

The information contained in Chapter Six: The Typical Roadway Cross-Section, dated May 2022, has been updated to reflect the January 2023 Errata. The errata addresses errors, changes in procedure, changes in NDOT department titles, changes in other Roadway Design Manual chapters and other reference material citations occurring since the latest publication of this chapter.

Chapter Six presents guidance for the design of New and Reconstructed projects; design guidance for 3R projects is provided in Chapter Seventeen.

Chapter Six

The Typical Roadway Cross-Section

The **Nebraska Department of Transportation (NDOT)** typical roadway cross-sections are presented in EXHIBITS 6.1 THROUGH 6.6 and EXHIBITS 6.8 THROUGH 6.10. Typical cross-sections for Interstates and interchange ramps are presented in Chapter Five: Interstates, Grade Separations, and Interchanges of this manual. Variations from these typical sections must be documented by the designer and submitted to the **Assistant Design Engineer (ADE)** for approval and to the **Traffic Engineering Division (Traffic Engineering)** for concurrence.

For additional information regarding roadway cross-section elements, see Chapter 4 of A Policy on Geometric Design of Highways and Streets (the *Green Book*) (Ref. 6.1).

1. THE TRAVELED WAY

1.A Travel Lane Widths

Lane width is determined by the roadway functional classification, traffic volumes, and design speed. The minimum lane widths are provided in the Nebraska Minimum Design Standards (MDS) (Ref. 6.2) (<http://www.roads.nebraska.gov/media/5593/nac-428-rules-regs-nbcs.pdf>) and in Appendix H, “AASHTO Minimum Design Guidance”, of this manual. The typical through lane width is 12 feet for rural and high-speed municipal roadways; low-speed municipal roadways are typically 11 feet in width.

1.B Travel Lane Cross Slopes

A crowned roadway cross-section “breaks” at the high point of the roadway, sloping to both shoulders, typically at a 2% cross slope (See EXHIBITS 6.1, 6.3 THROUGH 6.6, 6.8 AND 6.9). The high point of a non-superelevated crowned cross-section is usually located at the centerline of the roadway (for two-lane roadways) and at the centerline of the directional travel lanes (for multi-lane highways). Crowned cross-sections are preferred for two-lane roadways and for multi-lane divided roadways with depressed medians. The crowned cross-section allows for drainage to both sides of the roadway surface.

The tangent typical cross-section usually has the high point of the pavement on the inside (median) edge of the inner travel lane and slopes continuously across the travel lanes, typically at a 2% cross slope (See EXHIBIT 6.10). Tangent cross-sections are typically used for multi-lane divided roadways where there is a raised or flush median or where future lanes are to be added to the median (See EXHIBIT 6.7).

2. SHOULDERS

2.A Shoulder Width and Type

Shoulder width and type is based upon the roadway functional classification, traffic volumes, and design speed. Minimum shoulder widths are provided in the *MDS* (Ref. 6.2) and in Appendix H, “AASHTO Minimum Design Guidance”, of this manual.

NDOT prefers that an additional two feet of turf transition be provided beyond the minimum shoulder width (See EXHIBITS 6.1 THROUGH 6.6). This will maintain the minimum shoulder width after a future overlay surfacing grade raise. If this transition cannot be provided, **ADE** approval and a decision document in the project file is required. (See Chapter One: Roadway Design Standards, Section 10.C, of this manual).

2.A.1 Priority Commercial System Shoulder Width

The Priority Commercial System consists of the non-Interstate National Highway System routes (http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/nebraska/) and the Expressway System (<https://dot.nebraska.gov/media/5809/expressway-system-nebraska.pdf>). The Expressway System is also shown on the State and National Functional Classification Maps (<https://dot.nebraska.gov/travel/map-library/func-by-county/> <https://dot.nebraska.gov/travel/map-library/func-by-city/>). For New and Reconstructed projects on the Priority Commercial System with an ADT of between 400 VPD and 3,999 VPD inclusive, the minimum design standard for shoulder width is 6 feet paved, with an additional 2 feet turf transition. If this policy is not followed, a decision document shall be prepared for **Assistant Design Engineer (ADE)** approval. Factors to consider are:

- System continuity
- Crash history attributable to shoulder width or to vehicles parked on the shoulders
- High heavy-truck volumes (250 Heavy Trucks per day)
- Consultation with the **District** office, including anecdotal history of problems caused by parking on shoulders
- Alternative route for Interstate traffic
- Environmental impacts
- Cost

For 3R projects on the Priority Commercial System, the minimum shoulder width shall follow the *MDS* (Ref. 6.2).

2.A.2 Installation of Two-Foot Surface Shoulders on Lower Volume Roads

NDOT has determined that the installation of two-foot surface shoulders with edgeline rumble stripes is an effective countermeasure for reducing roadway departure crashes on two-lane roadways. After reviewing the crash data and research literature, NDOT has determined the following to be guiding principles for the installation of two-foot shoulders and edgeline rumble stripes on the state highway system:

1. Roadway Type – Rural two-lane undivided with two-way traffic.
2. Lane Width – ≥ 12 feet.
3. ADT - $\geq 1,000$ VPD (segments with ADTs from 1,000 ADT to 1,999 ADT are eligible for HSIP funding, see Chapter Twelve: Cost Estimating and Funding, Section 2.A.3).
4. Minimum Length of Segment – Three miles (historic highway segments may be added for continuity when the gap between highway segments with 2-foot surface shoulders with edgeline rumble stripes is less five miles in length).
5. Other segments may be included when the segments exhibit 0.25 or greater roadway departure crashes per year per mile
6. Connecting links on the Alternate Route System connecting the Interstate to the Parallel Alternate Route System (US-6, US-30, or US-34), regardless of the ADT. The following links are included despite having an ADT $< 1,000$ VPD:
 - L10B – Odessa
 - L10C – Gibbon
 - L10D – Shelton
 - L40C – Alda
 - S41B – Giltner
 - S93A - Henderson

After two-foot surface shoulders and edgeline rumble stripes are installed, they will be perpetuated on subsequent projects unless their function is replaced by a similarly effective mitigation measure for roadway departure crashes. Since the installation of two-foot surface shoulders and edgeline rumble stripes may substantially modify the roadway departure crash history, the above warrants would be inaccurate.

2.B Shoulder Cross Slopes

The cross slope of the shoulder is based upon the functional classification of the roadway and the type of shoulder construction (paved or turf). Typically, shoulder cross slopes for rural roadways are 4% for surfaced shoulders and 6% for turf shoulders.

Surfaced median shoulders which are four feet wide and are of the same surfacing material as the traffic lanes should be at the same cross slope as the adjacent traffic lane. Wider shoulders and shoulders of a different surfacing material than the traffic lanes should slope away from the traffic lanes for drainage, typically at a 4% cross slope.

