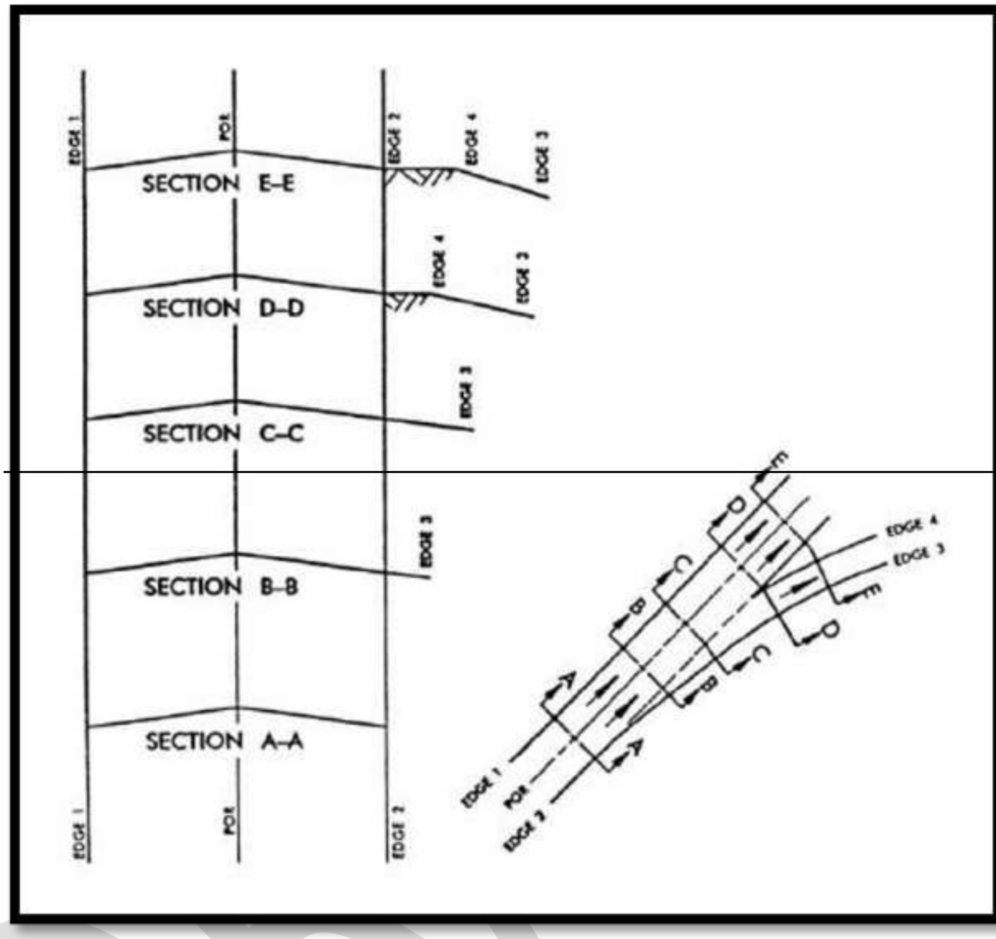
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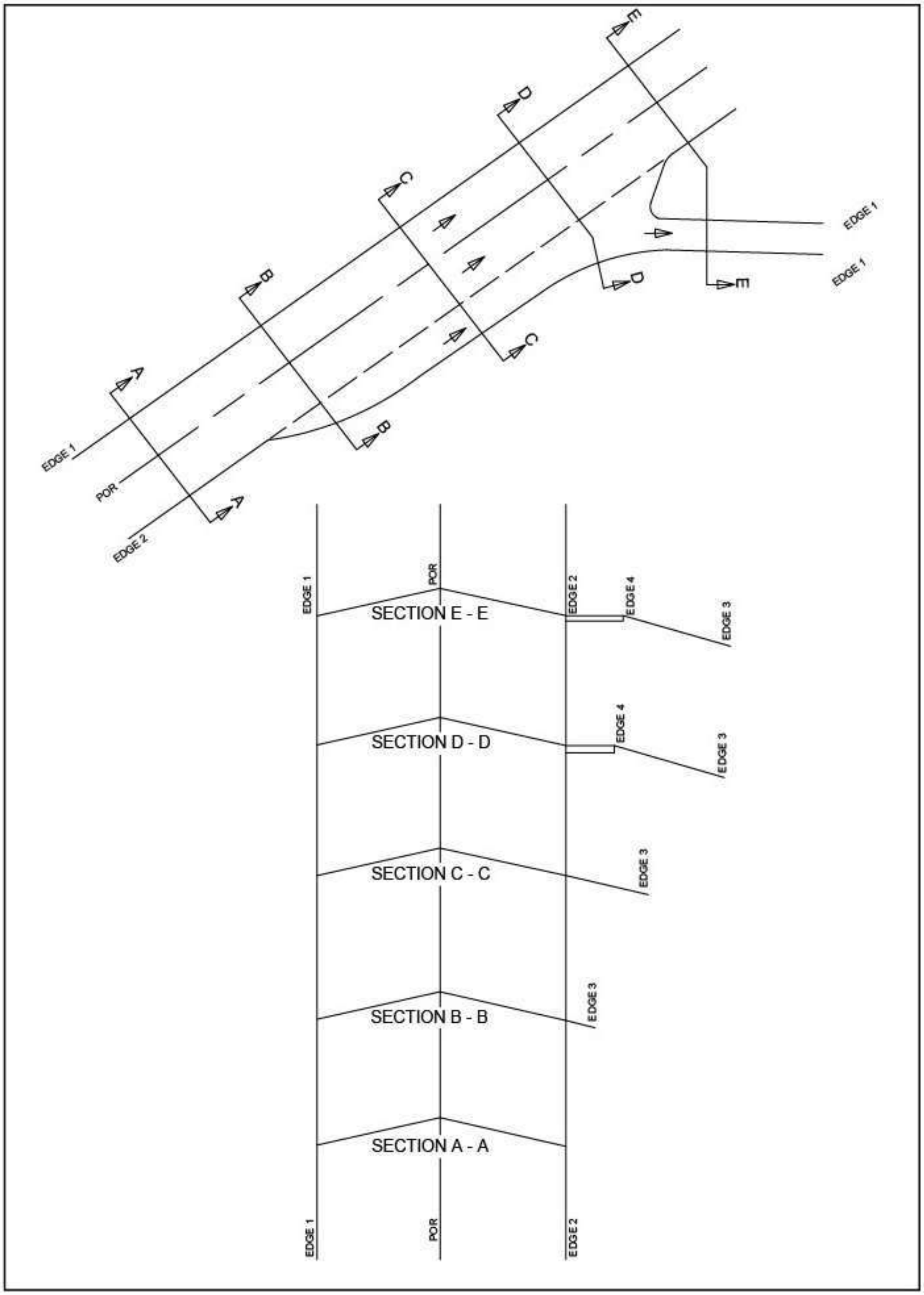
SECTION D–D
SECTION C–C
SECTION B–B
SECTION A–A
EDGE 1
POR
EDGE 2
EDGE 3
EDGE 4

Exhibit -10N~~KJ~~

~~DEVELOPMENT OF SUPERELEVATION ON TANGENT ROAD WITH TAPER AND PARALLEL~~Development of Superelevation on Tangent Road With Taper and Parallel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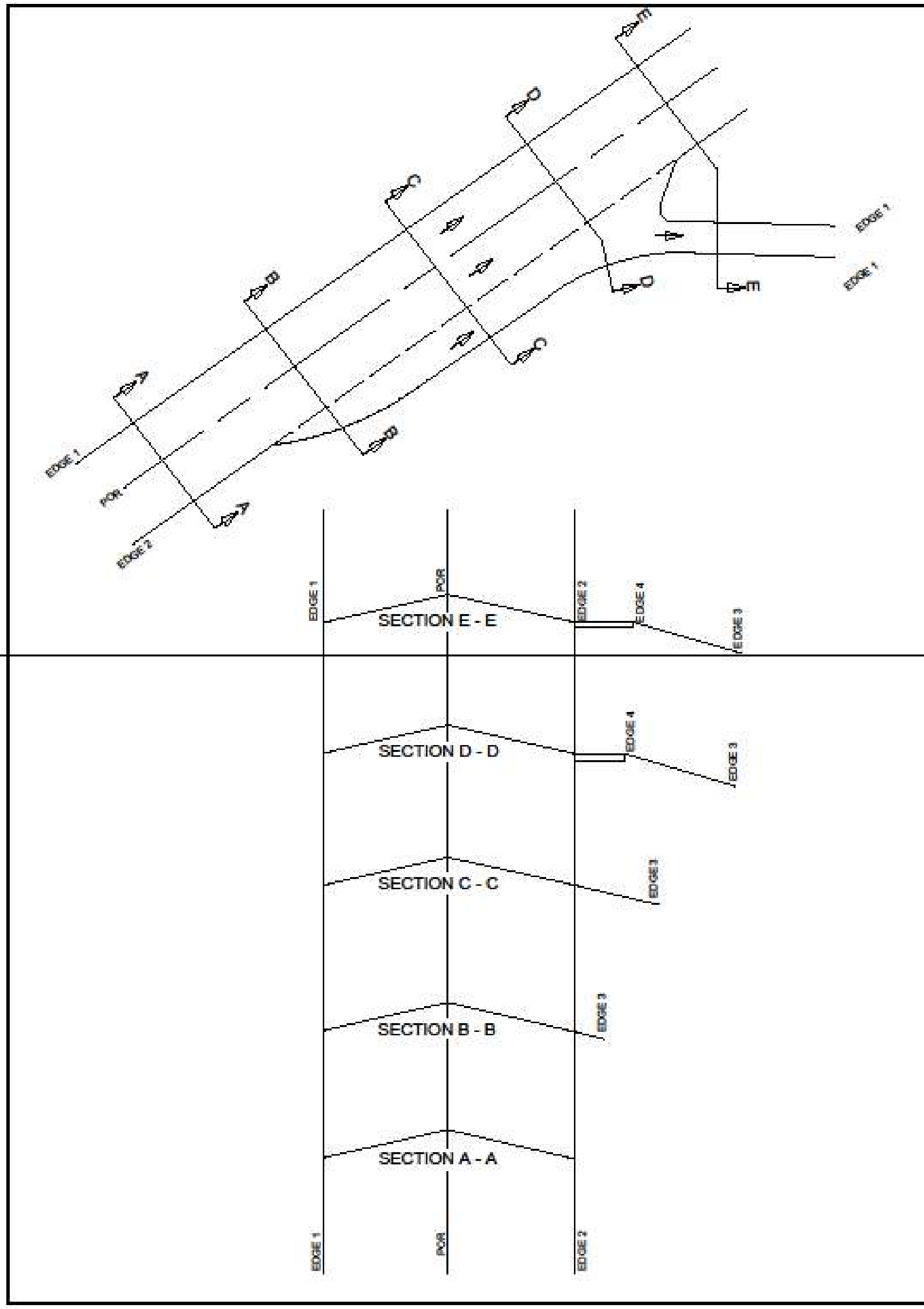
POR
EDGE 2
EDGE 3
EDGE 4
SECTION E - E
SECTION D - D
SECTION C - C
SECTION B - B
SECTION A - A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EDGE 4
EDGE 3
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SECTION C - C
SECTION B - B
SECTION A - A

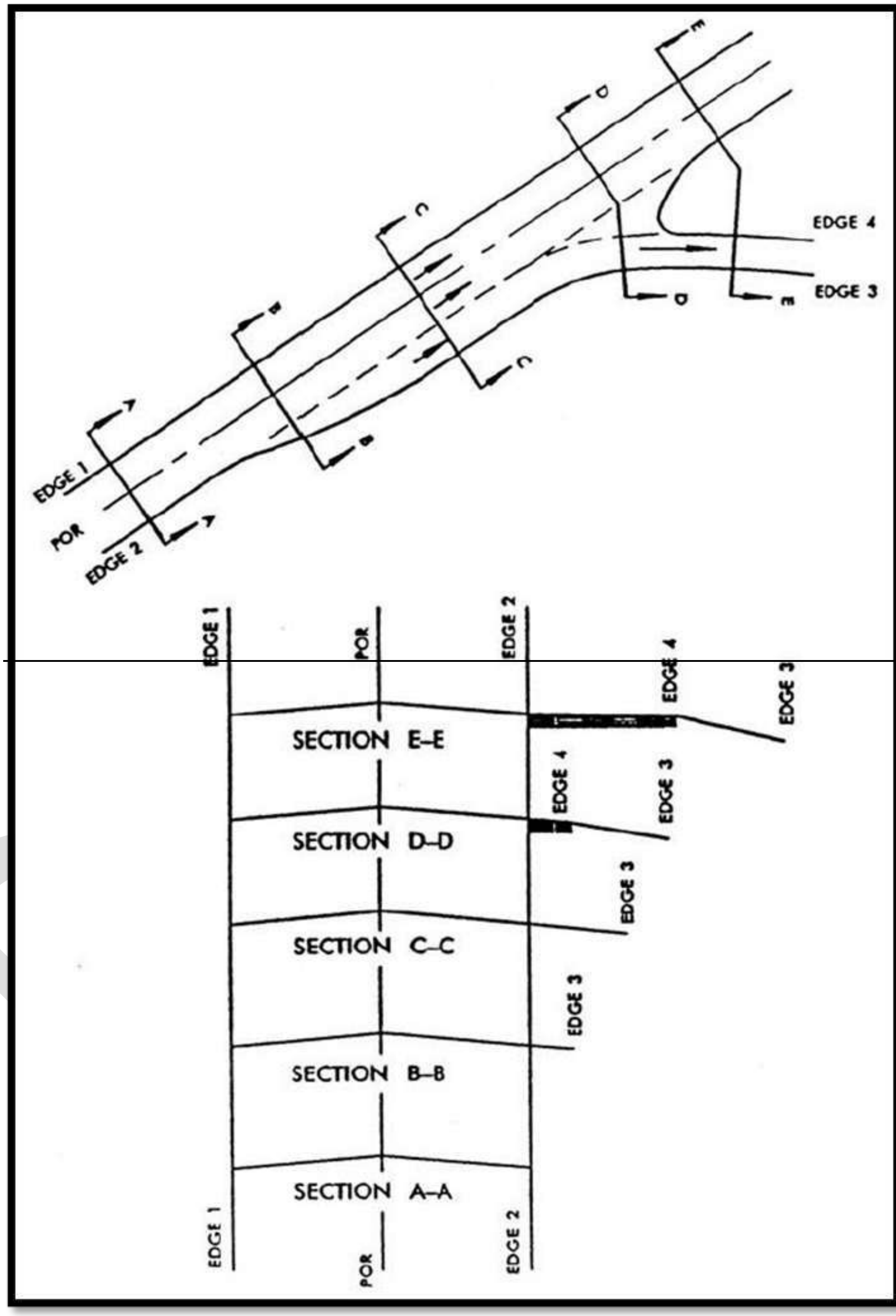
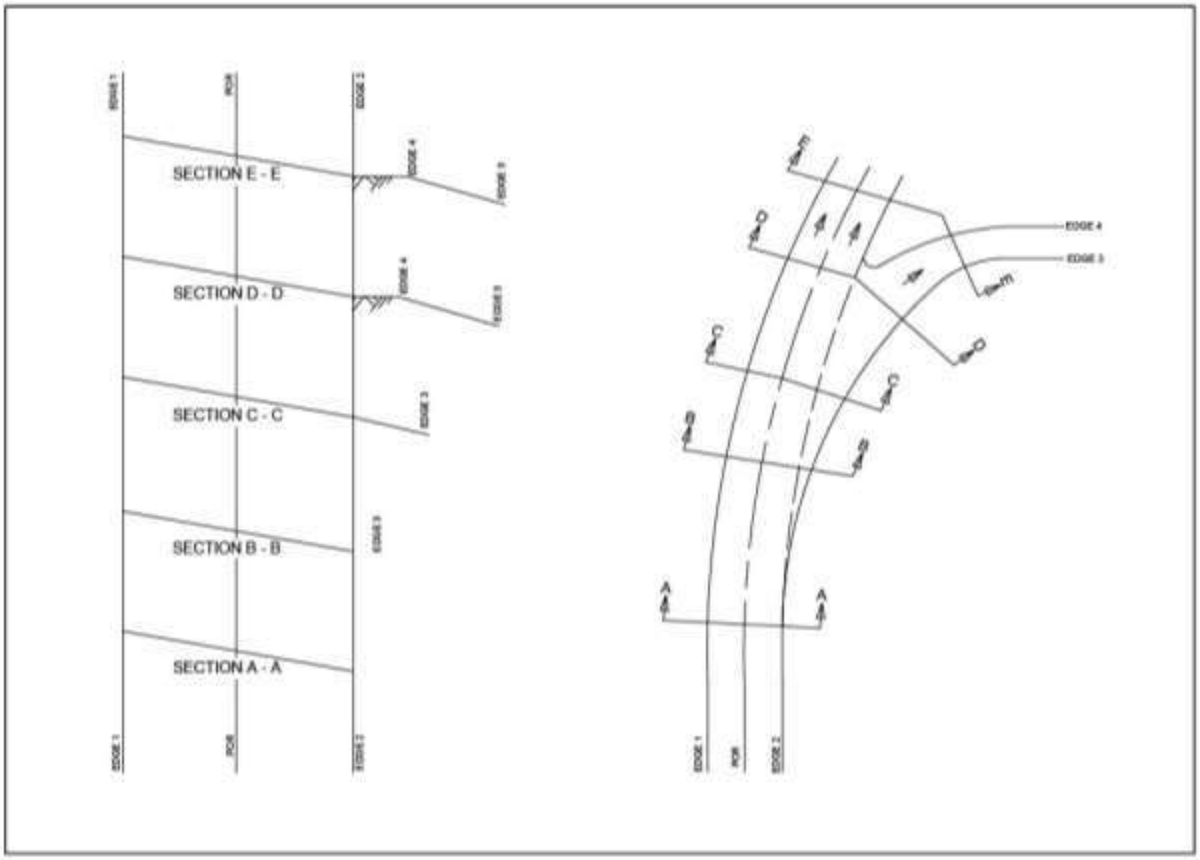
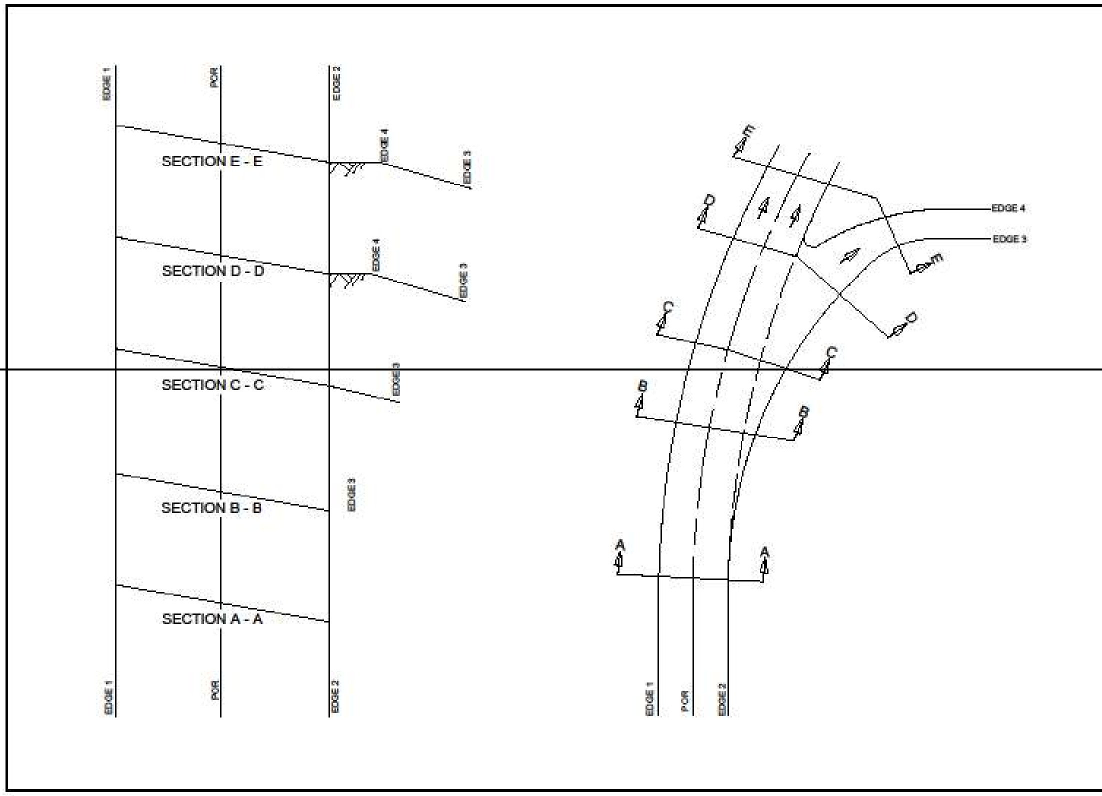


Exhibit -10O~~LK~~

~~DEVELOPMENT OF SUPERELEVATION ON SAME DIRECTION CURVED ROAD~~Development of Superelevation on Same Direction Curved Road

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POR
EDGE 2
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EDGE 3
SECTION D - D
SECTION C - C
SECTION B - B
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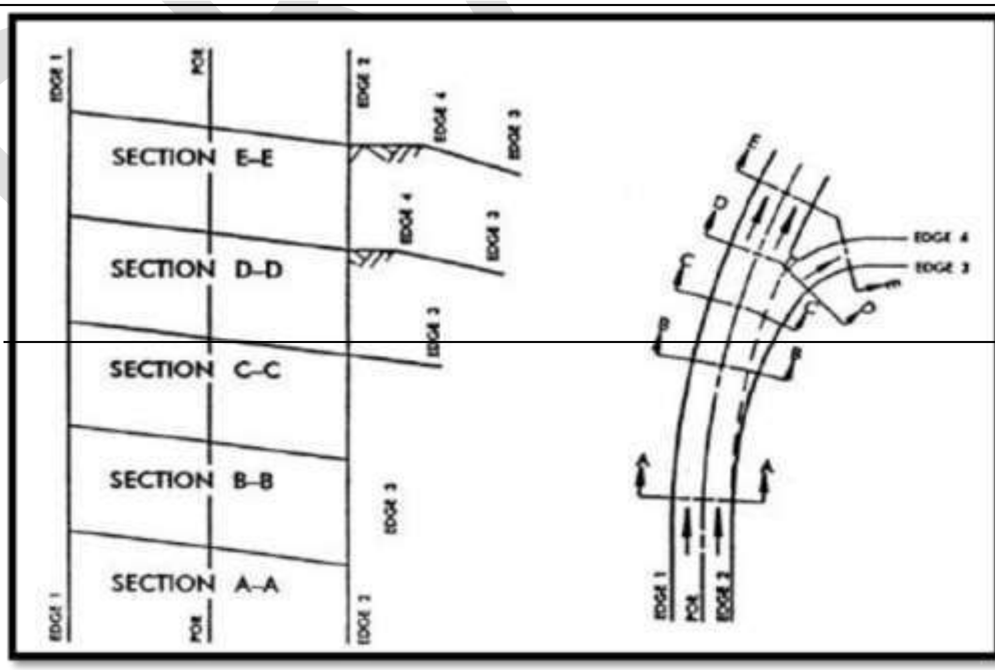
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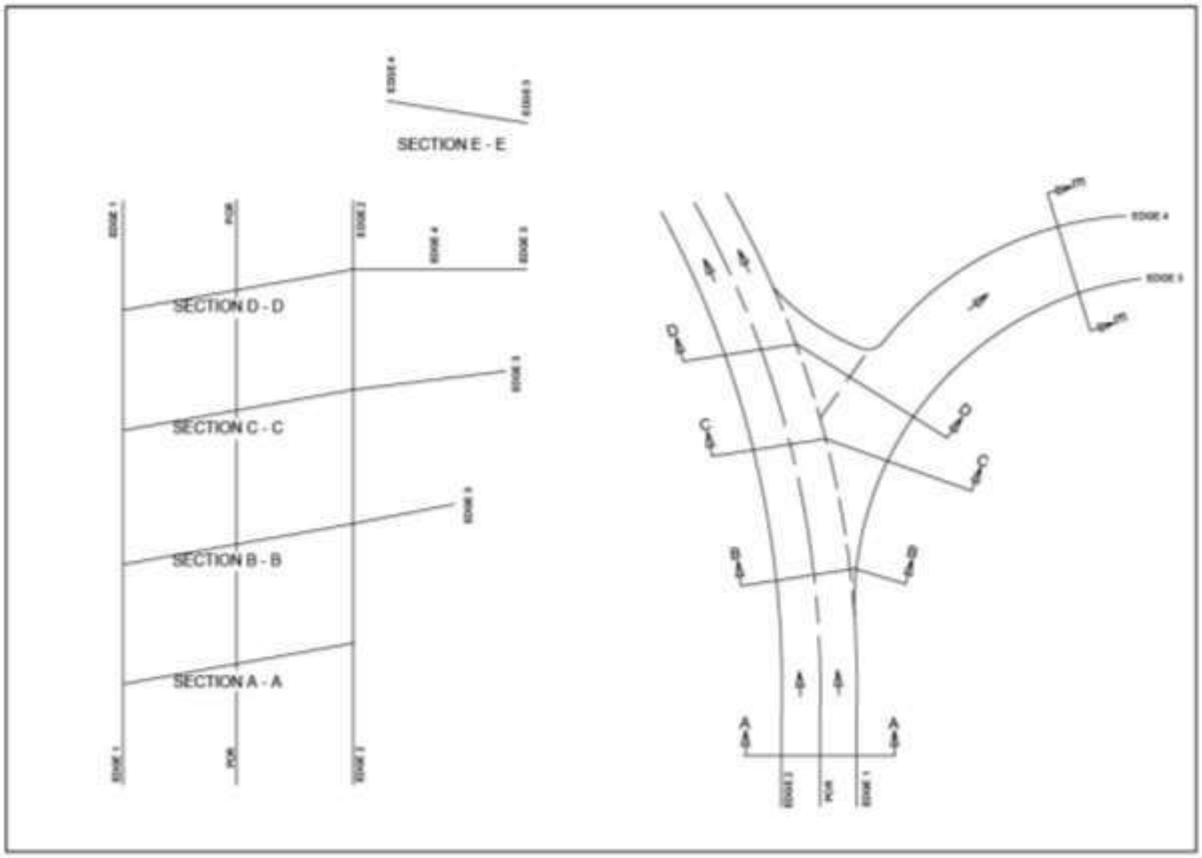
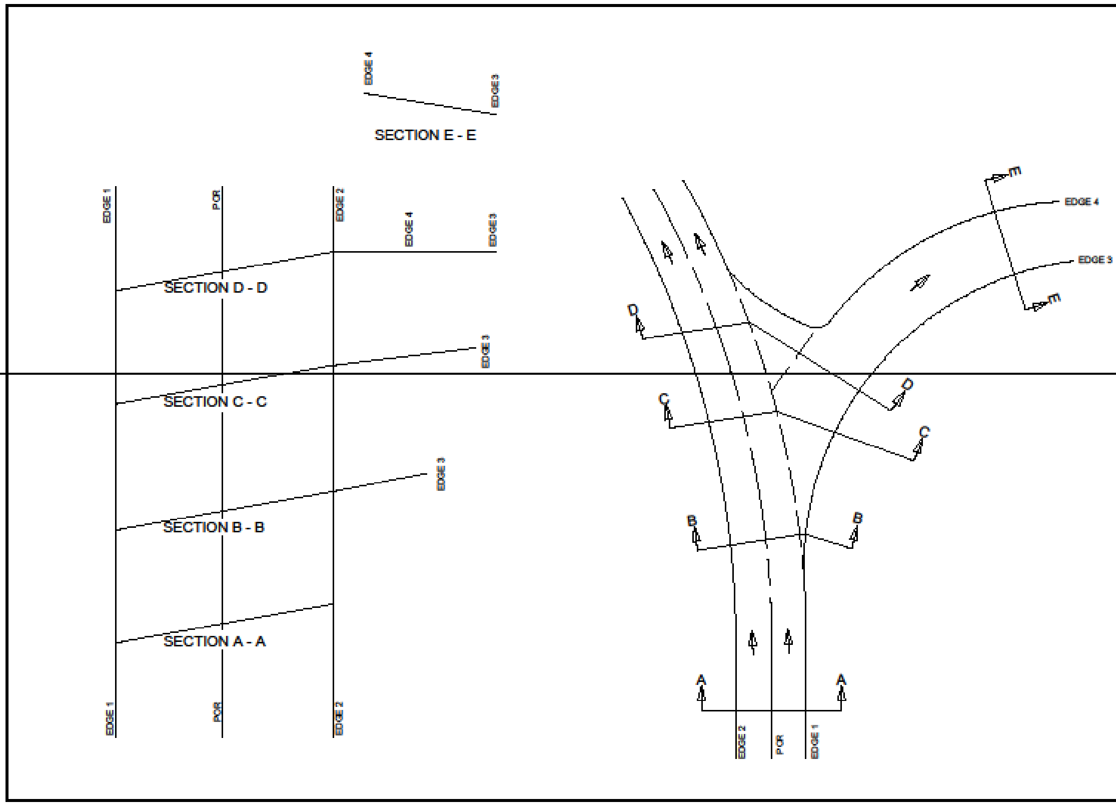
POR
EDGE 2
SECTION E–E
EDGE 4
EDGE 3
SECTION D–D
SECTION C–C
SECTION B–B
SECTION A–A

Exhibit -10P~~ML~~

~~DEVELOPMENT OF SUPERELEVATION ON OPPOSITE DIRECTION CURVED ROAD~~Development of Superelevation on Opposite Direction Curved Road

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EDGE 2
SECTION D - D
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EDGE 2
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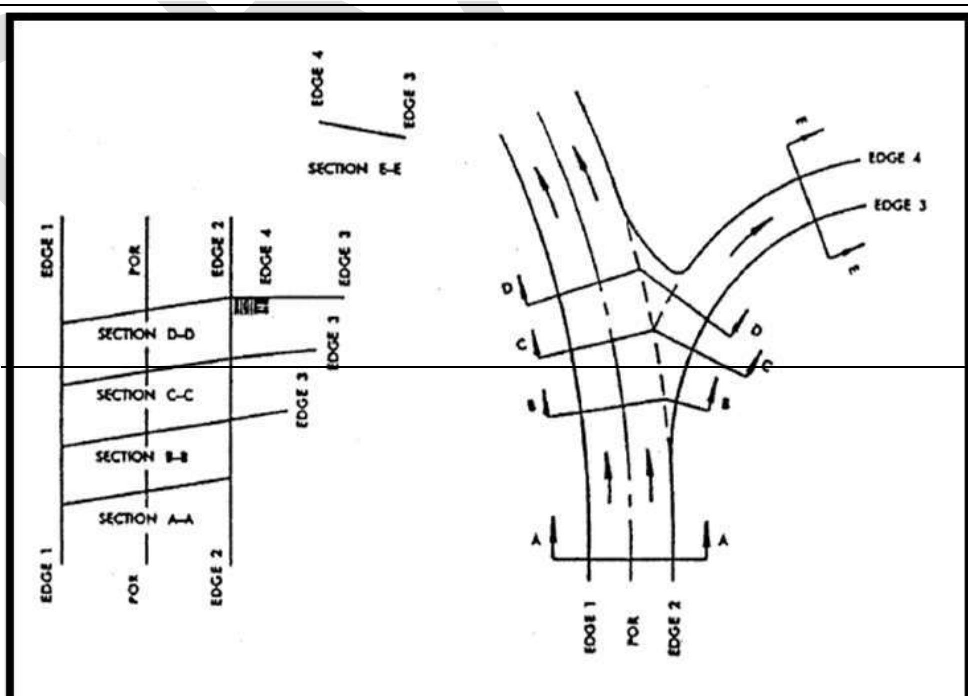
EDGE 1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EDGE 3
SECTION E-E
EDGE 1
POR
EDGE 2
SECTION D-D
SECTION C-C
SECTION B-B
SECTION A-A
D
C
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A
E
EDGE 1
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EDGE 2

Signing and Pavement Marking

The ability of drivers to follow the intended paths at interchanges depends largely on their relative spacing, geometric layout, and positive signing. The location and proper distances between the signs both depend to a large degree on whether effective and positive messages can be provided to inform, warn, and ~~control~~ direct drivers.

Pavement striping, delineators, and other markings are also important elements of driver communication at ramps. Signing and pavement marking should be uniform and consistent with the *Ontario Traffic Manual Books.*

Section 10.6.3.1 – Exit Terminal Design

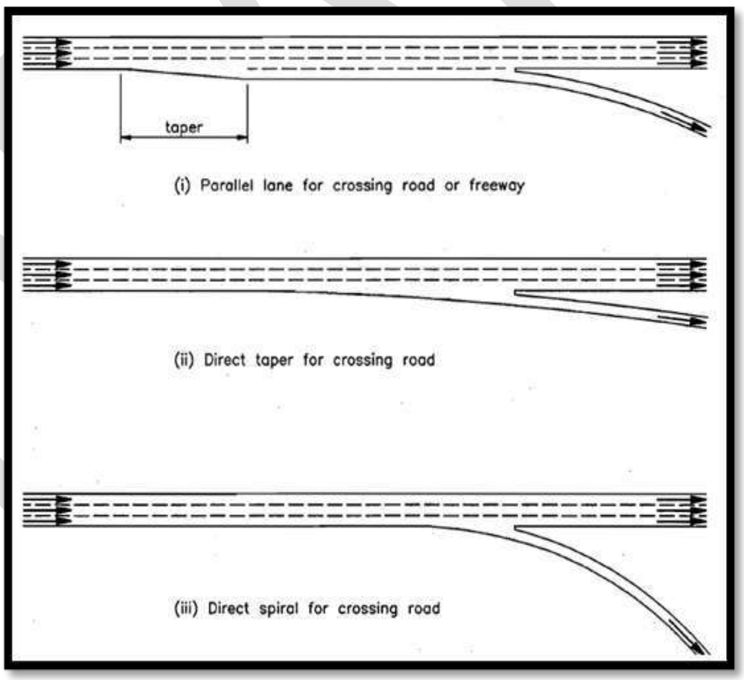
- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following ~~**additional Guidance**~~**additional guidance**:

Single-Lane Exit Design

On crossing roads, ~~the~~ direct spiral ~~form of~~ exit terminals~~ design~~ are~~is~~ used for through-road design speeds up to 60 km/h.~~, the~~ D~~d~~irect tapers ~~form is~~are used for through--road design speeds up to 100 km/h, and ~~the~~ parallel ~~form~~speed change lanes are~~is~~ used for higher design speeds. Types of single-lane exit configurations are shown in **Exhibit -10Q~~NM~~**.

Exhibit -10Q~~NM~~

~~**SINGLE-LANE EXIT TERMINAL CONFIGURATION**~~**Single-Lane Exit Terminal Configuration**

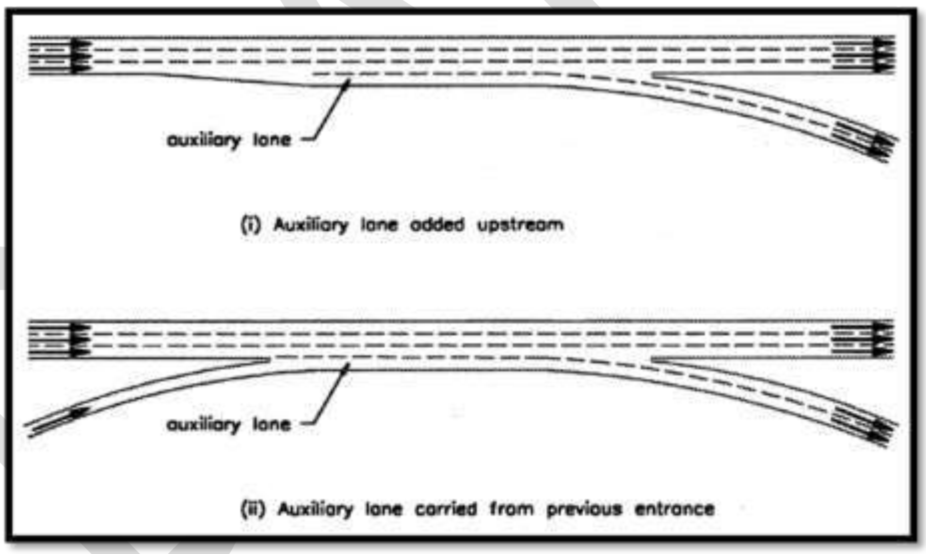


Two-Lane Exit Design

Types of two-lane exit configurations are shown in **Exhibit -10R~~ON~~**.

Exhibit -10R~~OO~~

~~TWO-LANE EXIT TERMINAL CONFIGURATION~~Two-Lane Exit Terminal Configuration

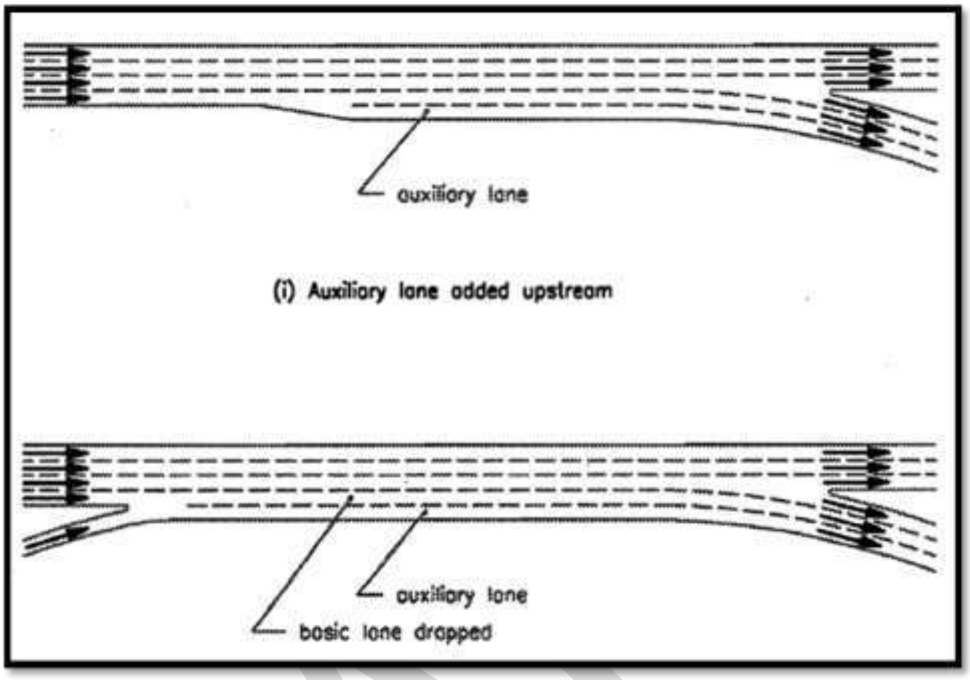


Three-Lane Exit Designs

Three-lane exits are sometimes ~~applied~~ used at~~ a~~ freeway-to-freeway interchanges where there is a reduction in the number of basic lanes. The design of a three-lane exit terminal is identical to that of a two-lane exit with an additional lane to the right (~~looking~~ in the direction of travel). Generally, the right lane is an auxiliary lane, and the adjacent lane is a basic lane ~~to be~~which is dropped at the interchange, illustrated in **Exhibit -10SP~~O~~**.

Exhibit -10S~~PO~~

~~THREE-LANE EXIT TERMINAL CONFIGURATION~~Three-Lane Exit Terminal Configuration



Exit Terminal Bullnoses

Bullnoses for exit terminals may include or exclude curb and gutter. If curb and gutter is omitted, the bullnose is squared off and if it is included the bullnose is rounded. Illustrations and dimensions ~~and~~ are shown in **Exhibits -10T** and **10U~~QP~~**. ~~and **Exhibit 10Q** respectively.~~

The exit bullnose is the decision point ~~area~~ that must be clearly seen and understood by the approaching driver. Collision rates in the vicinity of bullnoses are higher than at other locations at exits and for this reason the bullnose is ~~usually~~ typically offset laterally from ~~the~~ through traffic to provide a recovery area for errant vehicles.

Bullnose areas normally consist of pavement only, without curb, unless ~~drainage considerations indicate a benefit from use of curb~~a curb is required to accommodate drainage requirements.