See EXHIBITS 6.1 THROUGH 6.6 for typical shoulder cross slopes.

2.C Beveled Edge

A beveled edge is a sloping finish to the edge of the pavement (both asphaltic concrete and Portland Cement Concrete) allowing errant vehicles to more easily re-enter the travelled way. The beveled edge will be installed on rural high-speed ($V \geq 50$ mph) highways when:

1. The project includes two inches or greater of surfacing placement
2. Surfaced shoulders are less than six feet in width, not including segments of erosion control curbed shoulders
3. On the inside (median) shoulders which are less than six feet in width of Interstates, freeways and expressways with depressed medians
4. The roadway is not curbed
5. At other locations identified by **Traffic Engineering** as a mitigation measure for a crash history

The type of beveled edge to be used is based upon the project type and surfacing recommendation. For additional information, see Appendix I, "Installation of the Beveled Edge", of this manual and the **FHWA** publication Safety Edge_{SM} Design and Construction Guide (January 5, 2012)

https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/pdf/se_des_gde.pdf.

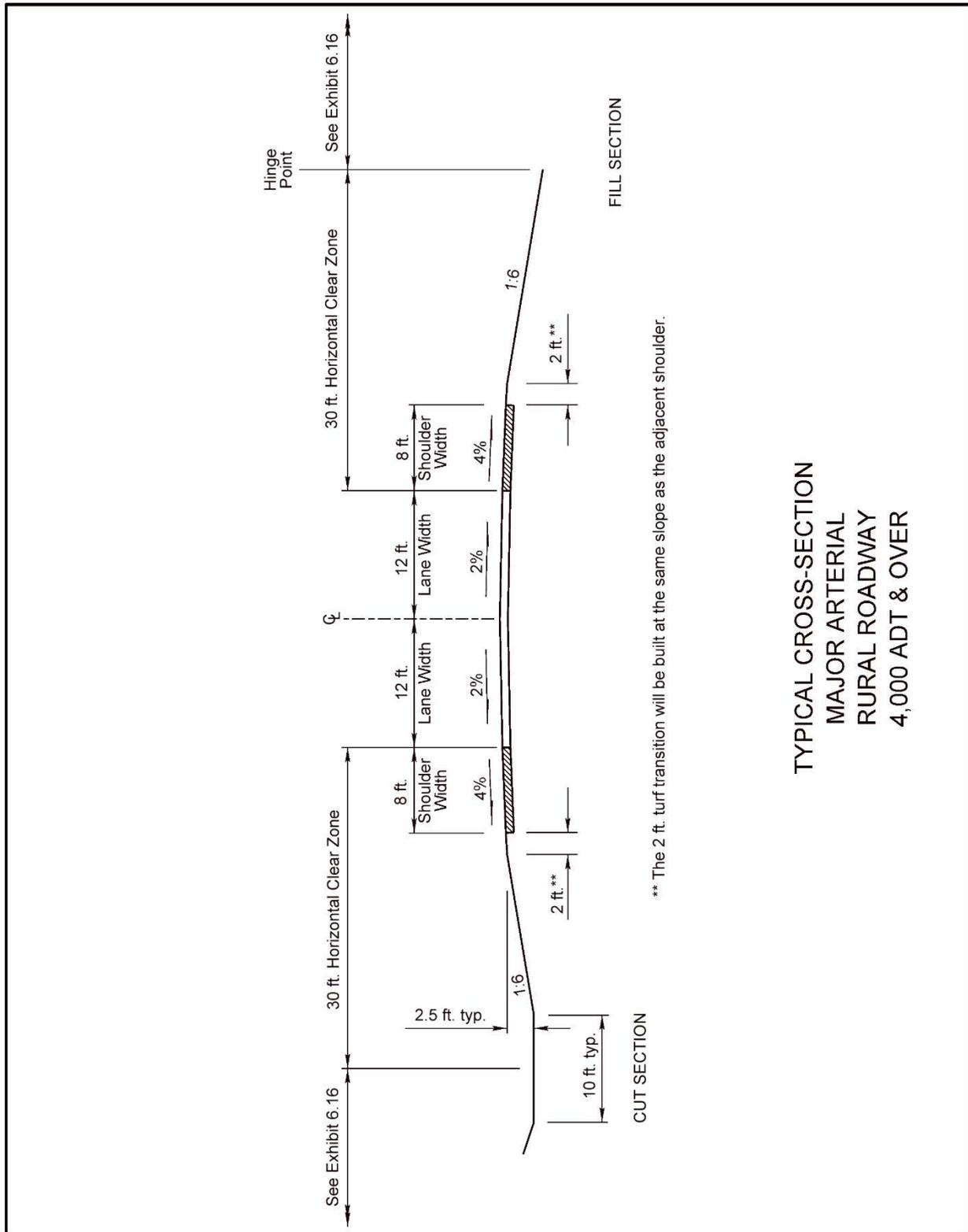


Exhibit 6.3 Typical Section - Rural Major Arterial 4,000 ADT and Over

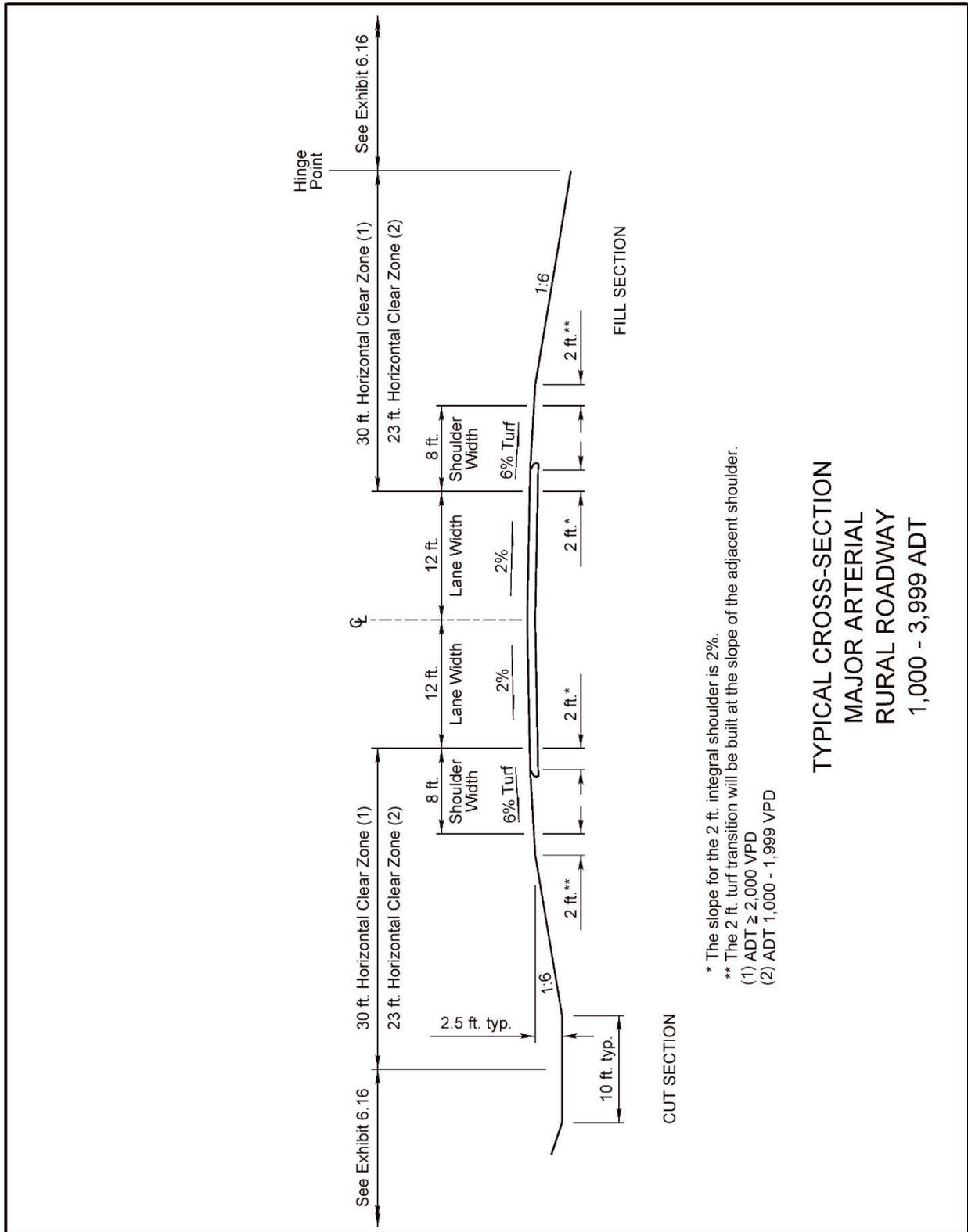
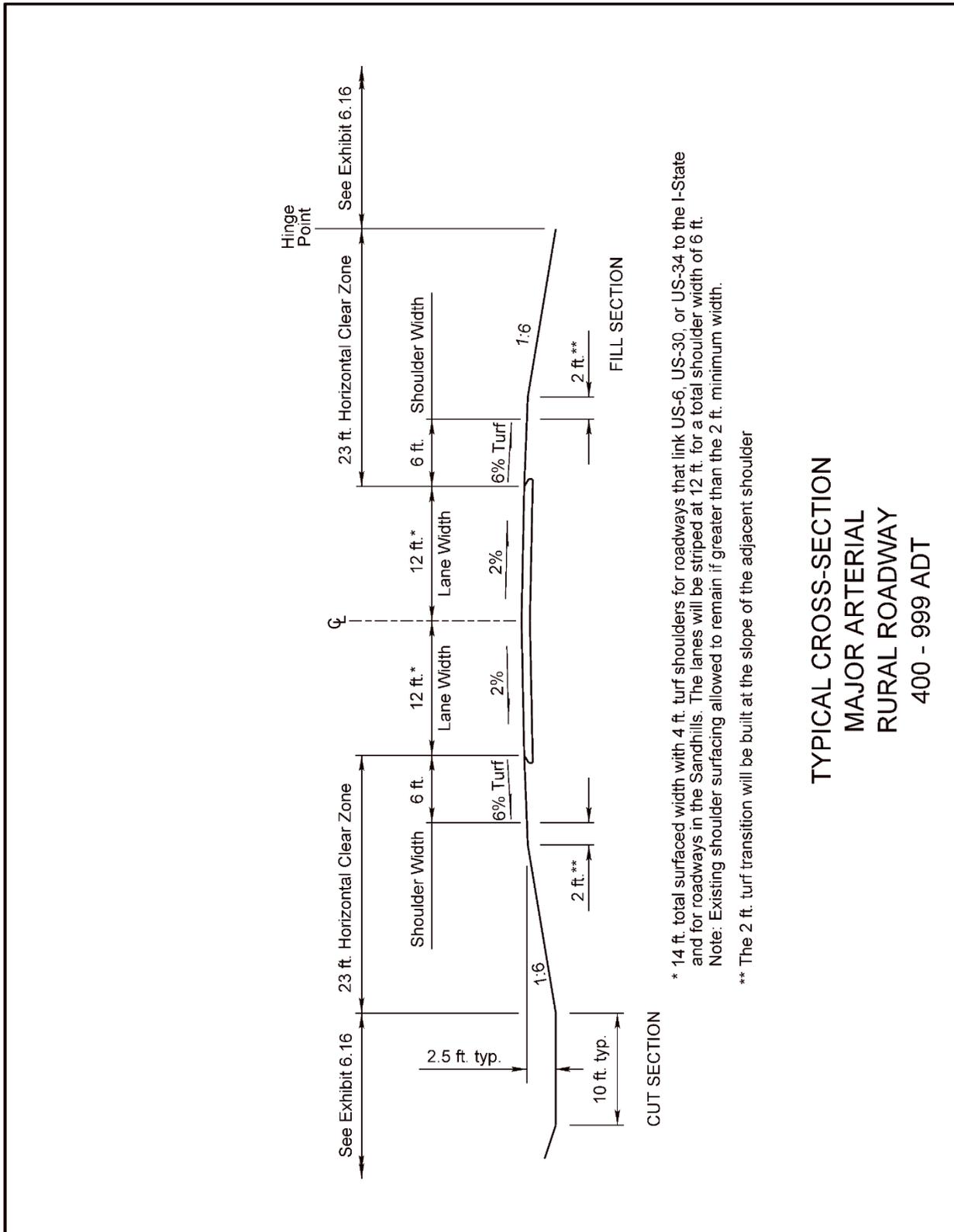