Exhibit -10T~~QP~~

Exit~~XIT~~ Terminal~~ERMINAL~~ Bullnose~~ULLNOSE~~ and ~~AND~~ Offset~~FFSET~~ Illustrations~~LLUSTRATIONS~~

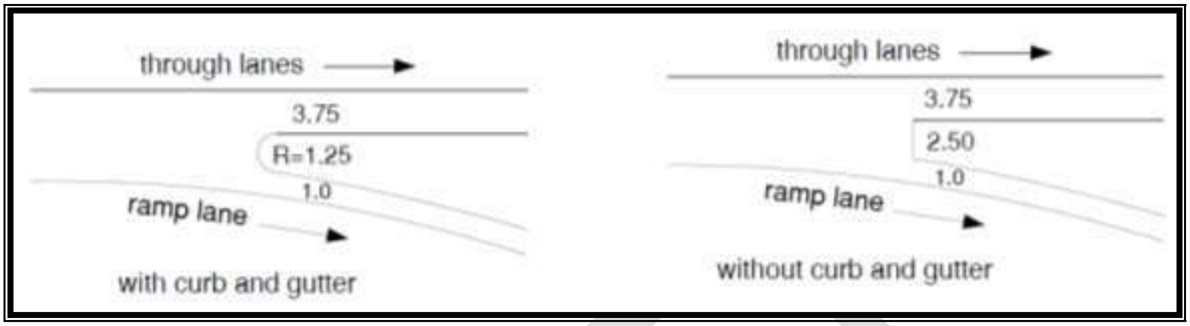


Exhibit -10U~~Q~~

Exit~~XIT~~ T~~ERMINAL~~erminal B~~ULLNOSE~~ullnose ~~AND~~and O~~FFSET~~ffset D~~IMENSIONS~~imensions

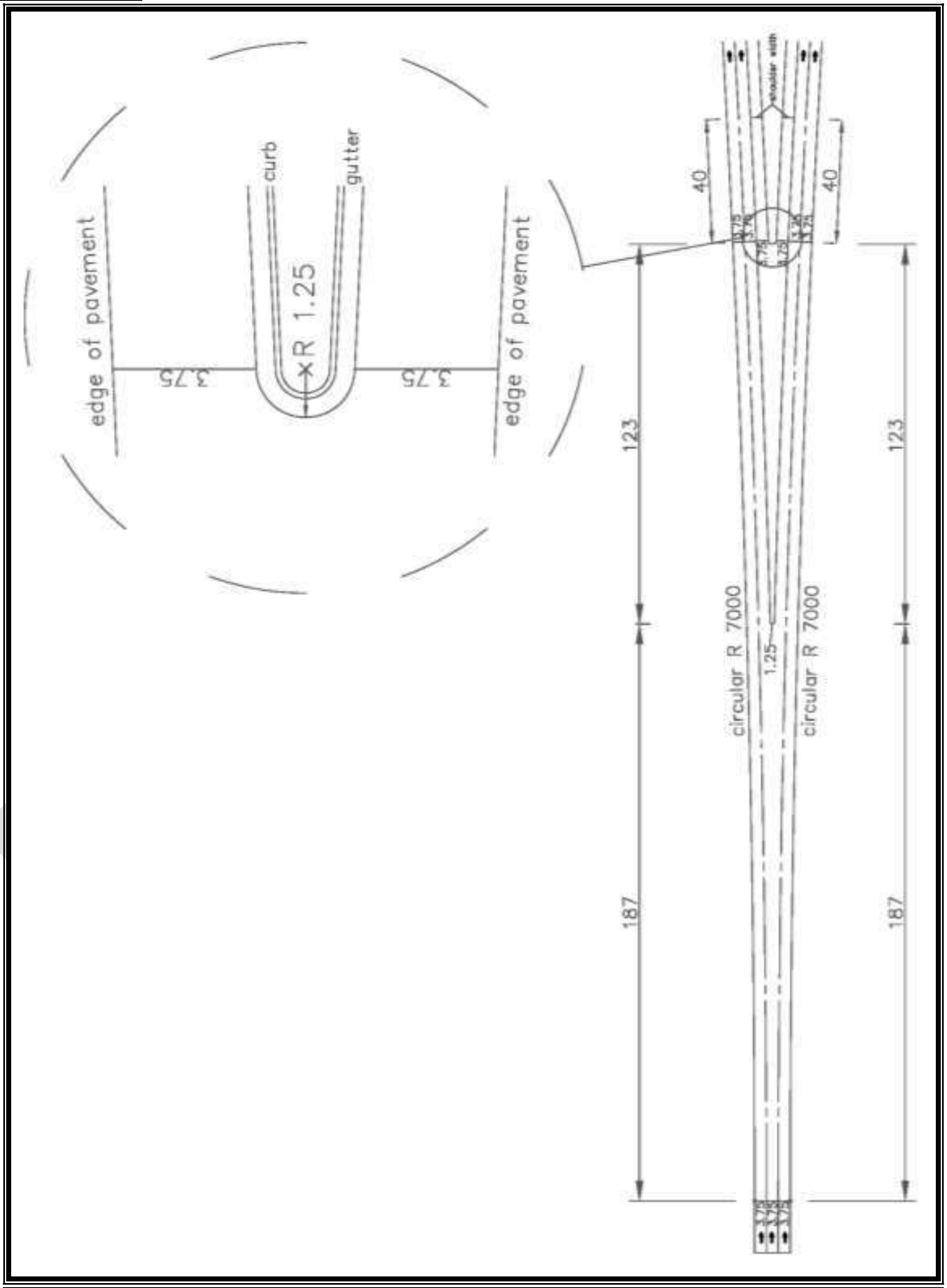
Design Speed km/h	50	60	70	80	90	100	110	120	130
Bullnose Offset ‘f’ (m)	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6

Major Forks

A major fork is a location where a highway divides into two separate, high-volume routes. Unlike a typical off-ramp serving a local road, both branches of a major fork typically carry significant traffic volumes and are designed to accommodate high speeds. **Exhibit 10V**~~?~~ Provides recommended design parameters for major forks.

Exhibit 10V~~?~~

~~—~~Major Fork



Section 10.6.3.4 – Sight Distance to Exit Terminals

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  Sight distance, greater than minimum stopping sight distance, is required for ~~the~~ a driver to make a series of decisions and execute ~~the~~ a manoeuvre safely. **Exhibit -10W~~R~~** shows sight distance to the bullnose for exit terminal (or sight distance to end of terminal for entrance ramp) for a range of design speeds. It is desirable for ~~the~~ a driver to see the pavement surface at the bullnose from a distance at least equal to this sight distance, illustrated in *Figure 10.6.3 of Chapter 10 - Interchanges*. Ideally, ~~the~~ a driver should have a view of the pavement surface of part of the ramp beyond the bullnose. A range of values is shown in the table to reflect the variation in complexity of different cases. In general, rural conditions are less complex and therefore the lower values are adequate, but urban conditions present a variety of complexities and higher values should be used.

Figure 10.6.3 – Sight Distance at Exit Terminals

- This Figure ~~is Applicable~~is **applicable except** driver eye height ~~of driver's eye should be~~is 1.08 m.

Exhibit -10W~~R~~

~~SIGHT DISTANCE AT EXIT OR ENTRANCE TERMINALS~~Sight Distance at Exit or Entrance Terminals

Design Speed km/h	60	70	80	90	100	110	120	130
Exit Sight Distance to Bullnose (m) **Entrance Sight Distance to End of Terminal (m)**	170 to 230	200 to 270	240 to 310	270 to 350	300 to 390	340 to 430	370 to 470	390 to 510

Section 10.6.4.1 – Entrance Terminal Design

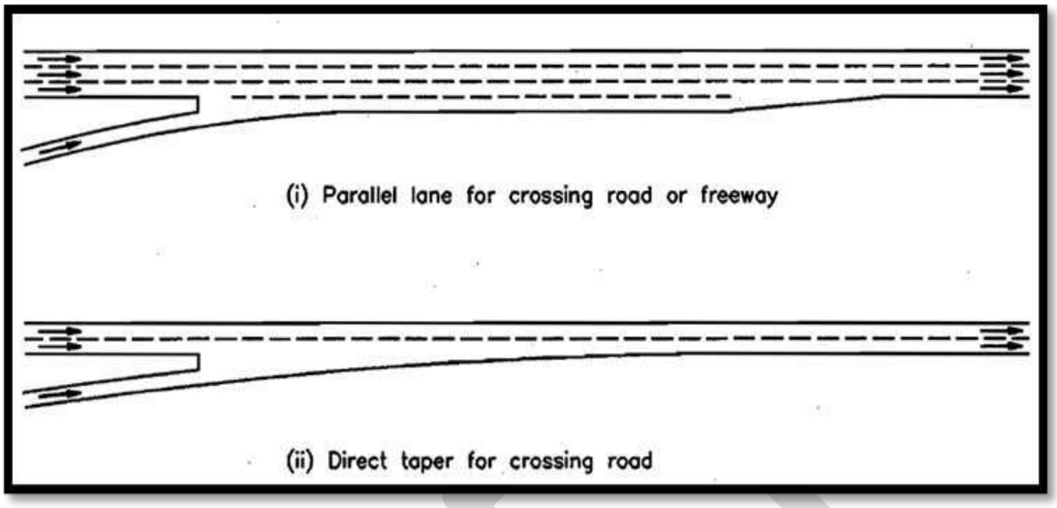
- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

  Single-Lane Entrance

  On crossing roads, ~~the~~ direct taper ~~form of~~ entrance terminals are~~is~~ used for through-road design speeds up to 80 km/h, and ~~the~~ parallel speed change lanes ~~form is~~are used for higher design speeds. Types of single-lane entrance configurations are shown in **Exhibit -10X~~S~~**.

Exhibit -10X~~S~~

~~SINGLE-LANE ENTRANCE TERMINAL CONFIGURATION~~Single-Lane Entrance Terminal Configuration

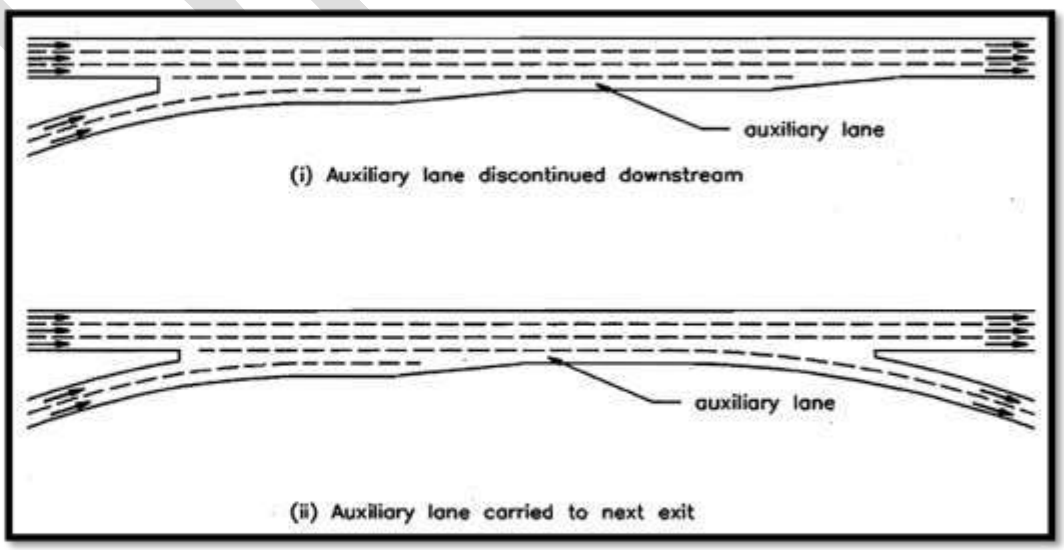


Two-Lane Entrance

Types of two-lane entrance configurations are shown in **Exhibit -10Y~~T~~**. Where both auxiliary lanes are terminated, the left auxiliary lane shall continue a minimum distance equal to the length of a single acceleration lane beyond the taper of the terminated right acceleration lane. Taper lengths, curve radii and parallel lane length shall be the same as for equivalent single acceleration lanes.

Exhibit -10Y~~T~~

~~TWO-LANE ENTRANCE TERMINAL CONFIGURATION~~Two-Lane Entrance Terminal Configuration

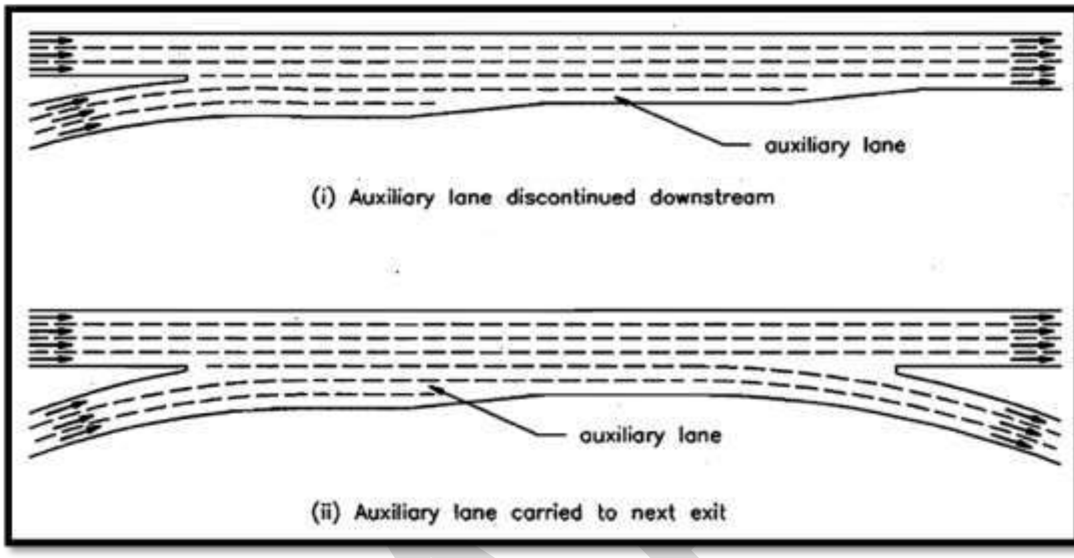


Three-Lane Entrance

Three-lane entrances are sometimes required at a freeway-to-freeway interchange where there is an increase in the number of basic lanes. The design of a three-lane freeway entrance terminal is identical to that of a two-lane entrance with an additional lane to the right. Commonly, the two right lanes are auxiliary lanes, and the adjacent lane is a basic lane added at the interchange, illustrated in **Exhibit -10Z~~U~~.** Where multiple acceleration lanes are terminated, the same guidance as for double lanes applies.

Exhibit -10Z~~U~~

Three~~HREE~~-Lane~~ANE~~ Entrance~~NTRANCE~~ Terminal~~ERMINAL~~ Configuration~~ONFIGURATION~~



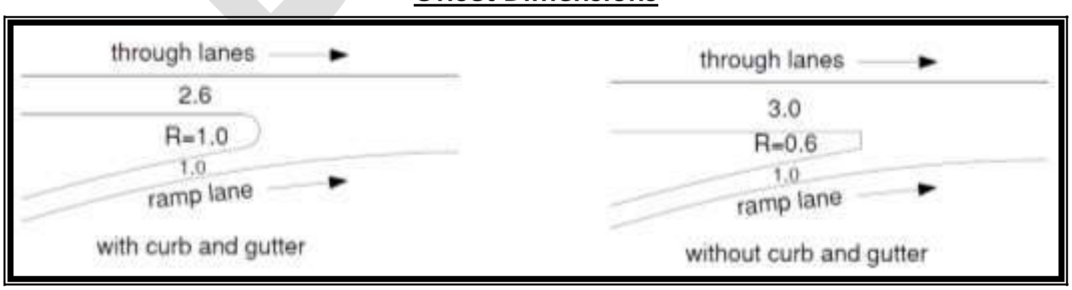
Entrance Terminal Bullnoses

Similar to exit terminal bullnoses, entrance terminals bullnoses may include or exclude curb and gutter. If curb and gutter is omitted the bullnose is squared off, and if it is included it is rounded. Dimensions are shown in **Exhibit- 10AA~~V~~**.

Bullnose areas normally consist of pavement only, without curb, unless a curb is required to accommodate drainage requirements~~drainage considerations indicate a benefit from use of curb~~.

Exhibit -10AA~~V~~

~~ENTRANCE TERMINAL BULLNOSE AND OFFSET DIMENSIONS~~Entrance Terminal Bullnose and Offset Dimensions



Section 10.6.4.2 Entrance Terminal Length

- This section is not applicable and is replaced with the following guidance:

The length of an entrance terminal is determined by the design speed of the freeway and whether the entrance terminal connects to an inner or outer loop ramp.

Exhibits 10AB~~?~~ and **10AC~~?~~** show the design parameters for entrance terminals. Acceleration lane lengths are measured from the bullnose to the end of the taper.

Where acceleration lanes are on grades steeper than 3% the speed change lane length shall be adjusted by the appropriate grade factor given in Table 10.6.3.

Trucks and buses require longer acceleration distances than passenger cars. Where a substantial number of large vehicles entering the freeway is expected, longer acceleration lanes are appropriate. Refer also to Sections 10.1.4.17 and 10.1.4.18.

Where entrance terminals occur on a crest curve, sight distances to the end of the lane may be affected and longer acceleration lanes are required.

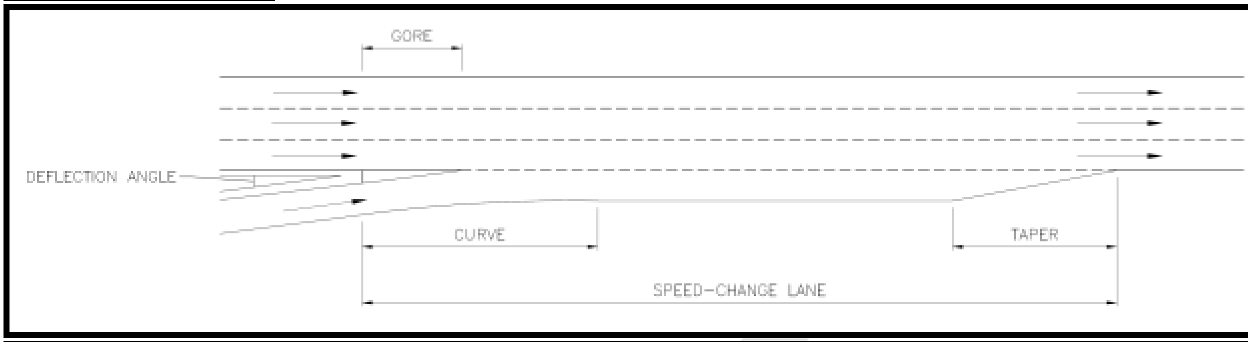
Exhibit 10AB~~?~~

Parallel Lane Entrance Design Dimensions

Design Speed of Freeway (km/h)	**Total Length of (S.C.L) Including Taper (m)**	**From Inner Loop**				**From Outer Loop**				**Taper Length (m)**
		Entry Curve		**Length of**		**Exit Curve**		**Length of**		
		Radius (m)	**Deflection Angle (degrees)**	**Gore Area (m)**	**Curve (m)**	**Radius (m)**	**Deflection Angle (degrees)**	**Gore Area (m)**	**Curve (m)**	
100	300	1000	6	35	105	2000	4	55	150	80
110	400	1250	6	40	120	3000	4	65	185	85
≥120	500	1500	5	45	130	4000	3	75	215	90

Exhibit 10AC

~~?~~ Parallel Lane Entrance Design Parameters



Direct taper style entrance terminals shall not be constructed on freeways and high-speed divided roadways. Such designs are typically stop or yield controlled which violates driver expectations. Violations of stop and yield controls are frequent which may require sudden evasive manoeuvers for through freeway traffic.

Direct entrance tapers on crossing roads are often associated with Parclo B- type interchanges which are not typically constructed as part of new or expanded facilities. Where ramp terminals require a right-turn channel and taper, these should be designed according to the guidance in Chapter 9.

~~Table 10.6.5 – Design Length for Acceleration~~

~~This Table is Not Applicable and is replaced with **Exhibit -10W:**~~

~~Exhibit -10W~~

~~Design Length for Acceleration~~

~~Speed of Roadway (km/h)~~		~~Length of Taper (m) L_1~~	~~Length of Acceleration Lane Excluding Taper (m) L_a — Design Speed of Turning Roadway Curve (km/h)~~							
~~Design~~	~~Merge~~		~~Stop condition~~	~~20~~	~~30~~	~~40~~	~~50~~	~~60~~	~~70~~	~~80~~
~~60~~	~~45~~	~~55~~	~~95~~	~~80~~	~~65~~	~~45~~	-	-	-	-
~~70~~	~~53~~	~~65~~	~~150~~	~~130~~	~~110~~	~~90~~	~~65~~	-	-	-
~~80~~	~~60~~	~~70~~	~~200~~	~~180~~	~~165~~	~~145~~	~~115~~	~~65~~	-	-
~~90~~	~~67~~	~~80~~	~~260~~	~~245~~	~~225~~	~~205~~	~~175~~	~~125~~	~~35~~	-
~~100~~	~~74~~	~~85~~	~~345~~	~~325~~	~~305~~	~~285~~	~~255~~	~~205~~	~~110~~	~~40~~
~~110~~	~~81~~	~~90~~	~~430~~	~~410~~	~~390~~	~~370~~	~~340~~	~~290~~	~~200~~	~~125~~
~~120~~	~~88~~	~~95~~	~~545~~	~~530~~	~~515~~	~~490~~	~~460~~	~~410~~	~~325~~	~~245~~
~~130~~	~~92~~	~~100~~	~~610~~	~~580~~	~~550~~	~~530~~	~~520~~	~~500~~	~~375~~	~~300~~

~~The selection of ramp design speed as discussed in Exhibit 10E should be referred.~~

~~1. The values in the above table are based on AASHTO Greenbook 2018.~~

Section 10.6.4.4 – Sight Distance at Entrance Terminal

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **additional guidance**:

  The required length of sight distance is provided in **Exhibit -10W~~R~~**.

Figure 10.6.4 – Line of Sight and Sight Distance at Entrance Terminals

- This Figure ~~is Applicable~~is **applicable** **except** driver eye height ~~of driver's eye should be~~is 1.08 m.