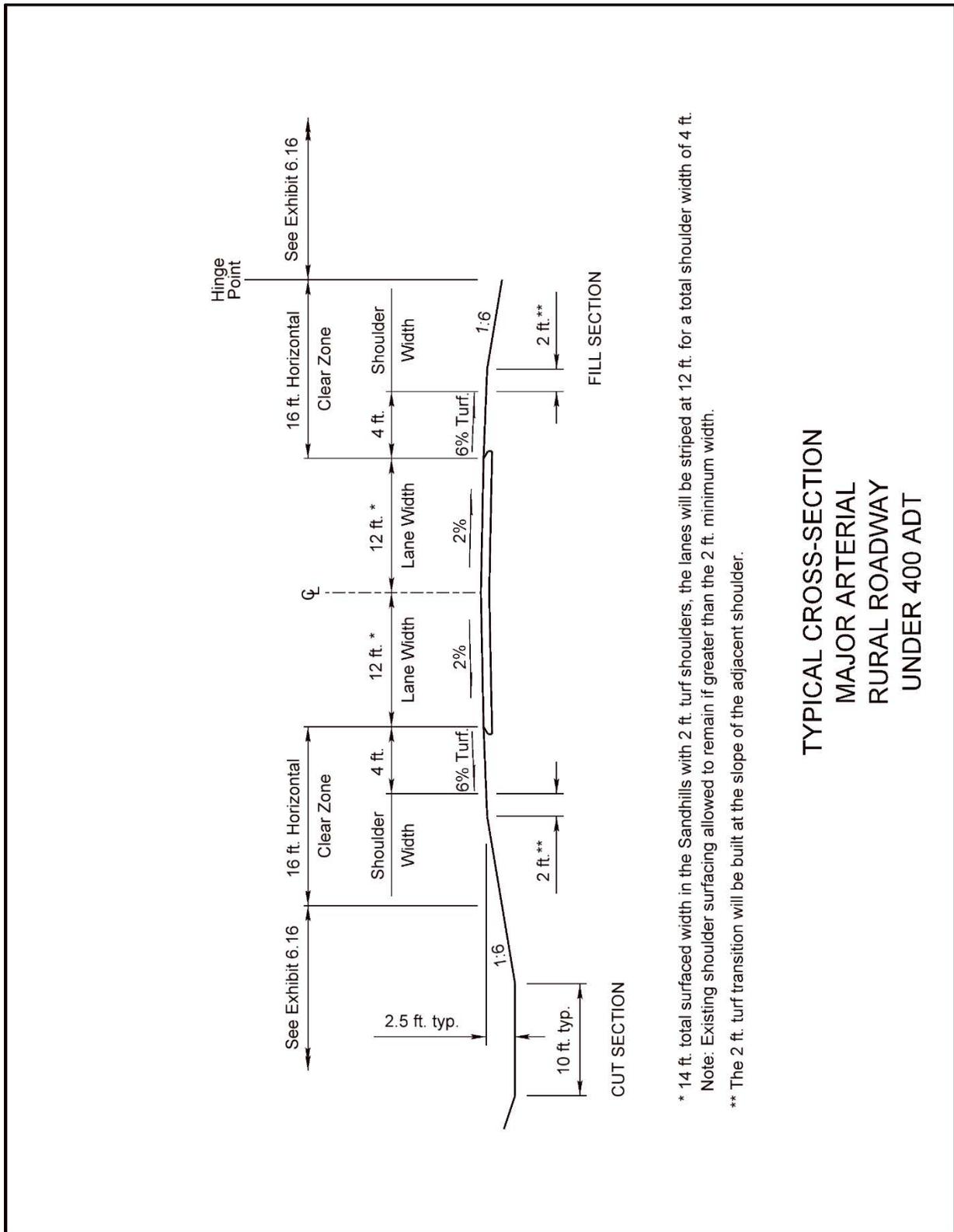
Exhibit 6.4 Typical Section - Rural Major Arterial 1,000 to 3,999 ADT



* 14 ft. total surfaced width with 4 ft. turf shoulders for roadways that link US-6, US-30, or US-34 to the I-State and for roadways in the Sandhills. The lanes will be striped at 12 ft. for a total shoulder width of 6 ft.
 Note: Existing shoulder surfacing allowed to remain if greater than the 2 ft. minimum width.

** The 2 ft. turf transition will be built at the slope of the adjacent shoulder

Exhibit 6.5 Typical Section - Rural Major Arterial 400 to 999 ADT



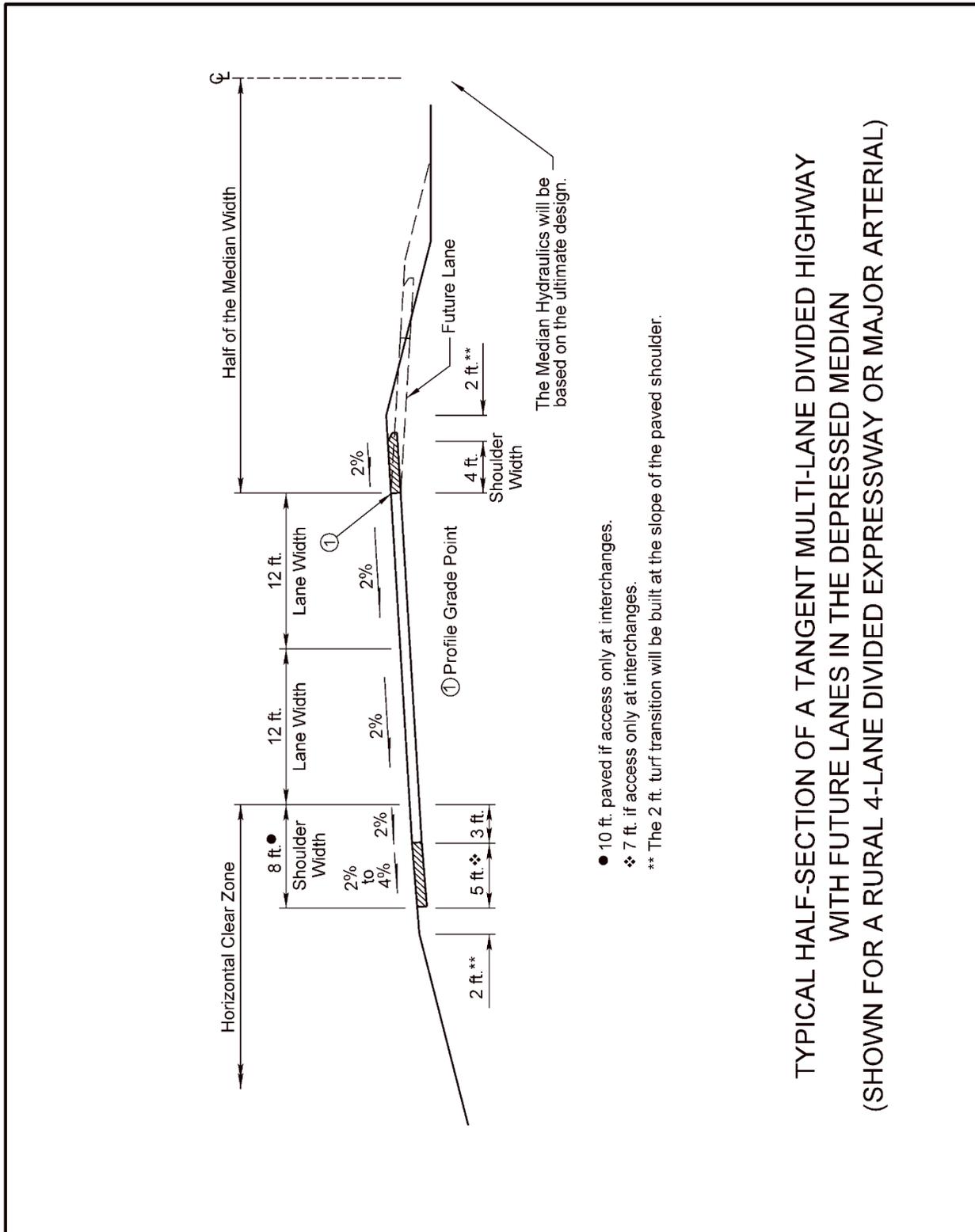
**TYPICAL CROSS-SECTION
 MAJOR ARTERIAL
 RURAL ROADWAY
 UNDER 400 ADT**

* 14 ft. total surfaced width in the Sandhills with 2 ft. turf shoulders, the lanes will be striped at 12 ft. for a total shoulder width of 4 ft.

Note: Existing shoulder surfacing allowed to remain if greater than the 2 ft. minimum width.

** The 2 ft. turf transition will be built at the slope of the adjacent shoulder.

Exhibit 6.6 Typical Section - Rural Major Arterial Under 400 ADT



TYPICAL HALF-SECTION OF A TANGENT MULTI-LANE DIVIDED HIGHWAY
 WITH FUTURE LANES IN THE DEPRESSED MEDIAN
 (SHOWN FOR A RURAL 4-LANE DIVIDED EXPRESSWAY OR MAJOR ARTERIAL)

Exhibit 6.7 Typical Half-Section of a Tangent Multi-Lane Divided Highway with Future Lanes in the Depressed Median