Section 10.6.5 – Ramp Terminal Spacing

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **~~additional Guidance~~additional guidance**:

Successive Entrance Ramps

Where two ramps enter a freeway in close succession, for example, in the case of a parclo A-4, the configuration may be treated in one of two ways as illustrated in **Exhibit 10-AD~~XW~~.**

The most ~~usual~~ common treatment is to carry each ramp directly and independently to the freeway as shown in **Exhibit~~-~~ 10AD~~XW~~ (i).** This ~~form~~ method provides ~~ramp~~ entering traffic with separate opportunities to merge with through traffic and to disperse.

An alternative treatment is to merge the two ramp movements ~~with~~ into a single movement and then to carry the combined ramp traffic onto the freeway through a single entrance, as shown in **Exhibit ~~-~~10AD~~XW~~ (ii)**. This form has ~~the~~ a disadvantage ~~in~~ that a stalled vehicle or ~~accident~~ collision downstream of the merging of the two ramp movements will also delay the upstream ramp traffic on both approaches. The design shown in (ii) is useful to minimize the number of ramp entrances to a freeway for example, if this were required for ramp metering.

Section 10.7.4 – Grading and Landscaping Development

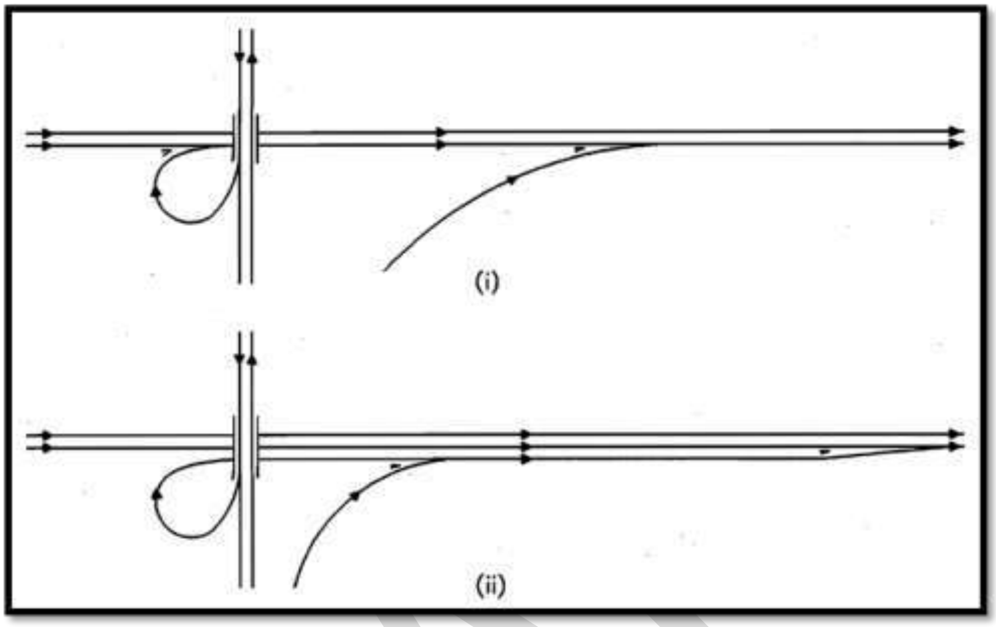
- ~~• This Section~~This section ~~is Applicable~~is **applicable** including the following ~~**additional Guidance**~~**additional guidance**:
-

Open ditches are preferable for drainage on interchange ramps whenever possible. Curb and gutter may be considered where property or other constraints make such construction more cost effective than drainage by open ditch.

  - Planting vegetation can increase ~~the~~ carbon-absorption capacity and reduce the overall carbon footprint of the highway infrastructure, as well as be more aesthetically pleasing.
  - Vegetation has a stabilizing effect that reduces erosion on slopes.
  - Vegetation serves to retain water from precipitation events and can potentially assist with drainage capacity.

Exhibit -10-X~~W~~

~~SUCCESSIVE ENTRANCE RAMPS~~Successive Entrance Ramps



Section 10.8 – Typical Interchange Design Features

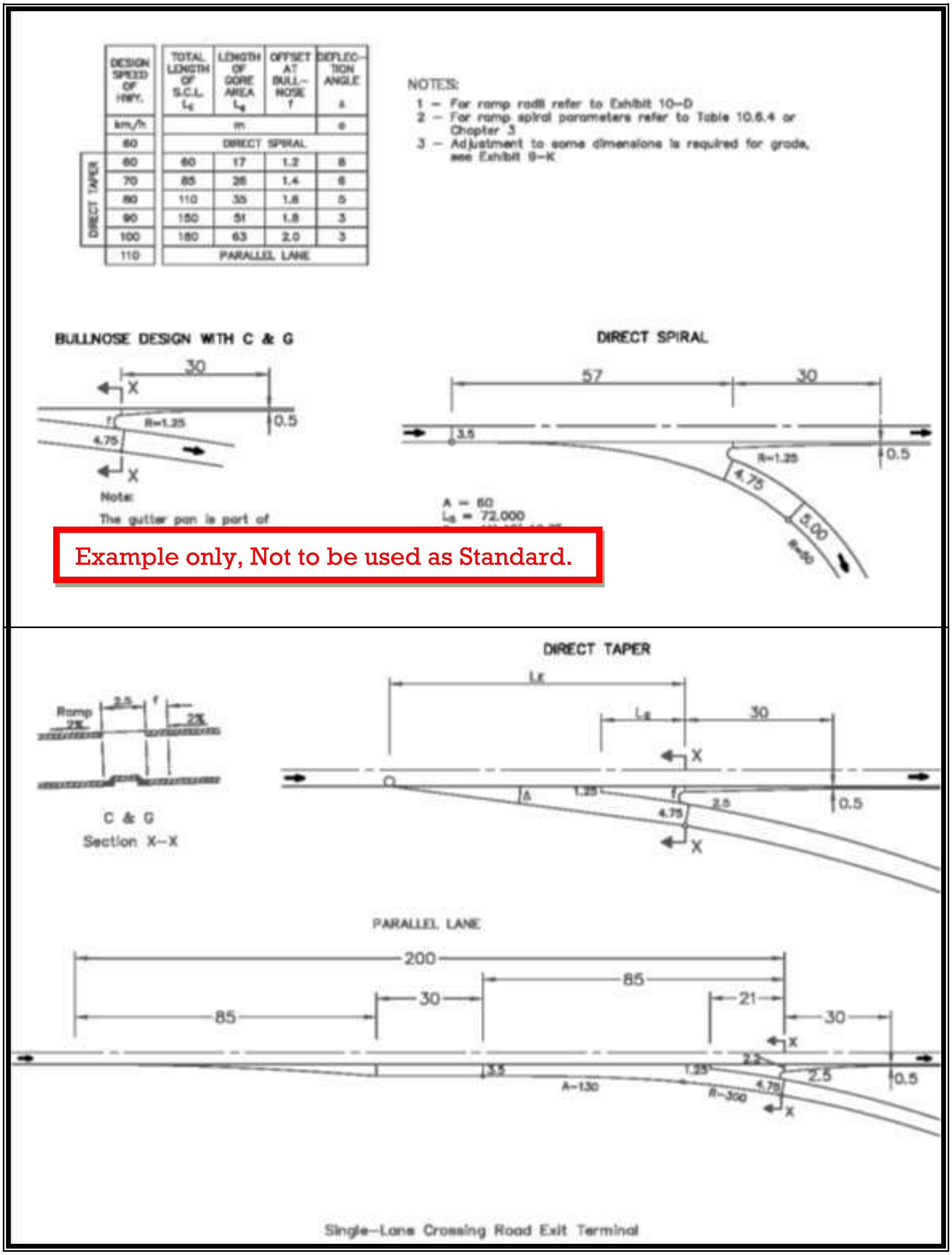
- Figure 10.8.1 to Figure 10.8.12 are ~~**Not Applicable**~~**not applicable** and are **replaced** with the following:

  Examples of typical design for exit terminals and entrance terminals are shown in **Exhibit -10AE~~YX~~** to **Exhibit -10AQ~~LK~~**, followed by examples of at-grade intersections of some commonly used Parclo A and Parclo B ramp terminals at crossing arterial roads in **Exhibit -10-AL~~HG~~** to **Exhibit -10-AP~~LK~~**. ~~Expressway/core-collector system are illustrated in **Exhibit -10-AMNM** and **Exhibit -10-ANON**.~~ These designs should be regarded as typical rather than standard and are for the guidance of the designer. Rigid adherence to these designs may produce unsatisfactory operation in some cases. Dimensions are typical, and variations are required to suit local conditions of alignment, grade profile, traffic volume, traffic mix and typical physical and environmental features. Nor are the designs necessarily complete in every detail, and additional detailing may be required.

  These exhibits are typical examples and for guidance only. ~~The designers should select~~For design ~~pusposes~~purposes, the values from the domains provided in the Chapter 10 of TAC GDG and this Design Supplement are to be used.

Exhibit -10AE~~YX~~

Single--Lane Crossing Road at Exit Terminal



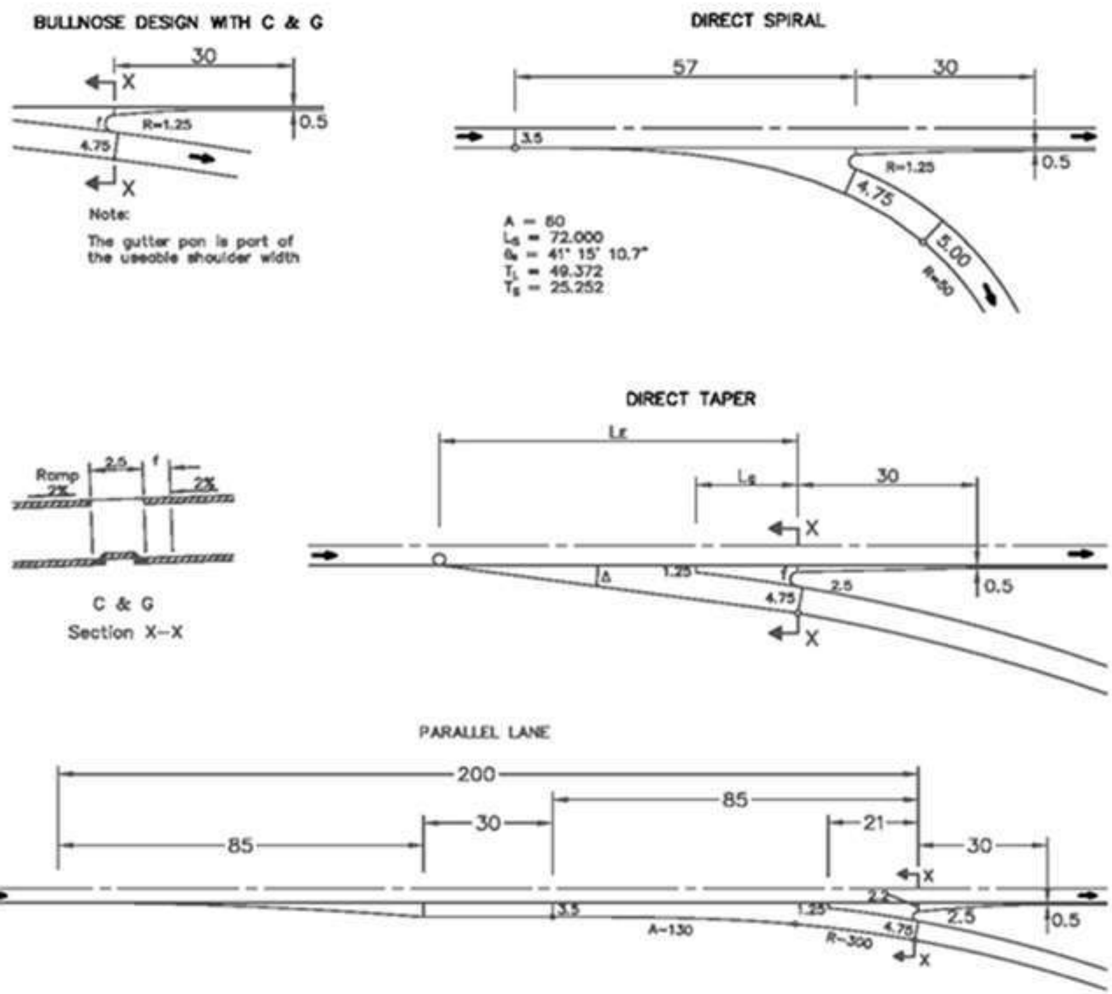
DESIGN SPEED OF HWY.	TOTAL LENGTH OF S.C.L. L_t	LENGTH OF GORE AREA L_g	OFFSET AT BULL-NOSE f	DEFLECTION ANGLE Δ
km/h	m			°
60	DIRECT SPIRAL			
60	60	17	1.2	8
70	85	26	1.4	6
80	110	35	1.6	5
90	150	51	1.8	3
100	180	63	2.0	3
110	PARALLEL LANE			

	Design Speed of Hwy.	Total Length of S.C.L. L_t	Length of Gore Area L_g	Offset at Bull-Nose f	Deflection Angle Δ
	km/h	m			°
	60	DIRECT SPIRAL			
DIRECT TAPER	60	60	17	1.2	8
	70	85	26	1.4	6
	80	110	35	1.6	5
	90	150	51	1.8	3
	100	180	63	2.0	3
	110	PARALLEL LANE			

Notes:

1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.

Example only, Not to be used as Standard.

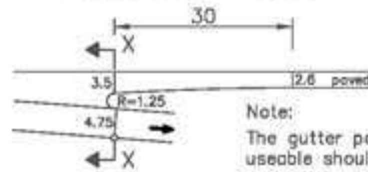


Single–Lane Crossing Road Exit Terminal

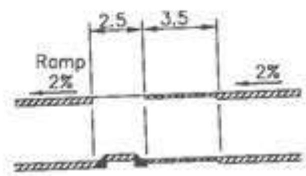
Exhibit -10AF~~ZY~~
Single-Lane Freeway Exit Terminal

DESIGN SPEED OF HWY.	TOTAL LENGTH OF S.C.L. INCL. TAPER L_E	TO INNER LOOP: EXIT CURVE: RADIUS R	TO INNER LOOP: EXIT CURVE: DEFLECTION ANGLE Δ	TO INNER LOOP: LENGTH OF: GORE AREA L_g	TO INNER LOOP: LENGTH OF: CURVE L_c	TO INNER LOOP: LENGTH OF: PARALLEL SECTION L_p	TO OUTER LOOP: EXIT CURVE: RADIUS R	TO OUTER LOOP: EXIT CURVE: DEFLECTION ANGLE Δ	TO OUTER LOOP: LENGTH OF: GORE AREA L_g	TO OUTER LOOP: LENGTH OF: CURVE L_c	TO OUTER LOOP: LENGTH OF: PARALLEL SECTION L_p	TAPER LENGTH L_T
km/h	m	m	°	m			m	°	m			m
100	290	1000	7	50	121	89	1800	5	67	162	48	80
110	315	1250	6	56	135	95	2000	5	70	170	60	85
120	345	1500	5	61	148	107	3000	4	86	209	46	90

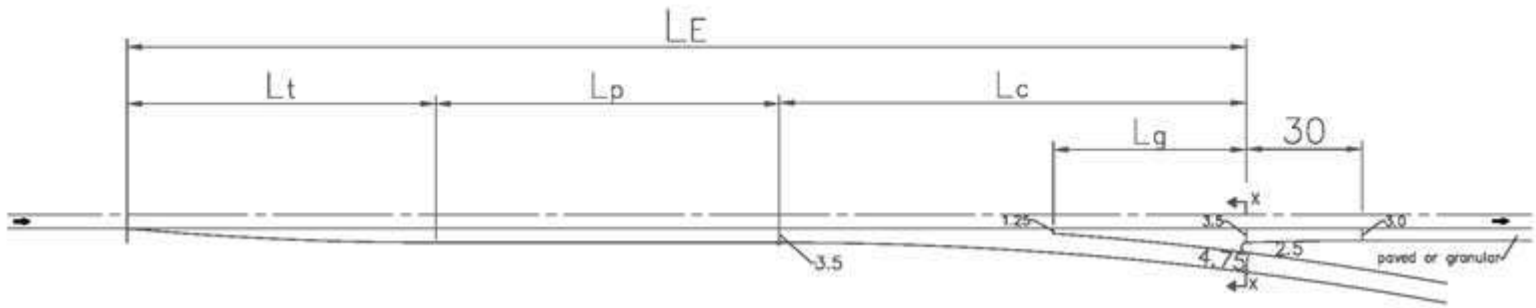
BULLNOSE DESIGN WITH C & G



Note:
The gutter pan is part of the useable shoulder width



C & G
Section X–X



EXIT CURVE DATA						
Δ	6°55'15"	6°11'15"	5°38'45"	5°09'10"	4°53'10"	3°59'15"
R	1000	1250	1500	1800	2000	3000
T	60.481	67.561	73.964	80.994	85.330	104.435
L	120.816	134.990	147.808	161.879	170.557	208.785

Notes:

1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.

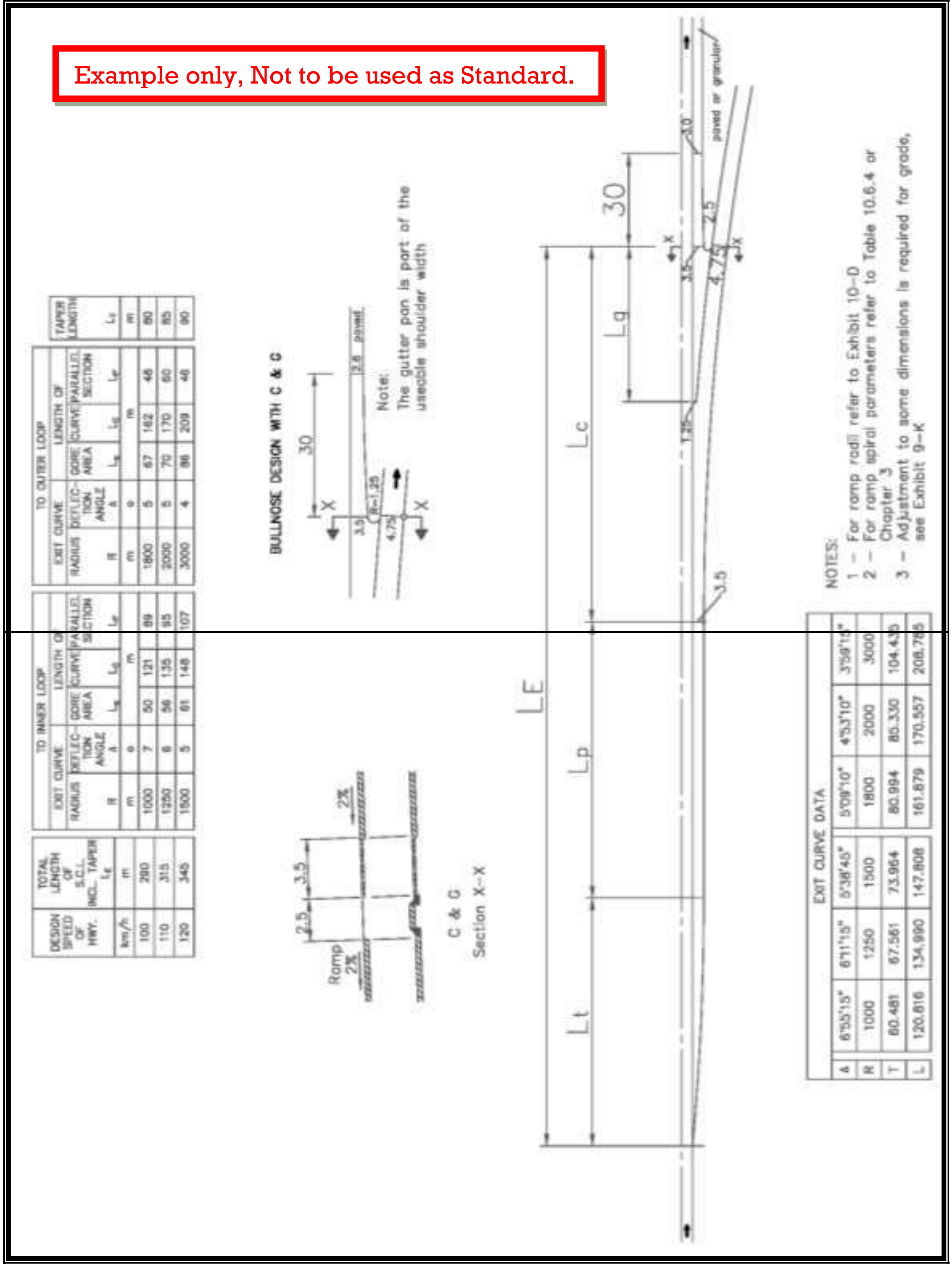
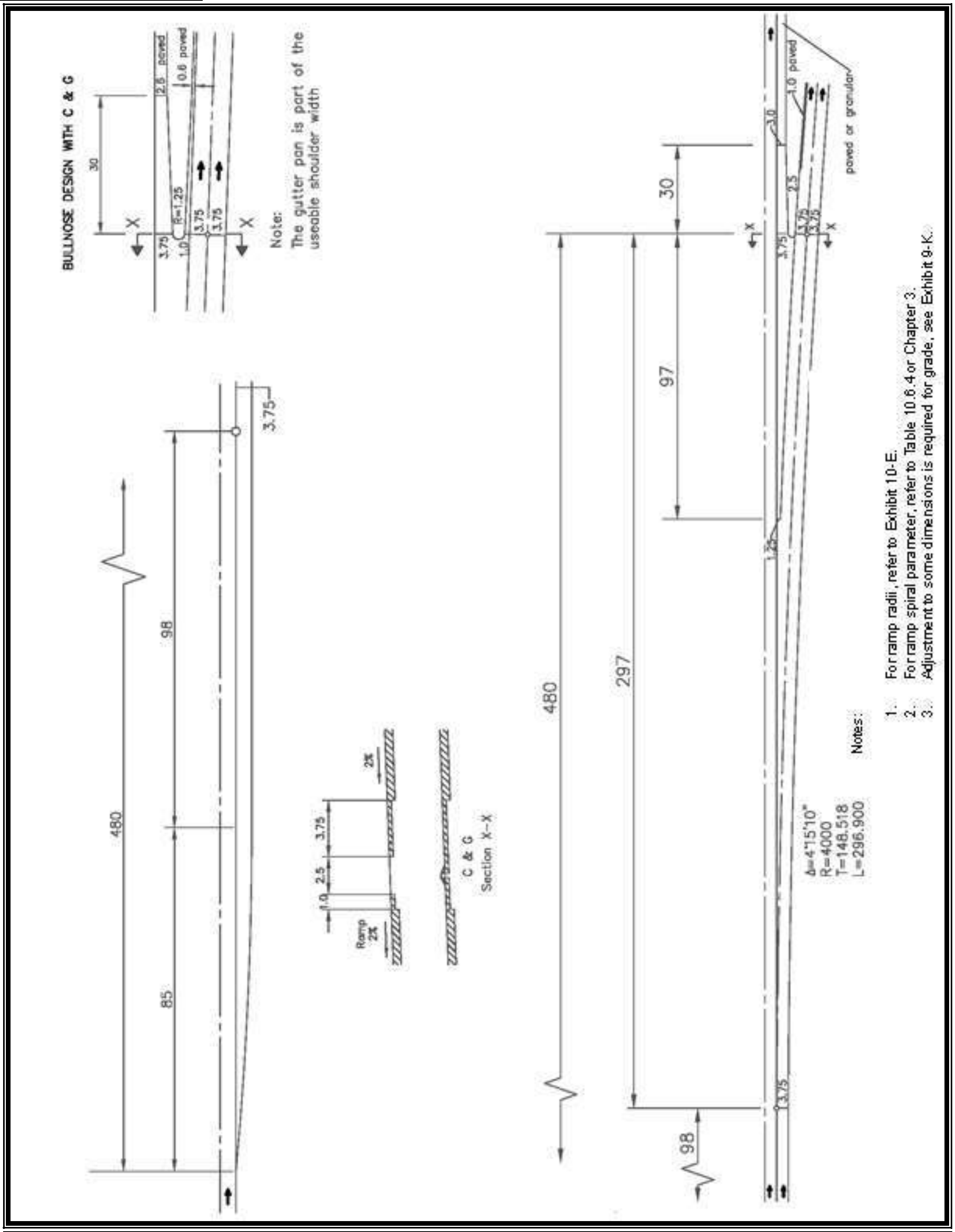