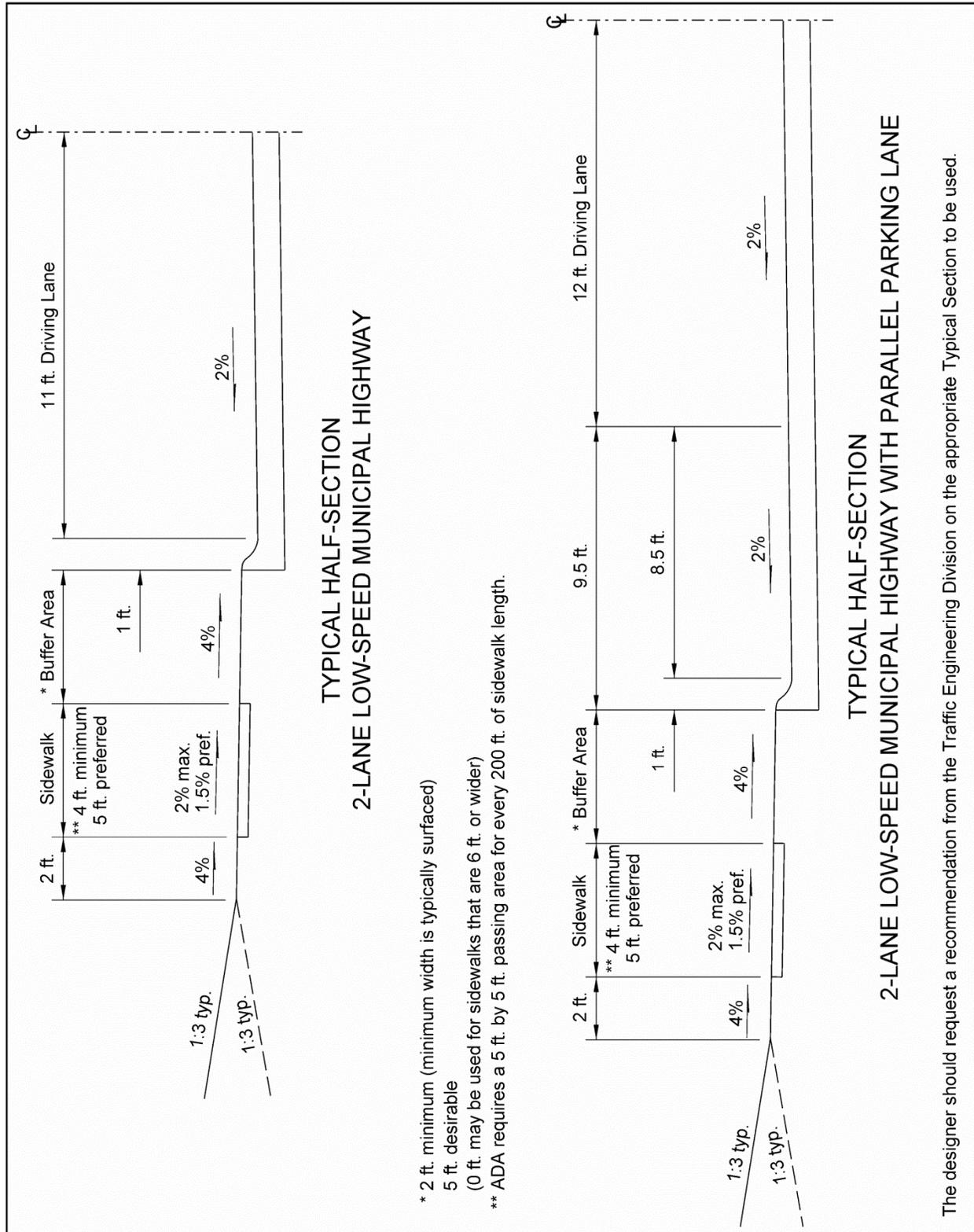


Exhibit 6.8 Typical Half-Sections of Two-Lane Low-Speed Municipal Highways

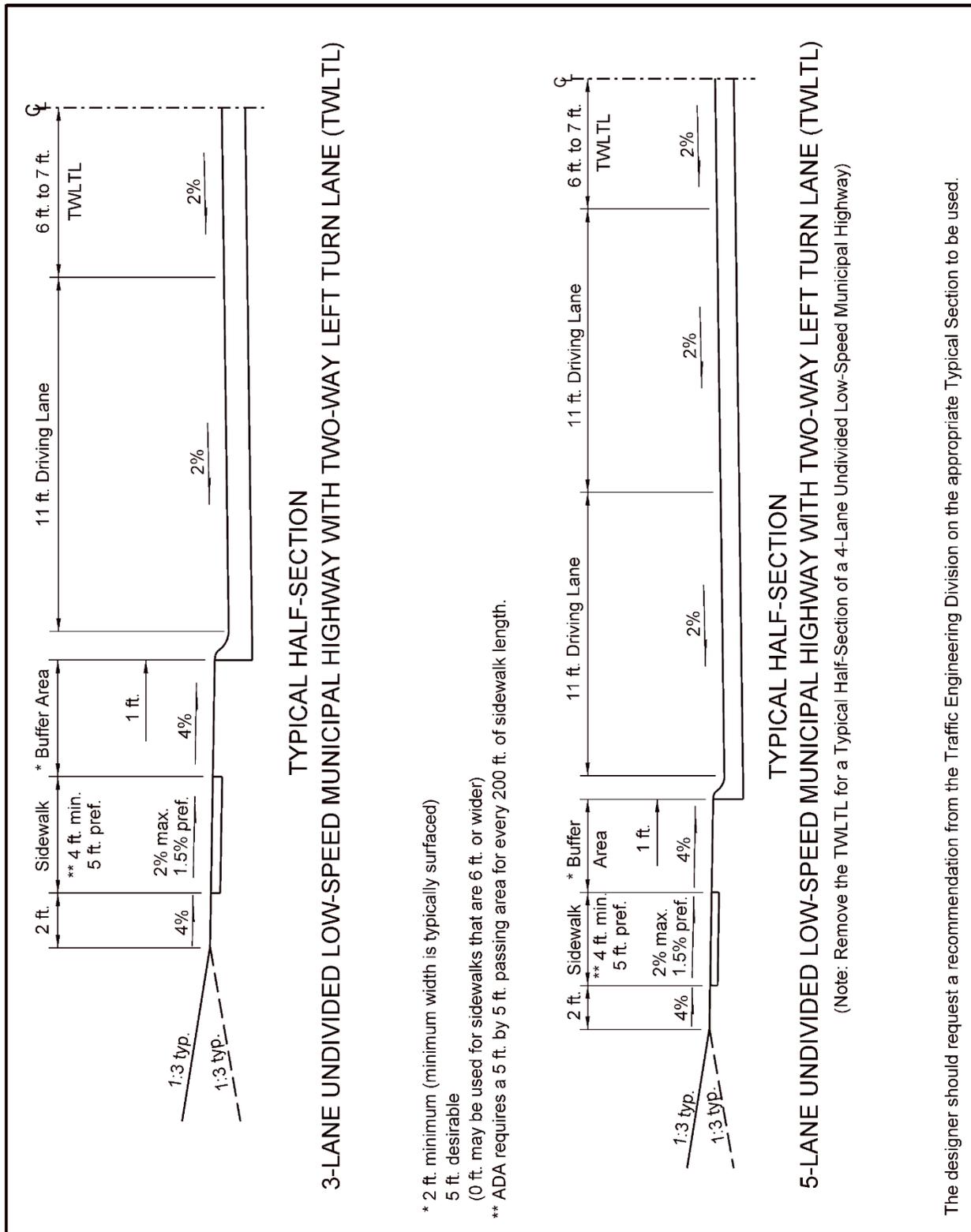
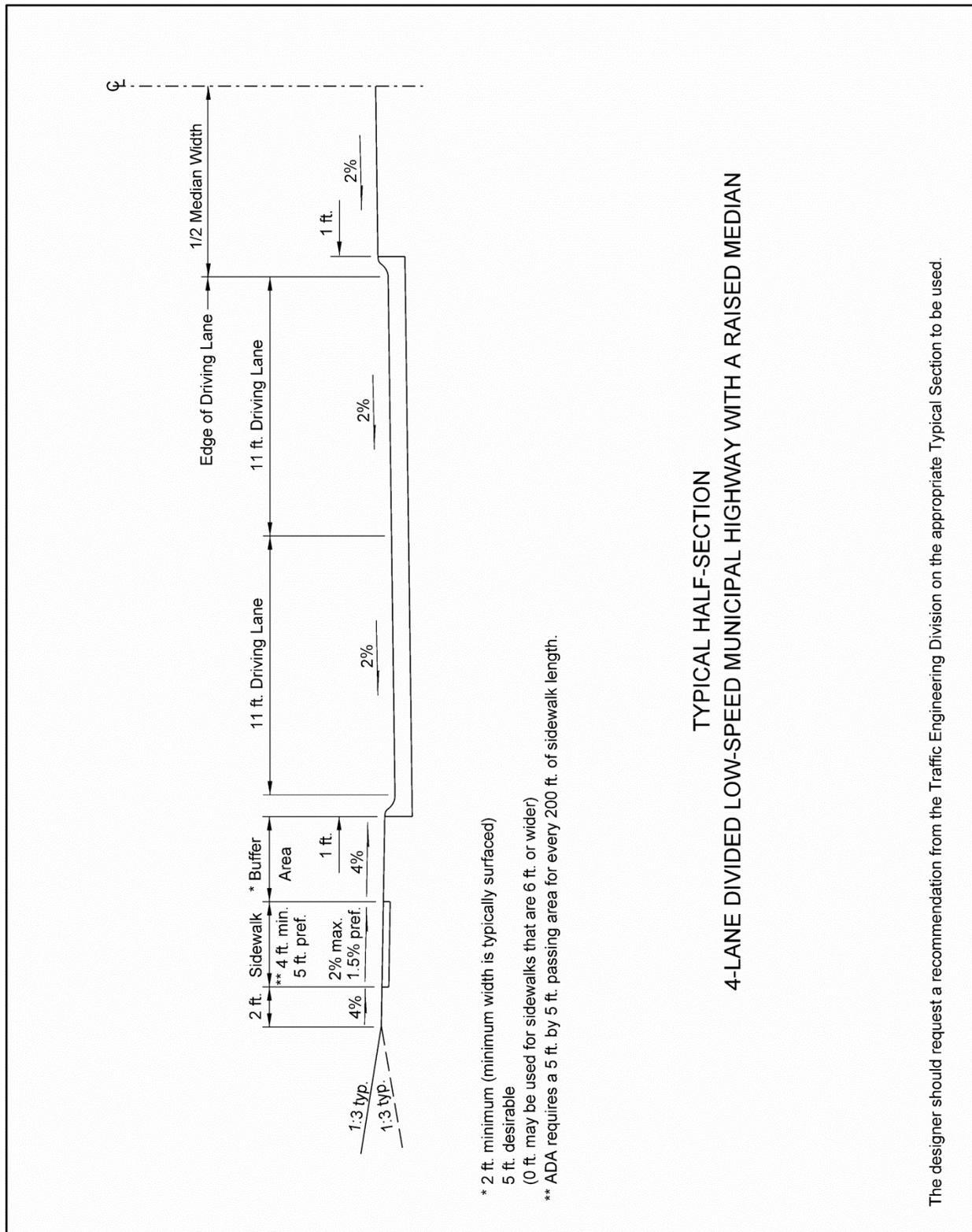


Exhibit 6.9 Typical Half-Sections of Three-Lane and Five-Lane Undivided Low-Speed Municipal Highways with Two-Way Left Turn Lanes

The designer should request a recommendation from the Traffic Engineering Division on the appropriate Typical Section to be used.