Exhibit- 10AG~~BZ~~

Two-Lane Freeway Exit Terminal, 110 km/h


BULLNOSE DESIGN WITH C & G
2.8 paved
0.6 paved
R=1.25
Note:
The gutter pan is part of the useable shoulder width
C & G
Section X–X
Ramp
2%
480
98
85
3.75
297
97
30
1.0 paved
paved or granular
Δ=4°15'10"
R=4000
T=148.518
L=296.900
Notes:
1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.

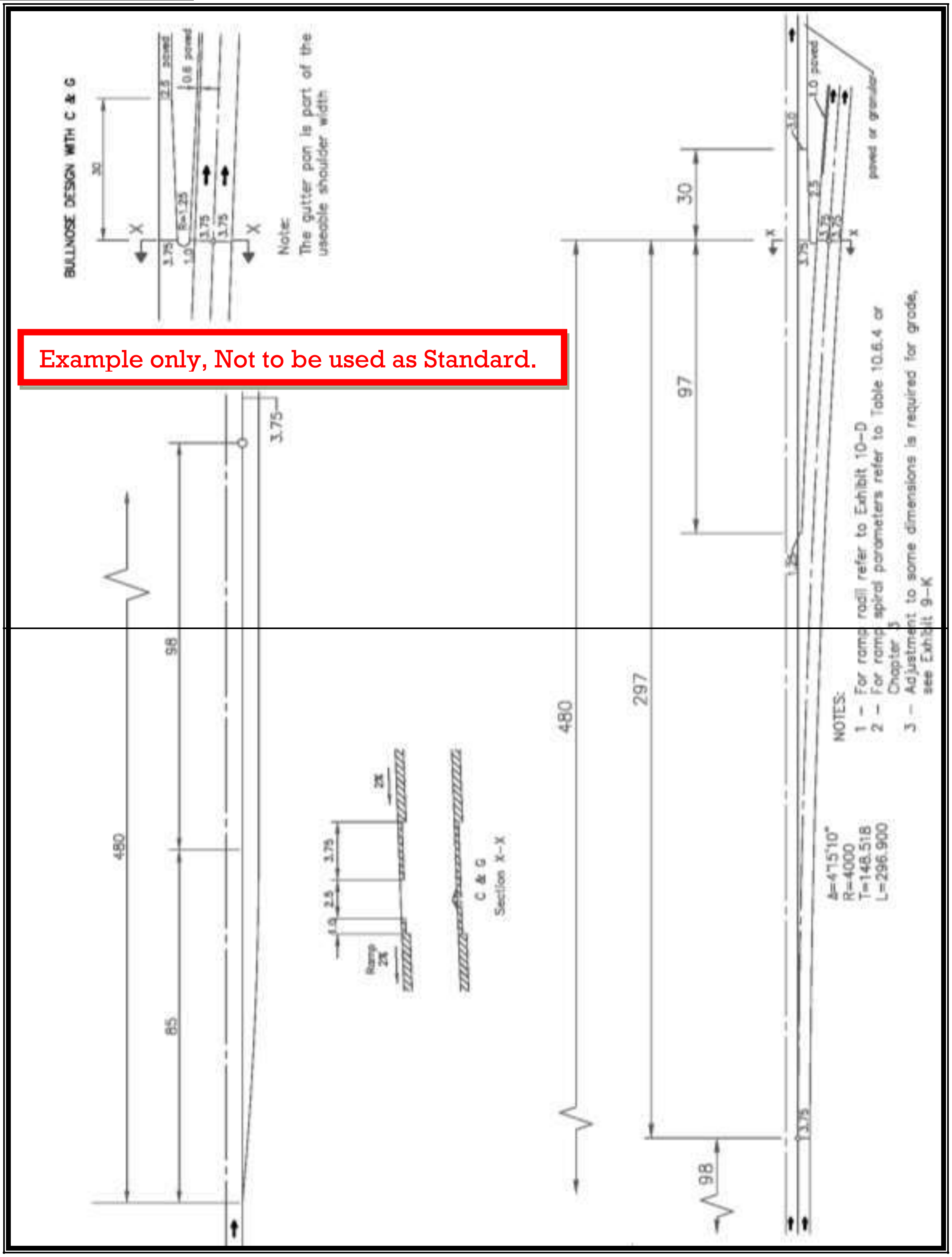
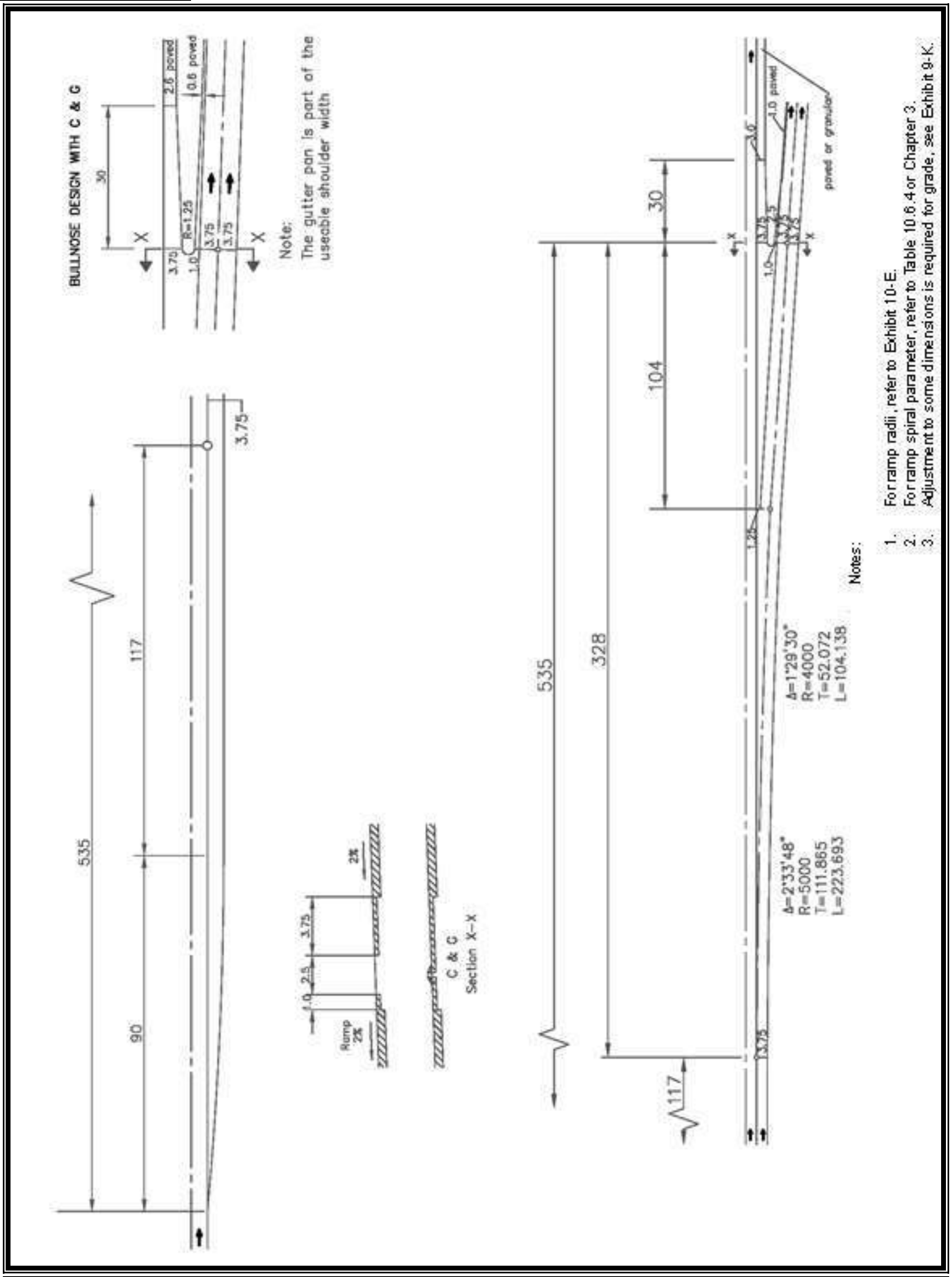


Exhibit -10AH~~CB~~

Two-Lane Freeway Exit Terminal, 120 km/h


BULLNOSE DESIGN WITH C & G
Note:
The gutter pan is part of the useable shoulder width
C & G
Section X–X
Δ=2°33'48"
R=5000
T=111.865
L=223.693
Δ=1°29'30"
R=4000
T=52.072
L=104.138
paved or granular
Notes:
1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.

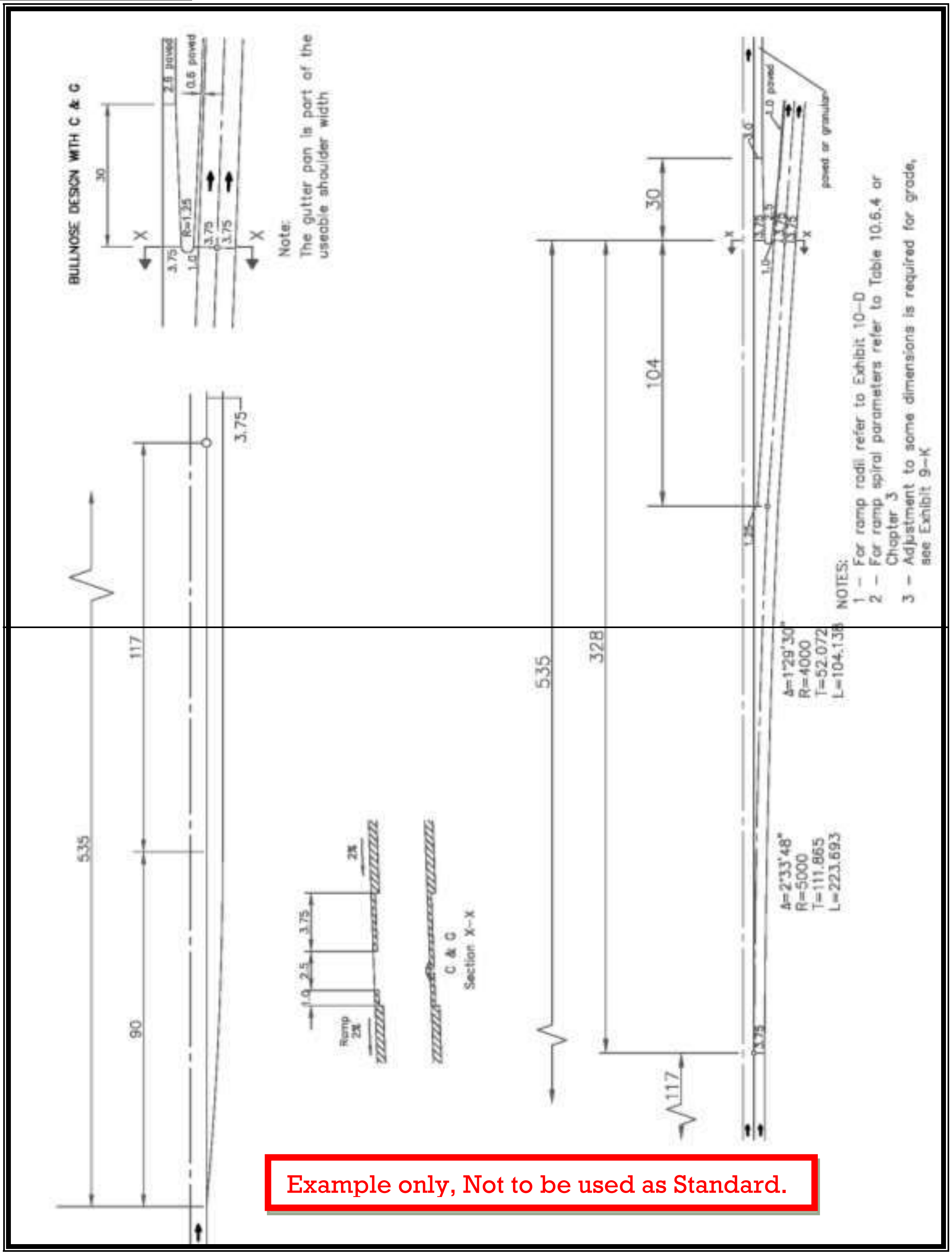
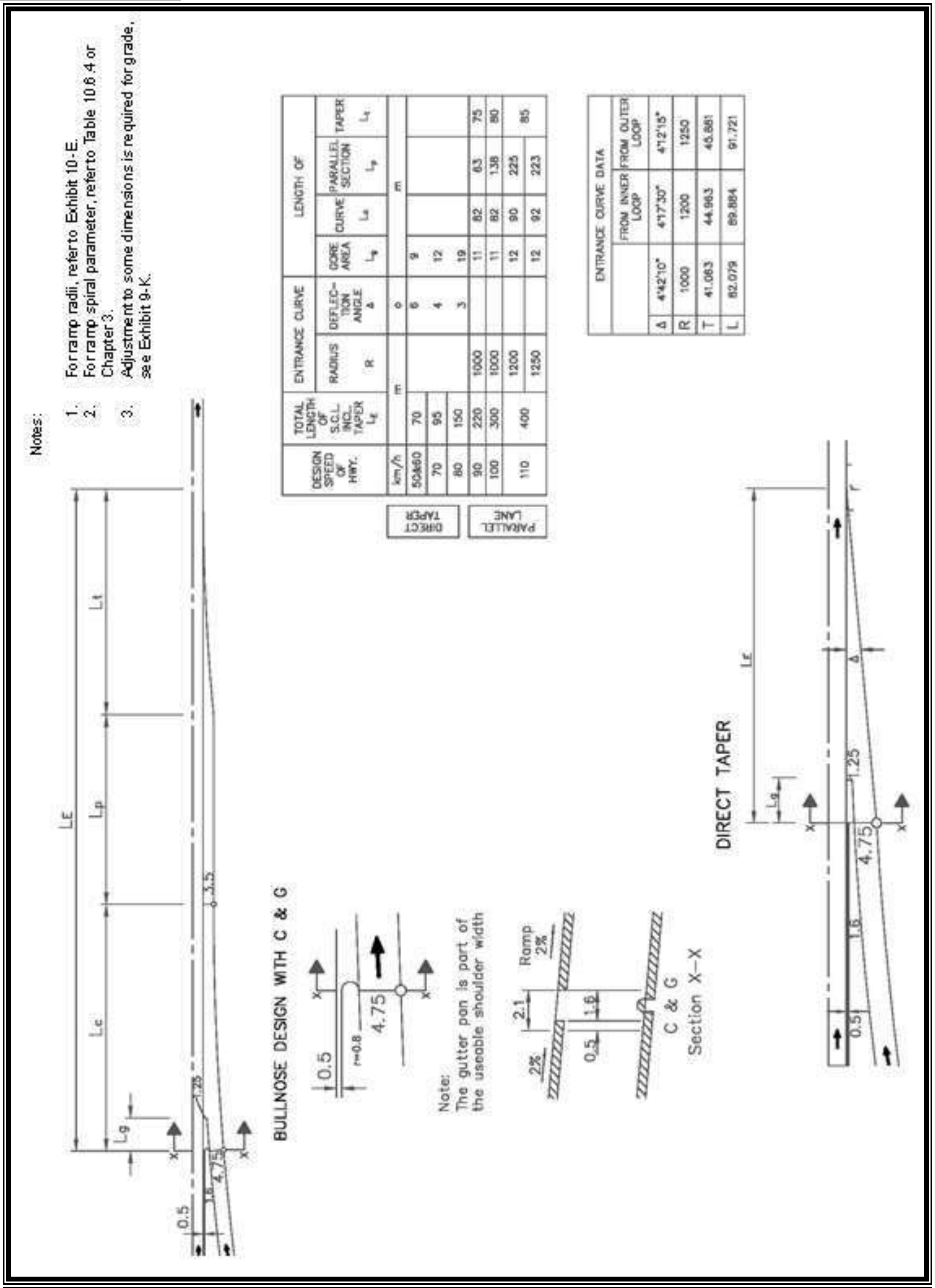


Exhibit ~~-~~10AI~~DC~~

Single-Lane Crossing Road Entrance Terminal

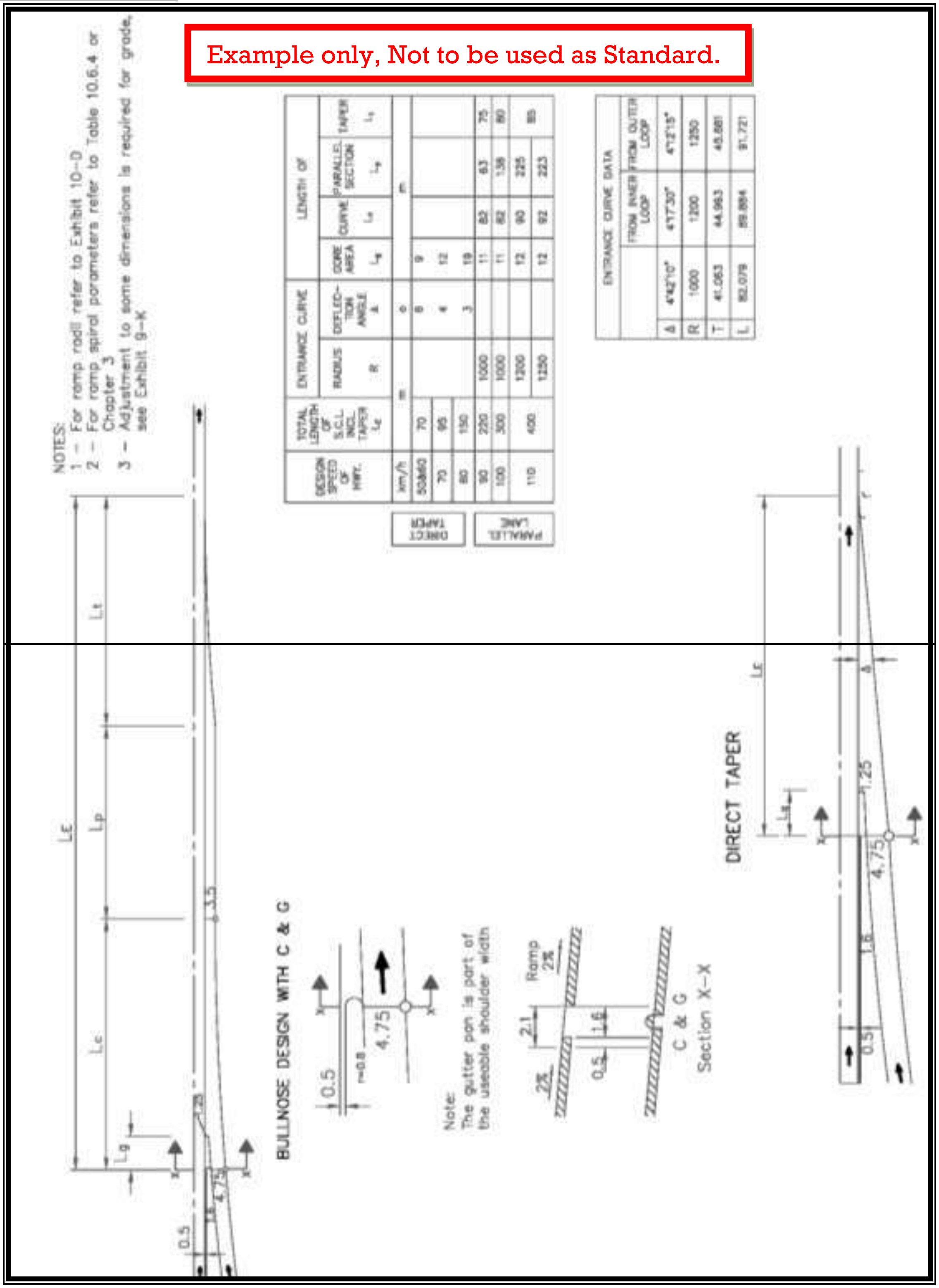


Notes:

1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.

	DESIGN SPEED OF HWY.	TOTAL LENGTH OF S.C.L. INCL. TAPER L_E	ENTRANCE CURVE RADIUS R	ENTRANCE CURVE DEFLECTION ANGLE Δ	LENGTH OF GORE AREA L_g	LENGTH OF CURVE L_c	LENGTH OF PARALLEL SECTION L_p	LENGTH OF TAPER L_t
	km/h	m		o	m			
DIRECT TAPER	50&60	70		6	9			
	70	95		4	12			
	80	150		3	19			
PARALLEL LANE	90	220	1000		11	82	63	75
	100	300	1000		11	82	138	80
	110	400	1200		12	90	225	85
			1250		12	92	223	

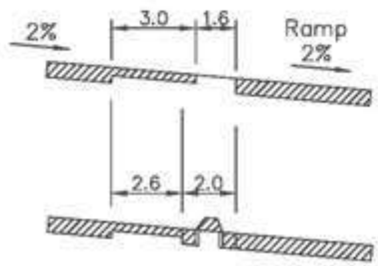
ENTRANCE CURVE DATA		FROM INNER LOOP	FROM OUTER LOOP
Δ	4°42'10"	4°17'30"	4°12'15"
R	1000	1200	1250
T	41.083	44.963	45.881
L	82.079	89.884	91.721



	DESIGN SPEED OF HWY.	TOTAL LENGTH OF S.C.L. INCL. TAPER L_E	ENTRANCE CURVE RADIUS R	ENTRANCE CURVE DEFLECTION ANGLE Δ	LENGTH OF GORE AREA L_g	LENGTH OF CURVE L_c	LENGTH OF PARALLEL SECTION L_p	LENGTH OF TAPER L_t
	km/h	m		o	m			
DIRECT TAPER	50&60	70		6	9			
	70	95		4	12			
	80	150		3	19			
PARALLEL LANE	90	220	1000		11	82	63	75
	100	300	1000		11	82	138	80
	110	400	1200		12	90	225	85
			1250		12	92	223	

ENTRANCE CURVE DATA		FROM INNER LOOP	FROM OUTER LOOP
Δ	4°42'10"	4°17'30"	4°12'15"
R	1000	1200	1250
T	41.063	44.963	45.881
L	82.079	89.884	91.721

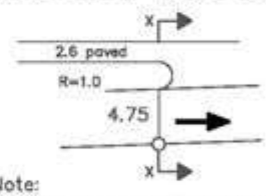
Exhibit -10AJ~~ED~~
Single-Lane Freeway Entrance Terminal



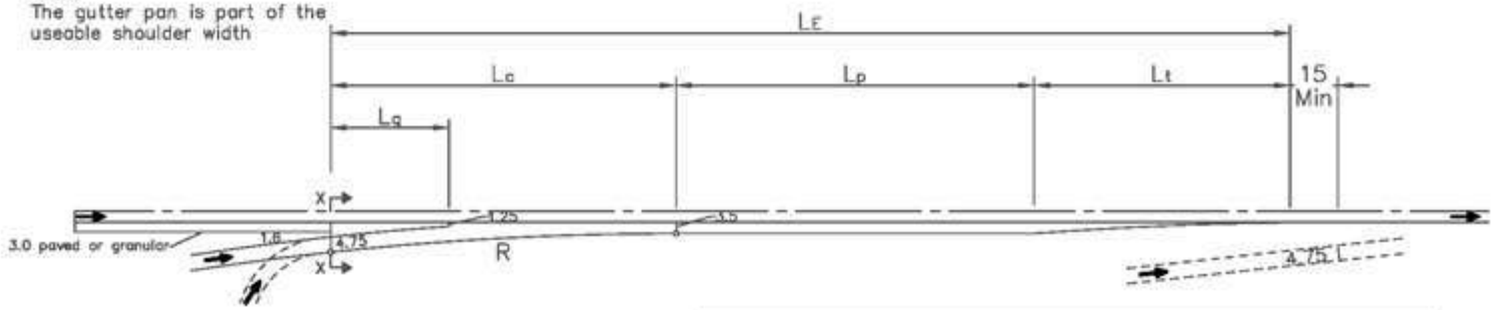
C & G
Section X–X

DESIGN SPEED OF HWY	TOTAL LENGTH OF S.C.L. INCL. TAPER L_E	FROM INNER LOOP: EXIT CURVE: RADIUS R	FROM INNER LOOP: EXIT CURVE: DEFLECTION ANGLE Δ	FROM INNER LOOP: LENGTH OF: GORE AREA L_g	FROM INNER LOOP: LENGTH OF: CURVE L_c	FROM INNER LOOP: LENGTH OF: PARALLEL SECTION L_p	FROM OUTER LOOP: EXIT CURVE: RADIUS R	FROM OUTER LOOP: EXIT CURVE: DEFLECTION ANGLE Δ	FROM OUTER LOOP: LENGTH OF: GORE AREA L_g	FROM OUTER LOOP: LENGTH OF: CURVE L_c	FROM OUTER LOOP: LENGTH OF: PARALLEL SECTION L_p	TAPER LENGTH L_T
km/h	m	m	o	m			m	o	m			m
100	300	1000	6	37	108	112	2000	4	53	153	67	80
110	400	1200	6	41	119	196	3000	4	65	187	128	85
120	500	1500	5	46	133	277	4000	3	75	216	194	90
THIS DESIGN IS USED WHEN LOCAL CONDITIONS WARRANT												
110	400	1000	6	37	108	207						
120	500	1000	6	37	108	302						

BULLNOSE DESIGN WITH C & G



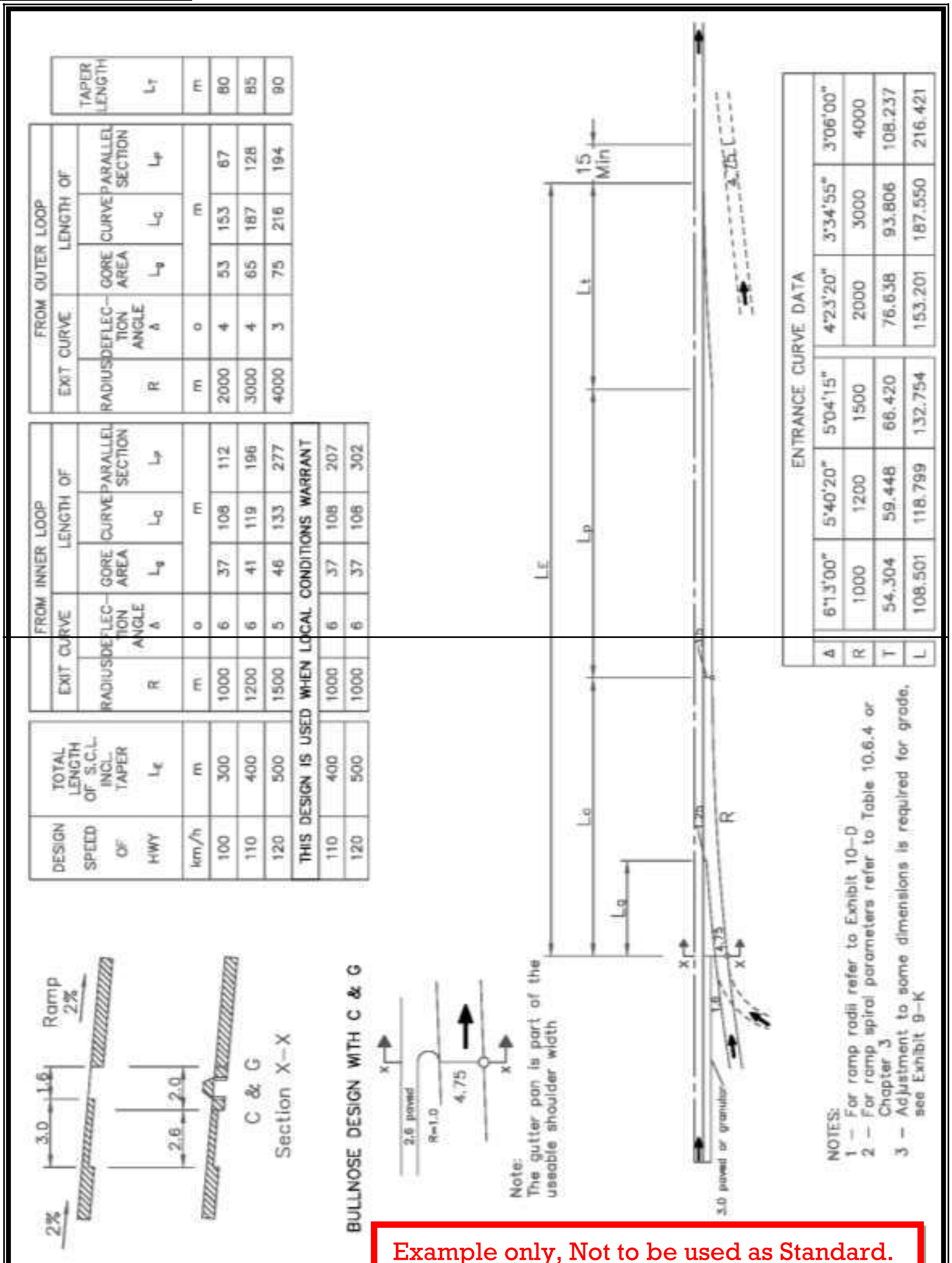
Note:
The gutter pan is part of the useable shoulder width



Notes:

1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.

ENTRANCE CURVE DATA						
Δ	6°13'00"	5°40'20"	5°04'15"	4°23'20"	3°34'55"	3°06'00"
R	1000	1200	1500	2000	3000	4000
T	54.304	59.448	66.420	76.638	93.806	108.237
L	108.501	118.799	132.754	153.201	187.550	216.421



DESIGN SPEED OF HWY	TOTAL LENGTH OF S.C.L. INCL. TAPER L_E	FROM INNER LOOP: EXIT CURVE RADIUS R	FROM INNER LOOP: EXIT CURVE DEFLECTION ANGLE Δ	FROM INNER LOOP: LENGTH OF GORE AREA L_g	FROM INNER LOOP: LENGTH OF CURVE L_c	FROM INNER LOOP: LENGTH OF PARALLEL SECTION L_P	FROM OUTER LOOP: EXIT CURVE RADIUS R	FROM OUTER LOOP: EXIT CURVE DEFLECTION ANGLE Δ	FROM OUTER LOOP: LENGTH OF GORE AREA L_g	FROM OUTER LOOP: LENGTH OF CURVE L_c	FROM OUTER LOOP: LENGTH OF PARALLEL SECTION L_P	TAPER LENGTH L_T
km/h	m	m	°	m			m	°	m			m
100	300	1000	6	37	108	112	2000	4	53	153	67	80
110	400	1200	6	41	119	196	3000	4	65	187	128	85
120	500	1500	5	46	133	277	4000	3	75	216	194	90
THIS DESIGN IS USED WHEN LOCAL CONDITIONS WARRANT												
110	400	1000	6	37	108	207						
120	500	1000	6	37	108	302						

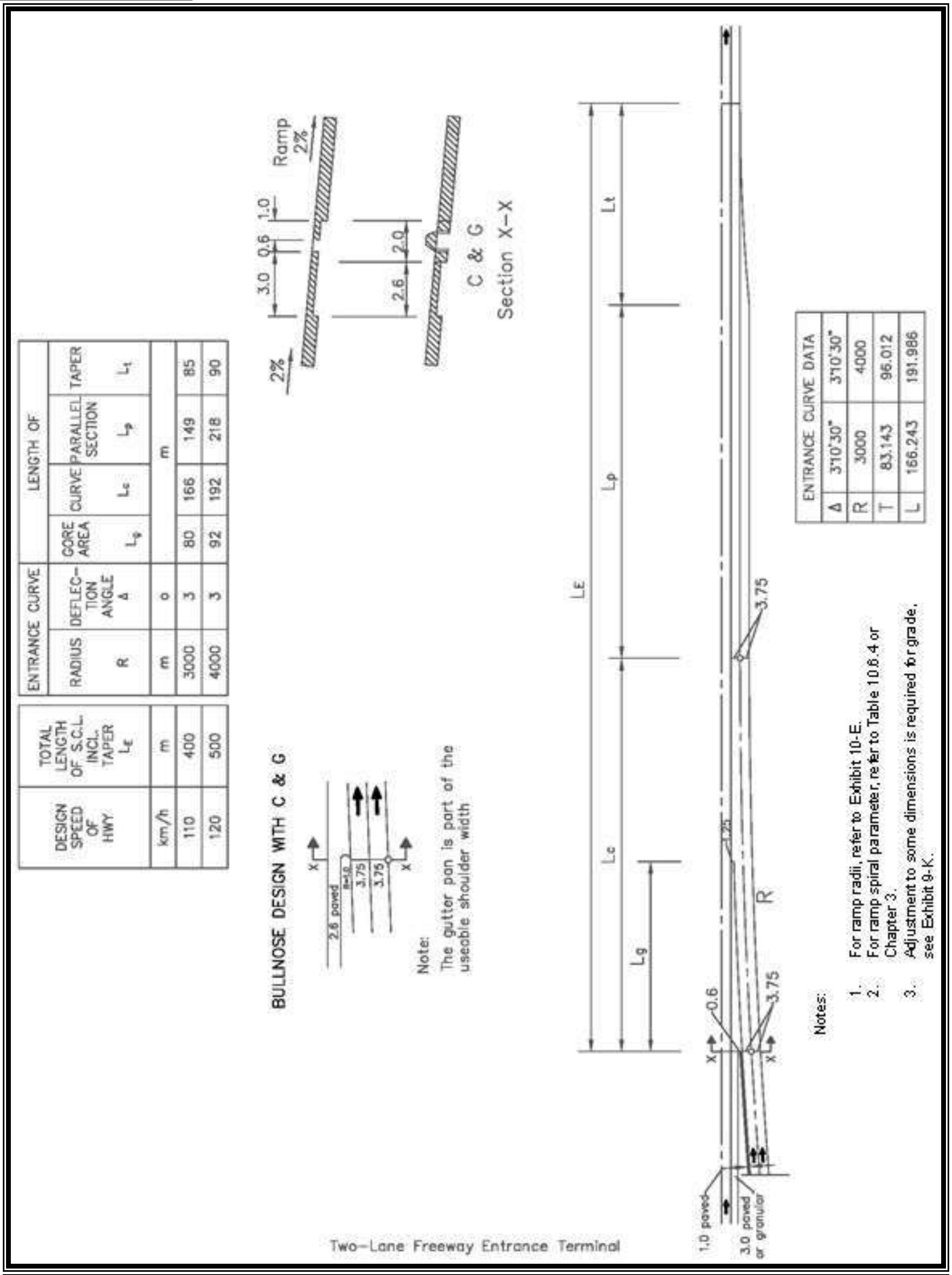
ENTRANCE CURVE DATA

Δ	6°13'00"	5°40'20"	5°04'15"	4°23'20"	3°34'55"	3°06'00"
R	1000	1200	1500	2000	3000	4000
T	54.304	59.448	66.420	76.638	93.806	108.237
L	108.501	118.799	132.754	153.201	187.550	216.421

Example only, Not to be used as Standard.

Exhibit ~~-~~10AK~~FE~~

Two-Lane Freeway Entrance Terminal

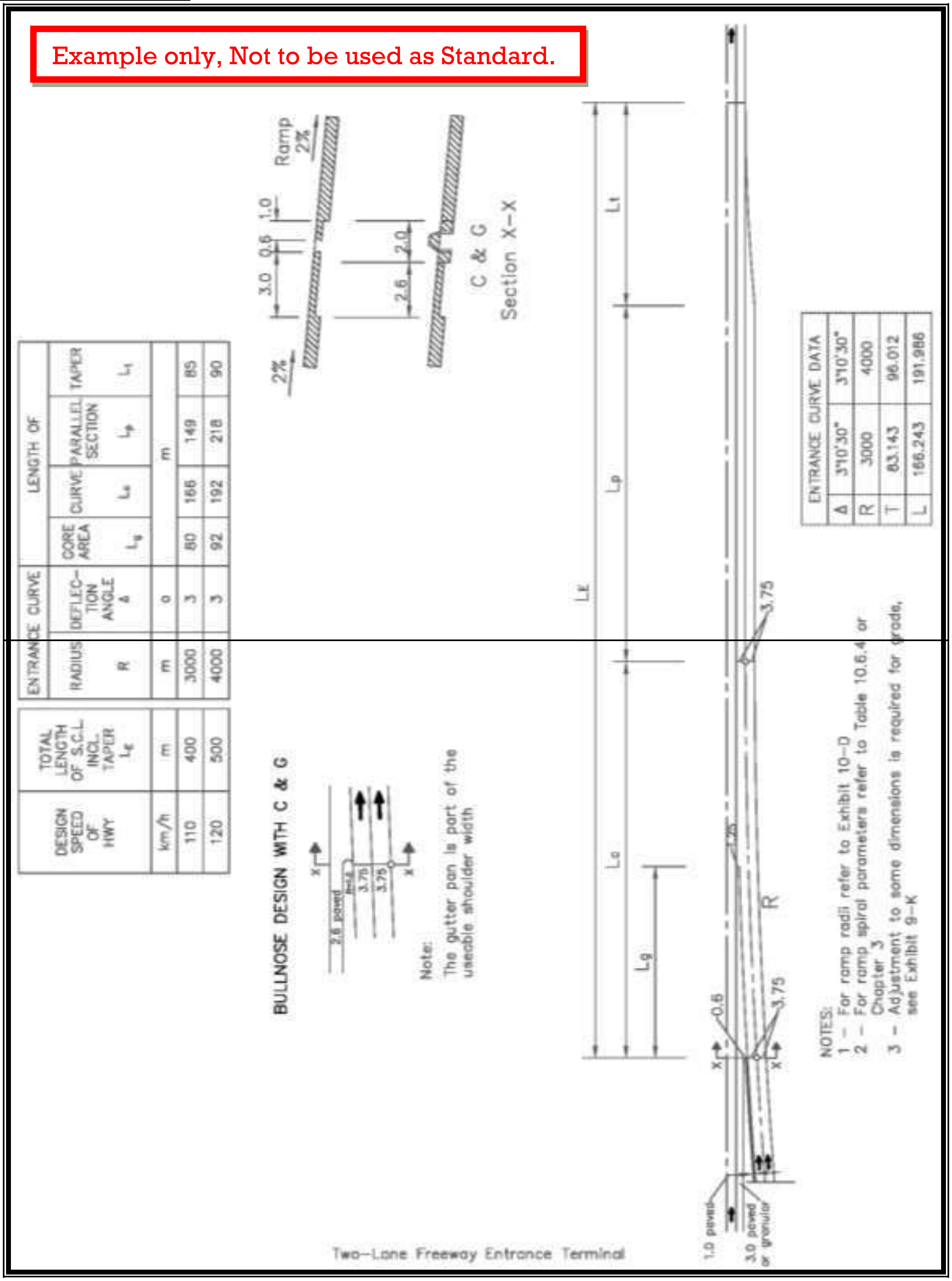


DESIGN SPEED OF HWY	TOTAL LENGTH OF S.C.L. INCL. TAPER L_E	ENTRANCE CURVE		LENGTH OF			
		RADIUS R	DEFLECTION ANGLE Δ	GORE AREA L_g	CURVE L_c	PARALLEL SECTION L_p	TAPER L_t
km/h	m	m	°	m			
110	400	3000	3	80	166	149	85
120	500	4000	3	92	192	218	90

ENTRANCE CURVE DATA		
Δ	3°10'30"	3°10'30"
R	3000	4000
T	83.143	96.012
L	166.243	191.986

Notes:

1. For ramp radii, refer to Exhibit 10-E.
2. For ramp spiral parameter, refer to Table 10.6.4 or Chapter 3.
3. Adjustment to some dimensions is required for grade, see Exhibit 9-K.