The designer should request a recommendation from the Traffic Engineering Division on the appropriate Typical Section to be used.

Exhibit 6.10 Typical Half-Section of a Four-Lane Divided Low-Speed Municipal Highway with a Twenty Foot Raised Median

3. CURBS

The type and location of curbs affect driver behavior and the utility of a highway. Most commonly found in urban areas, curbs may facilitate:

- Drainage
- Pavement edge delineation
- Delineation of pedestrian walkways
- Traffic channelization
- Access management

3.A Curb Warrants

The selection of a curbed roadway section depends on many factors including, but not limited to:

- Traffic management
- Design speed
- Urban/ rural location
- Drainage
- Future or ultimate development
- Construction costs
- At a roundabout

Urban Locations - Curbed sections are typically used in urban locations due to:

- Traffic management
- Drainage requirements
- Right-of-way constraints
- Access management

Rural Locations - Curbs on rural highways may be warranted for the following conditions, as well as others:

- Traffic management
- Where a raised median is constructed
- Erosion control
- Right-of-way constraints

The need for and location of curbed sections should be discussed during the preliminary design.

3.B Curb Types

The three general types of curb are:

1. Barrier: Barrier curbs are relatively steep-faced and are intended to keep the vehicle from leaving the roadway.
2. Mountable: Mountable curbs (e.g. the integral concrete curb) are designed so that errant vehicles can cross them easily.
3. Slope: Sloping curbs are usually three or four inches in height with a simple angular rise. They are also designed to be easily crossed and are preferred over mountable curbs due to ease of hand construction.

Curbs are constructed of either Portland Cement Concrete or asphaltic concrete. Examples of various curb types are shown in [EXHIBIT 6.12](#) and in Standard Plan 301 in the [Standard/Special Plans Book \(Standard Plans\)](#) (Ref. 6.3) (<http://www.roads.nebraska.gov/business-center/design-consultant/stand-spec-manual/>).

The following guidelines should be used to determine the appropriate curb height:

- High-speed roadways (design speed \geq 50 mph): three-inch asphaltic concrete curb, three-inch concrete slope curb, or four-inch concrete slope curb (See [EXHIBIT 6.13](#)).
- Low-speed roadways (design speed \leq 45 mph): six inch curbs.
- Teardrop islands on side roads intersecting high-speed roadways: inside of the Horizontal Clear Zone of the mainline the curb will be three-inch asphaltic concrete curb, three-inch concrete slope curb, or four-inch concrete slope curb (See [EXHIBIT 6.11](#)).
- Roundabouts: the splitter islands will be six-inch integral concrete curb. A three-inch truck apron curb will be used for the truck apron and a four inch sloping curb will be used for the inner circle of the center island (See [EXHIBITS 6.12 AND 4.2](#)).

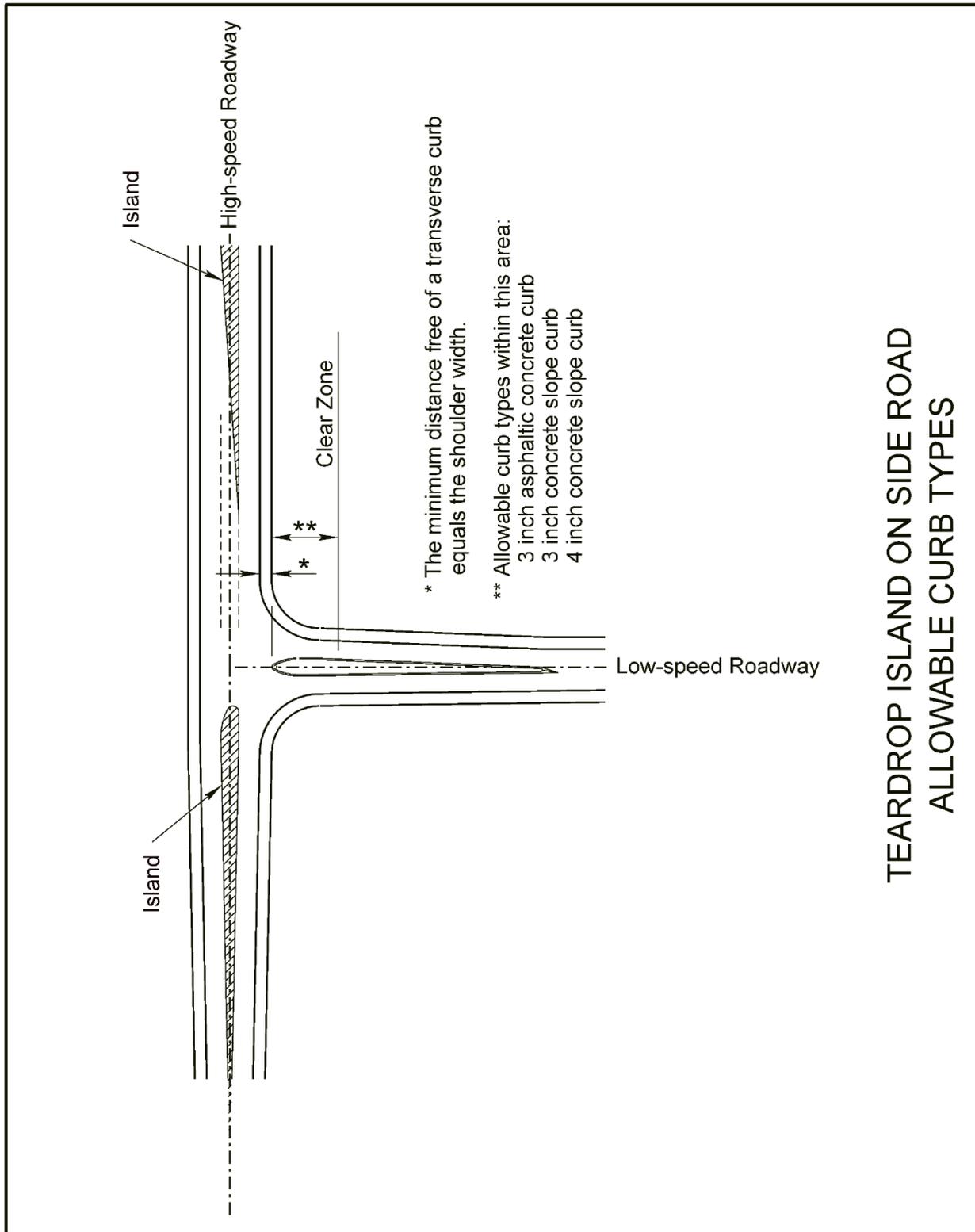


Exhibit 6.11 Teardrop Island on Side Road
 Allowable Curb Types

3.C Curb Design Considerations

Drainage - Curb height influences hydraulic design and analysis (See the Drainage Design and Erosion Control Manual (*Drainage Manual*) (Ref. 6.4), Chapter One: Drainage, Section 10) (<http://www.roads.nebraska.gov/business-center/design-consultant/rd-manuals/>).