~~Exhibit 10AGF~~

~~**Major Fork**~~

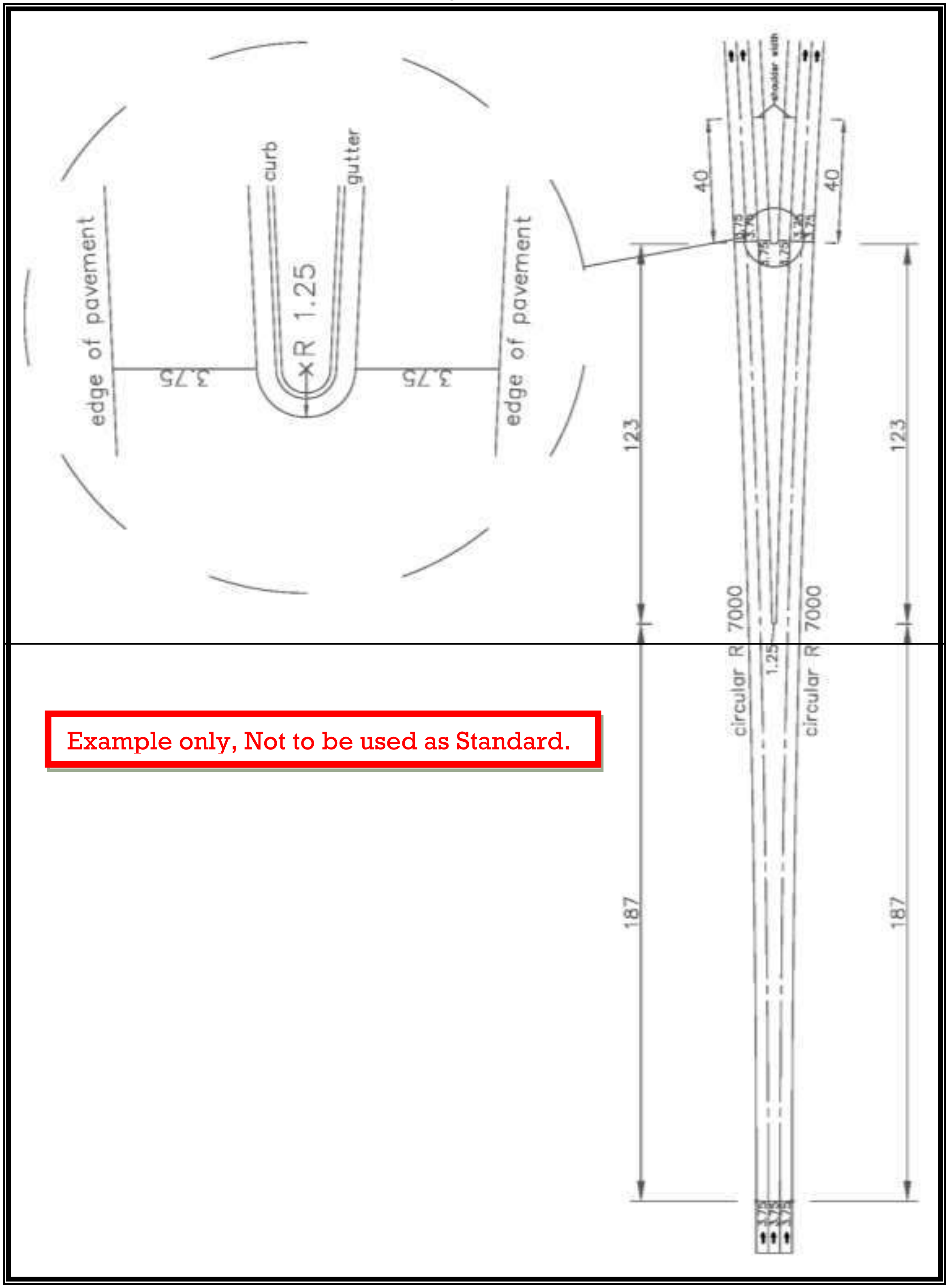

edge of pavement
curb
gutter
R 1.25
3.75
3.75
edge of pavement
shoulder width
40
40
123
123
circular R 7000
1.25
circular R 7000
187
187
Example only, Not to be used as Standard.

Exhibit -10AL~~HG~~

Parclo A-2 Crossing Road Terminal

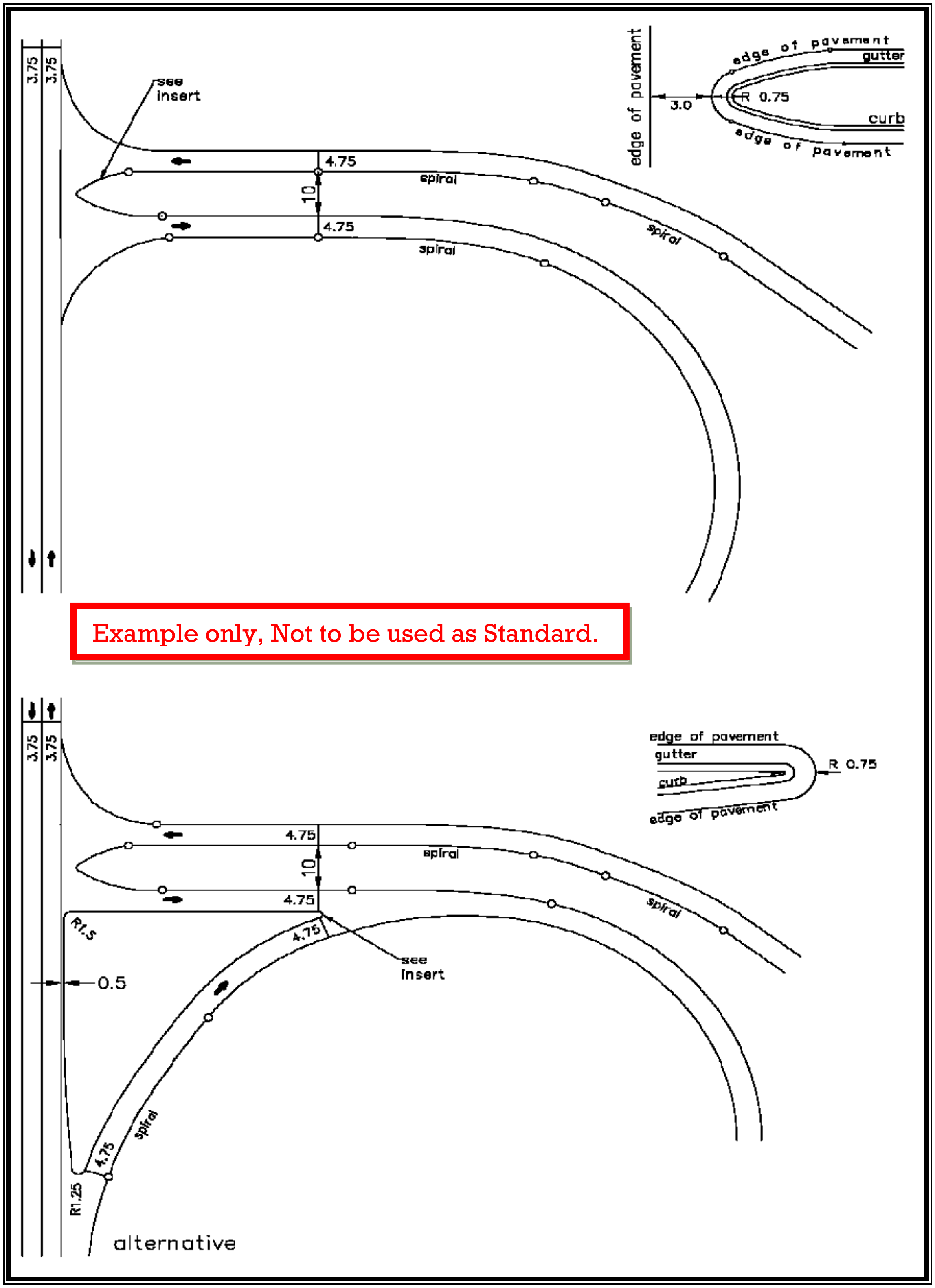


Exhibit -10AM~~IH~~

Parclo A-4 Crossing Road Terminal, One Left-Turning Lane

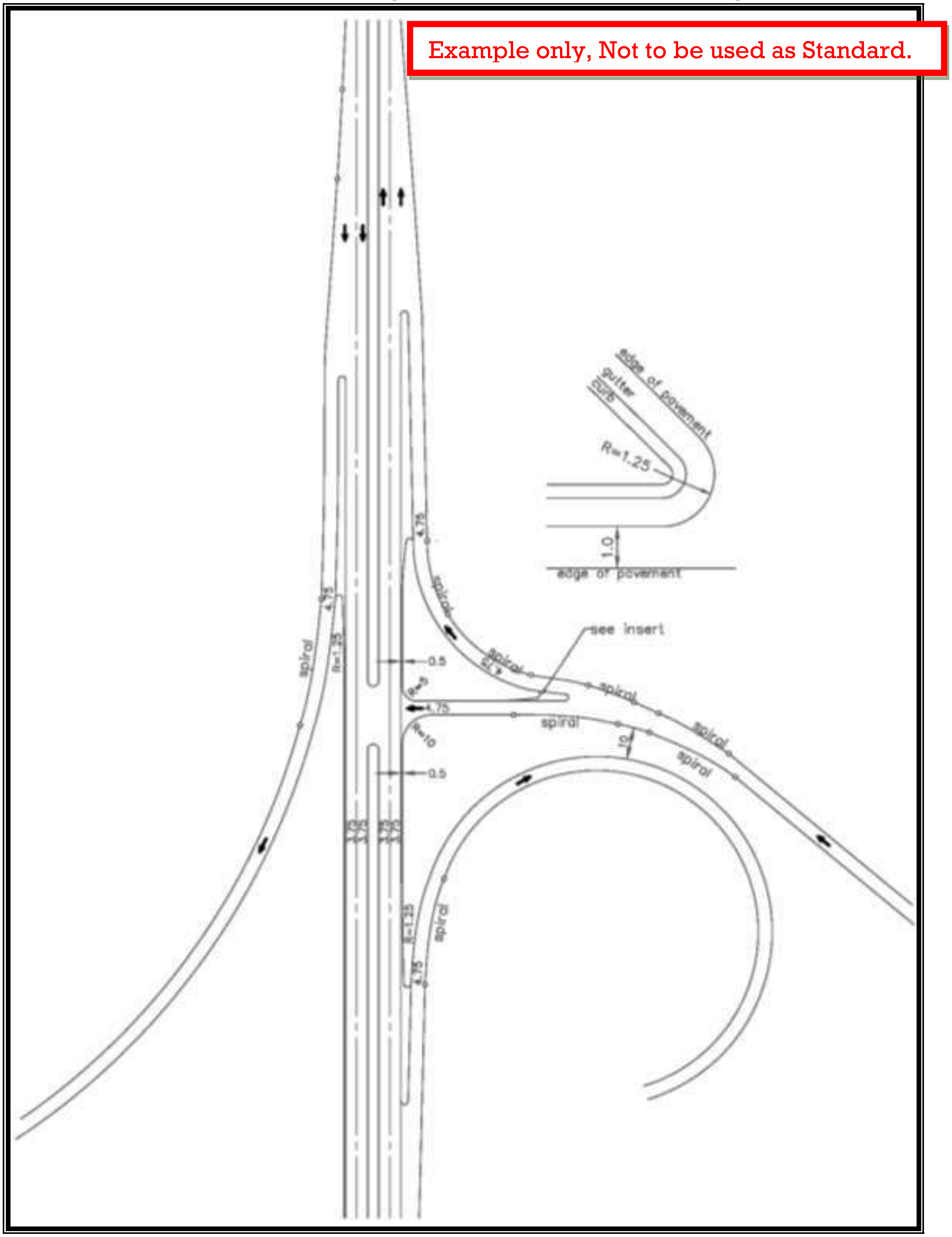


Exhibit -10AN~~JJ~~

Parclo A-4 Crossing Road Terminal, Two Left-Turning Lanes

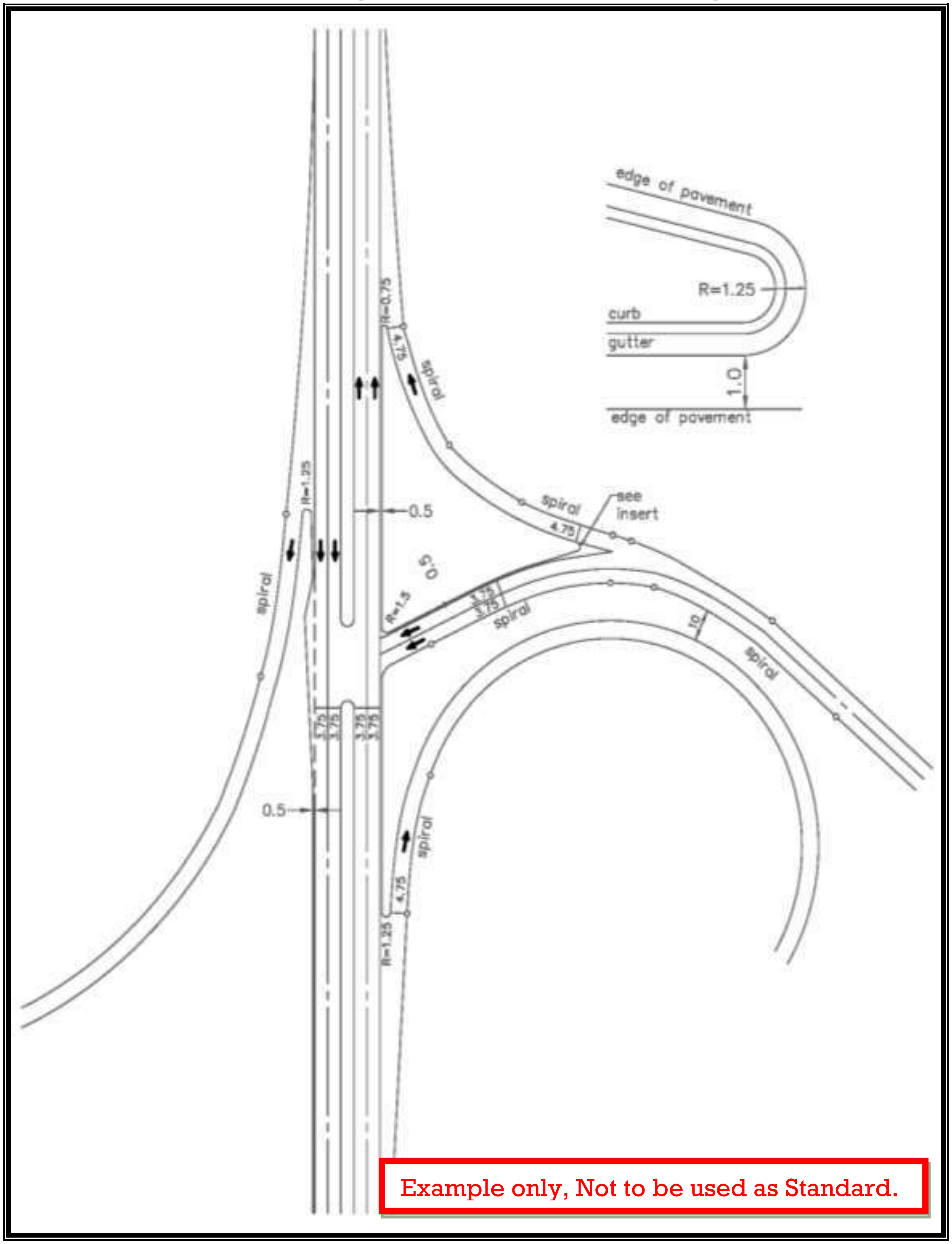


Exhibit -10AO~~KJ~~

Parclo B-2 Crossing Road Terminal

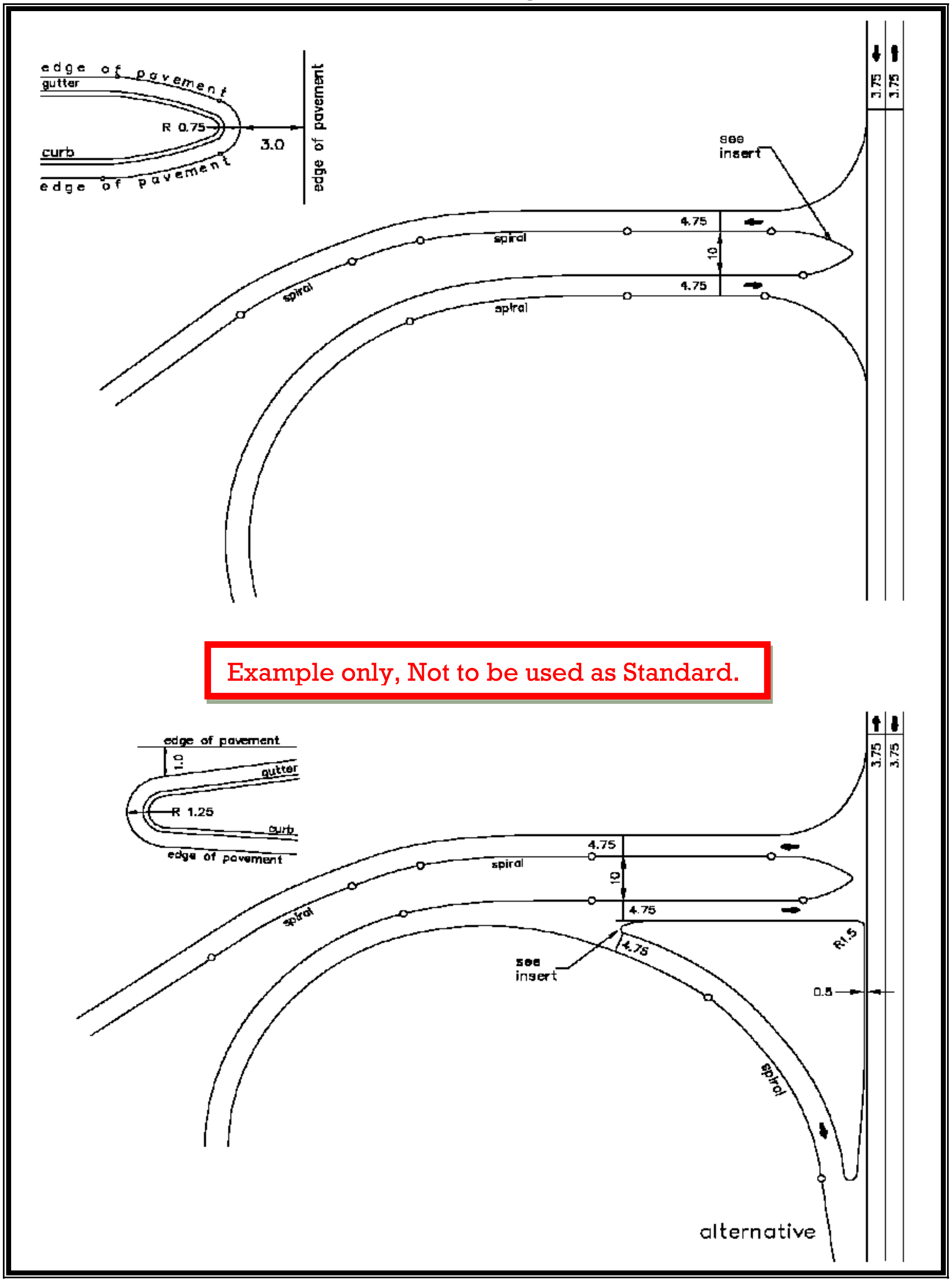
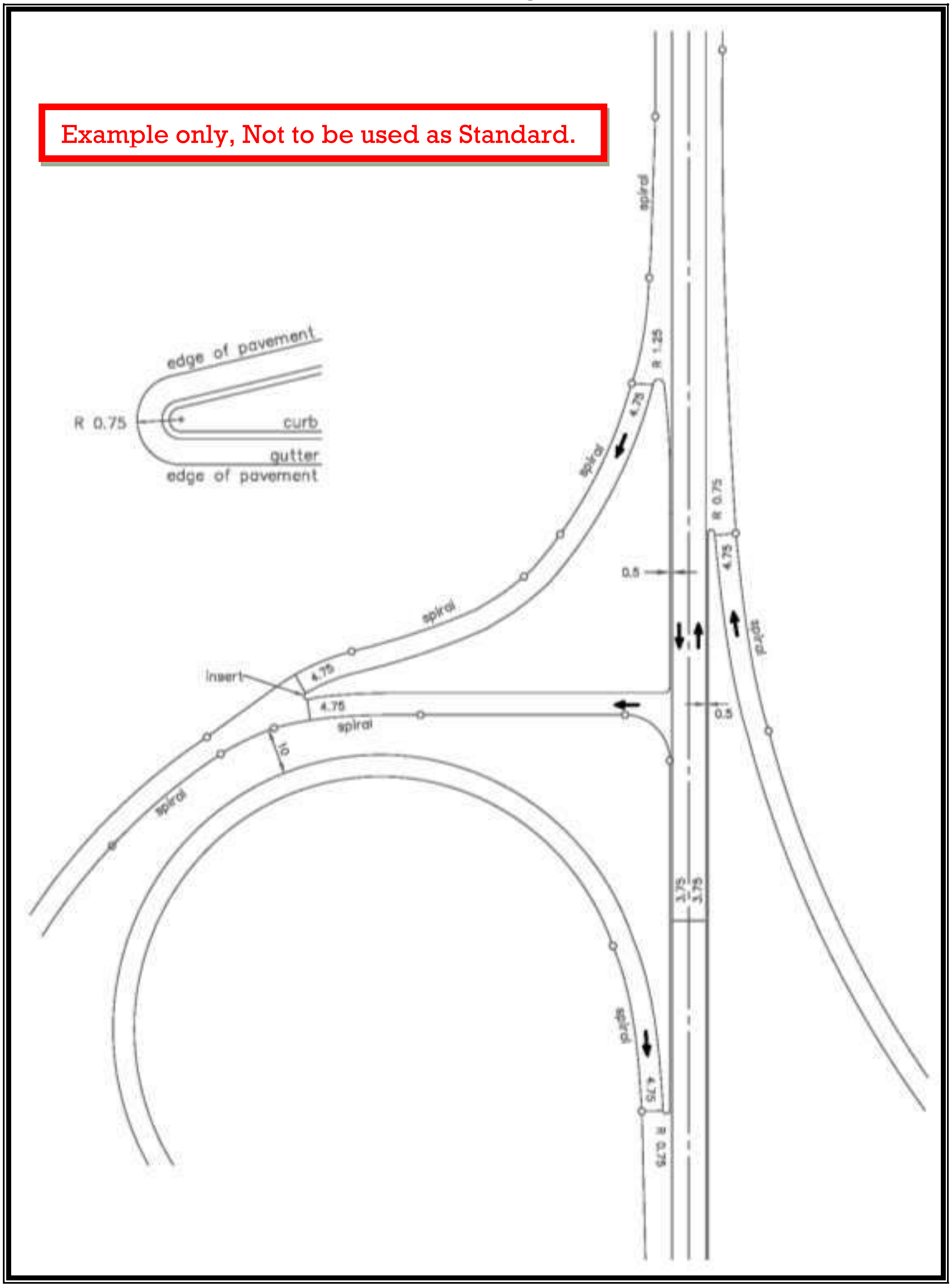


Exhibit ~~-~~10AP~~LK~~

Parclo B-4 Crossing Road Terminal



ADDITIONAL GUIDANCE

The following ~~additional Guidance~~additional guidance regarding Collector-Express and Transfer Lane configuration ~~is Applicable~~is applicable for Chapter 10 – Interchanges:

COLLECTOR LANES

General

Collector lanes are separate from and parallel to the express lanes and perform the function of collecting and distributing traffic between arterial roads and the express lanes. Collector lanes in terms of functional classification are freeways, having full control of access, no at-grade intersections and interchanging with crossing arterial roads with normal freeway-arterial type interchanges. Geometric design features and characteristics are the same as ~~essentially~~ those of a regular freeway, however, distribution to and from the express~~through~~ lanes is via transfer lanes which generate a number of left exits and entrances ~~on~~ in the collector lanes.

A separated highway system using the express and collector lanes aims to allow for more efficient use of the highway which helps to lower overall emissions through efficient travel. Express lanes allow vehicles to remain at more constant speeds without weaving in and out of traffic. This can ~~lead to~~result in less braking and reduced speed variability in those lanes and hence the reduction of emissions from the vehicles in express lanes. Collector lanes aim to accommodate vehicles entering or exiting the highway and serve the same purpose of allowing for more efficient travel in the express lanes.

Benefits

Collector lanes normally have two or three basic lanes in each direction, which when added to a normal three or four basic lane in each direction on the express lanes, provide a total capacity of five to seven basic lanes in each direction. ~~Spreading~~ Distributing large numbers of basic lanes on separate roadways instead of a single roadway has some advantages.

Traffic on roadways of not more than four basic lanes is always within one lane of a shoulder in case of emergency. With five or more basic lanes, traffic ~~has to~~must change at least two lanes to reach a shoulder for an emergency stop. This is hazardous both for the vehicle requiring the shoulder and other traffic on the roadway.

Traffic on the express lanes of an express-collector system is through traffic on relatively long trips. Transfer lanes to and from the collector lanes are relatively infrequent and therefore, the through traffic is comparatively uninterrupted by entering and exit traffic. Weaving manoeuvres associated with entering traffic and exiting traffic are confined to the collector lanes.

Design Features

Design speed and other design criteria for collector lanes are the same as for the adjacent express lanes. Geometric design features of alignment, profile and cross section elements should meet the same standards as those for the express lanes. The principles of good lane balance, maintenance of basic lanes and the dimensions of ramps terminals should be applied.

Collector lanes are separated from the express lanes carrying traffic in the same location by an outer separation. An outer separation is similar to a median in design but different in function, in that it separates traffic travelling in the same direction. Outer separations normally contain two shoulders and a barrier to prevent traffic crossing between the two roadways or at least a fence to discourage it. Because collector lanes have left exits and entrances to transfer lanes, lane continuity is an important consideration. This is defined and discussed in *Chapter 3 – Alignment and Lane Configuration* and the design of collector lanes should be carefully checked to ensure that continuity of basic lanes is maintained. Where continuity is lost, it can ~~usually~~ be corrected by the application of auxiliary lanes between successive entrance and exits, illustrated in *Figure 3.7.1 of Chapter 3 – Alignment and Lane Configuration.*

The complexity of roads entering and exiting collector roads from both right and left, makes proper signing critical to the successful operation of these facilities. Before finalizing the location of transfer lanes, interchanges and ramps, it should be checked to ensure that it can be adequately signed and readily understood by ~~the~~ a driver, particularly the unfamiliar driver. Advance signing well ahead of exits is essential for the smooth operation of collector roads.

Transfer Lanes

Transfer lanes between collector roads and express lanes are similar to ramps between freeways, in that they carry traffic between two controlled access facilities. Transfer lanes are relatively short and level unless they are part of a basket weave configuration between collector lanes and express lanes. Like ramps they consist of three elements, the exit terminal, the entrance terminal and the section between the two bullnoses or transfer lanes proper.

Whereas the design speed of a ramp is normally less than that of the associated freeway, the design speed of a transfer lane should ~~be the same as~~match that of the ~~freeway, since~~freeway since ~~the~~ a driver travelling between the two roadways does not adjust speed to make this manoeuvre.

Transfer roadways normally have two lanes. Although design volumes may indicate that one lane is sufficient, it is generally considered that two lanes are required to provide the necessary degree of flexibility to accommodate a variety of traffic patterns, for traffic moving between collector and express lanes. Transfer lane widths are the same as those of through freeway lanes and shoulders on both sides of the transfer lanes should be maintained.

Alignment and profile geometrics should be consistent with design speed, discussed above. Visibility to exit bullnoses on transfer lanes is important and decision sight distance to exit terminal bullnoses suggested in *Section 10.6.3.4 of Chapter 10 – Interchanges* applies.

Transfer lanes are ~~usually~~ typically preceded by or followed by a weaving section on the collector lanes. This is illustrated in **Exhibit 10-AQ~~ML~~**. Since the transfer lanes are in effect left exits and entrances, the weaving induced on the collector lanes is more intensive than under the more common condition in which a right entrance is followed by a right exit.

In the case weaving is between the two ramp movements and the through freeway traffic is not part of the weaving manoeuvre. In the case of the transfer lanes on the collector lane much, if not all, of the traffic on the transfer lane is weaving with the through collector lanes traffic. This calls for additional weaving length over that of the normal right entrance/right exit condition. These weaving sections merit detailed analysis applying the techniques provided in *Provincial Engineering Memorandum;*

HSBM DCSO # 2016-05 dated March 31, 2016 for Capacity Analysis Manual – January 2016.

Typical recommended designs for the transfer roadways are shown in **Exhibit -10AR~~NM~~** and **Exhibit -10AS~~ON~~**.

Basket Weaves

A basket weave consists of a pair of transfer lanes crossing each other and separated vertically. The successful operation of the basket weave depends on the geometrics of the alignment and profile. Drivers expect to be able to maintain speeds close to ~~the~~ freeway speeds when transferring between express lanes and collector lanes in a basket weave. For this reason, design speed in the basket weave should be not less than 10 km/h less than the design speed of the express and collector roads.

Exhibit -10AQ~~ML~~

~~WEAVING ON COLLECTOR LANES DUE TO TRANSFER LANES~~Weaving on Collector Lanes Due to Transfer Lanes

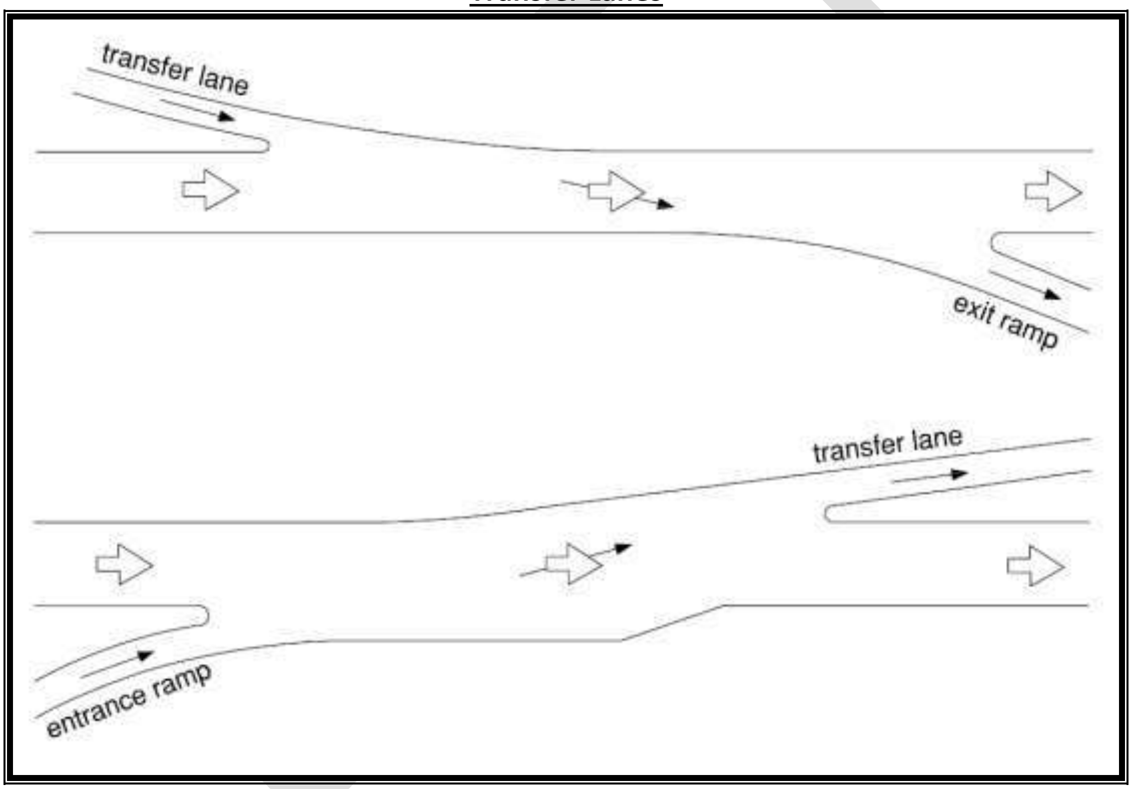


Exhibit -10AR~~NM~~

~~TRANSFER ROADWAY: COLLECTOR TO EXPRESS LANES~~Transfer Roadway: Collector to Express Lanes

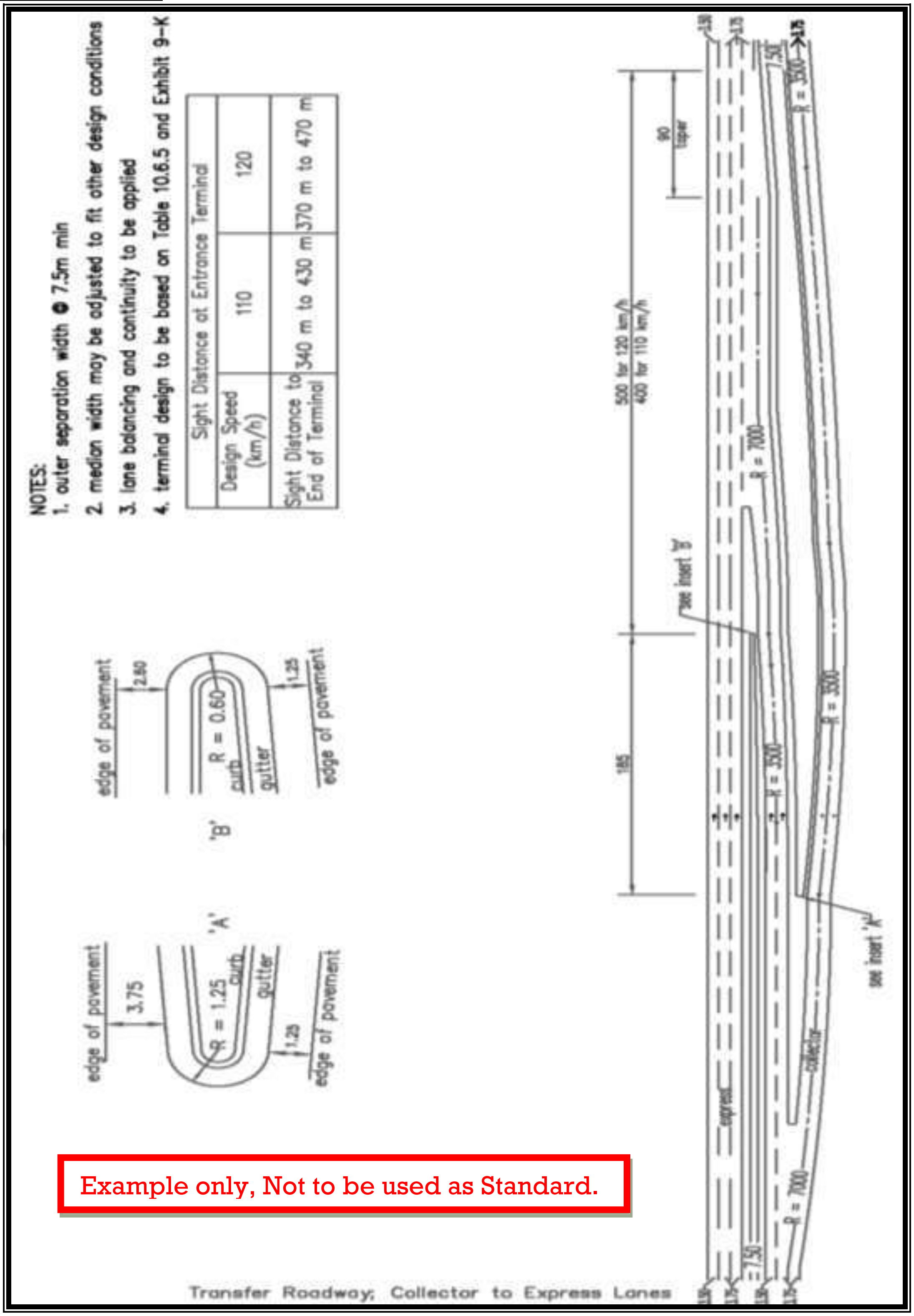
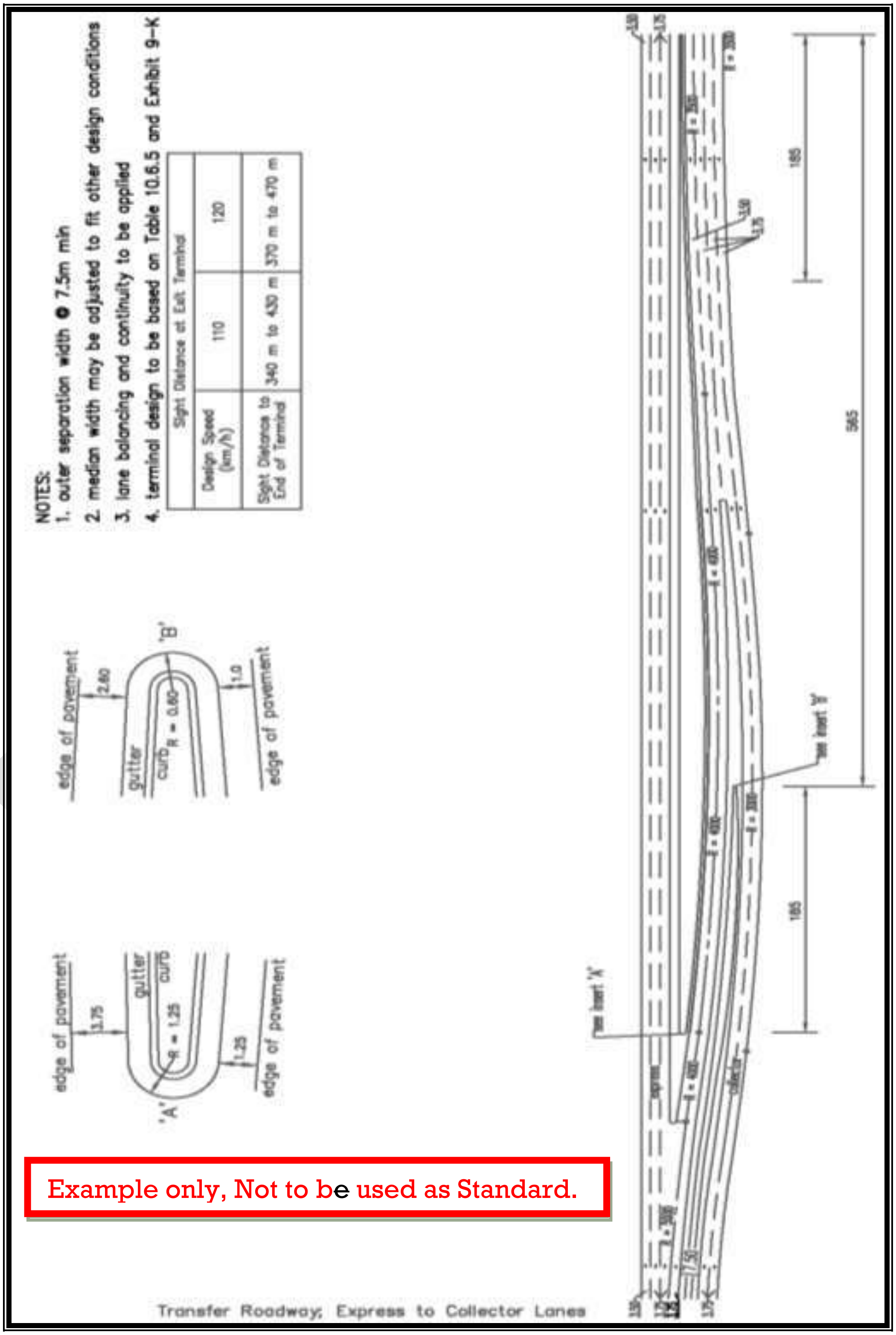


Exhibit -10AS~~ON~~

~~TRANSFER ROADWAY: EXPRESS TO COLLECTOR LANES~~Transfer Roadway: Express to Collector Lanes



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MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 11 for Chapter 11

Special Roads

~~October~~ July~~TBD~~ 2026~~3~~

MTO Design Supplement
Appendix 11 for Chapter 11
Special Roads

This chapter is **applicable** with the following **additional ~~Guidance~~guidance**.

- All information contained in this chapter is only to be considered for roadways with AADT ≤ 200. For roadways with AADT > 200 see Chapters 1 to 10 of TAC GDG along with Appendix 1 to 13 except 11 as applicable.

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