Roadside Geometry - Side slope configuration is based on whether a curbed or uncurbed section is used.

Transitions - EXHIBIT 6.14 illustrates the standard procedure for curbed to uncurbed transition.

Erosive Soils - Curb and concrete flumes may be installed on a project to protect earth shoulders and side slopes from stormwater runoff in regions where native soils are commonly susceptible to soil erosion (such as the Sandhills Region and loess soil areas) (See the *Drainage Manual* (Ref. 6.4), Chapter Two: Erosion and Sediment Control, Section 7.E).

Design Guidelines - The following guidelines have been developed for the design of curbed roadway sections:

1. When curbs are constructed, the top of the abutting turf or sidewalk should be at the same elevation as the top of the curb (See EXHIBITS 6.8, 6.9 AND 6.10).
2. When a curb is used in high-speed conditions (design speed \geq 50 mph), the gutterline of the curb should be located six feet from the edge of the lane or at the edge of the surfaced shoulder width given in the *MDS* (Ref. 6.2), whichever is greater (See EXHIBIT 6.13). The curb may also be located flush with or behind a bridge railing or guardrail.
3. When curb and flume is constructed at the edge of the shoulder, the edge of the through traffic lane will be at the same elevation or higher than the top of the curb to prevent the spread of water onto the high-speed travel lane. The drainage will be designed to conform to the design spread criteria (See the *Drainage Manual* (Ref. 6.4), Chapter One: Drainage Design, EXHIBIT 1.37).
4. When erosion control or sloping curbs are constructed in rural areas the typical section will show the turf transition behind the curb to be a minimum of two feet in width and finished to the top of the curb. Four foot wide turf transitions are preferred if there is an erosion problem or if the project is in the Sandhills region (See EXHIBIT 6.13). A wider turf transition may be necessary if guardrail is installed at curbed sections.
5. Installing an erosion control curb does not change the clear zone requirements presented in the *MDS* (Ref. 6.2).
6. Curb cuts will be provided as required for existing and future access drives (See Chapter Four: Intersections, Driveways and Channelization, Section 2.B, of this manual).

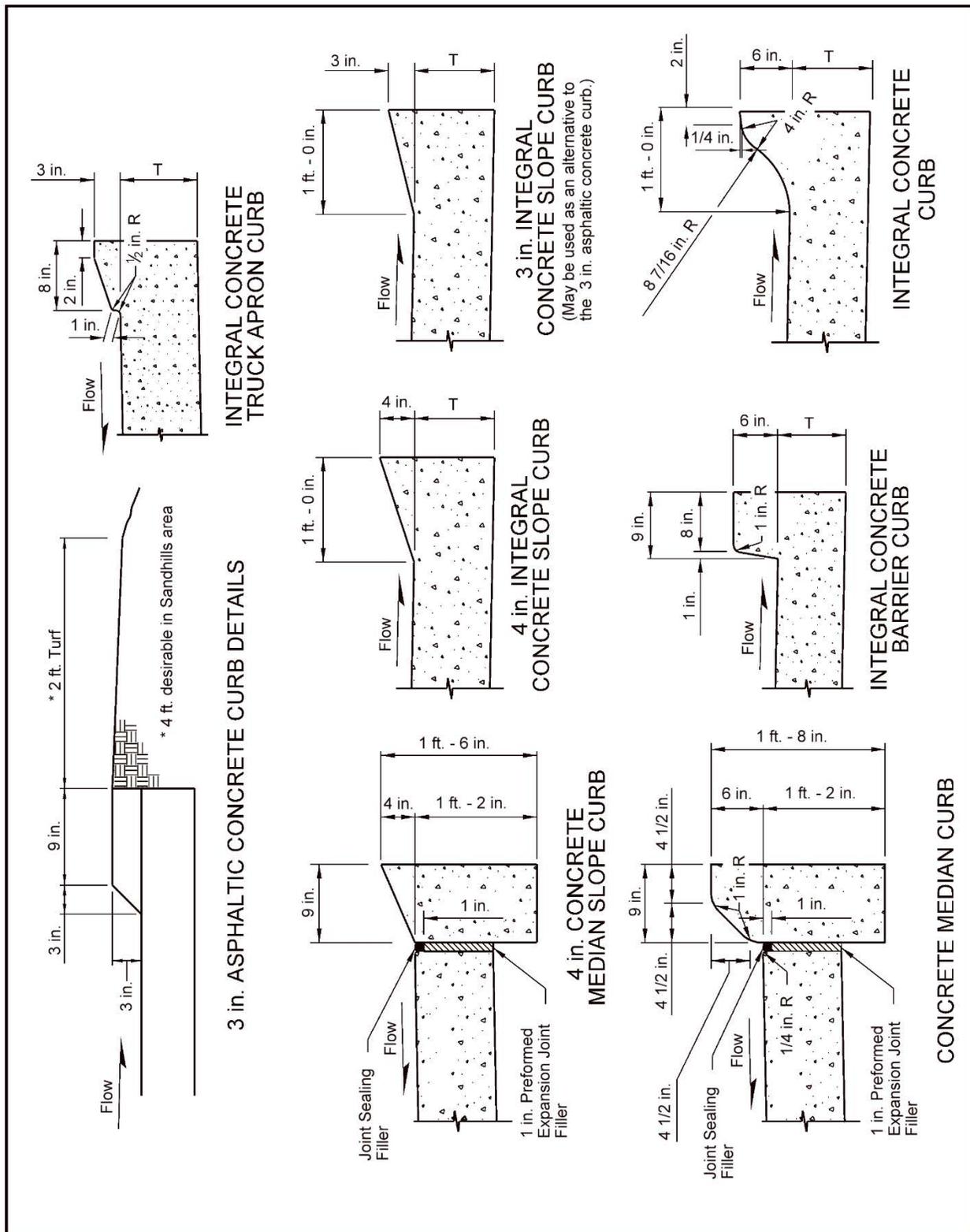
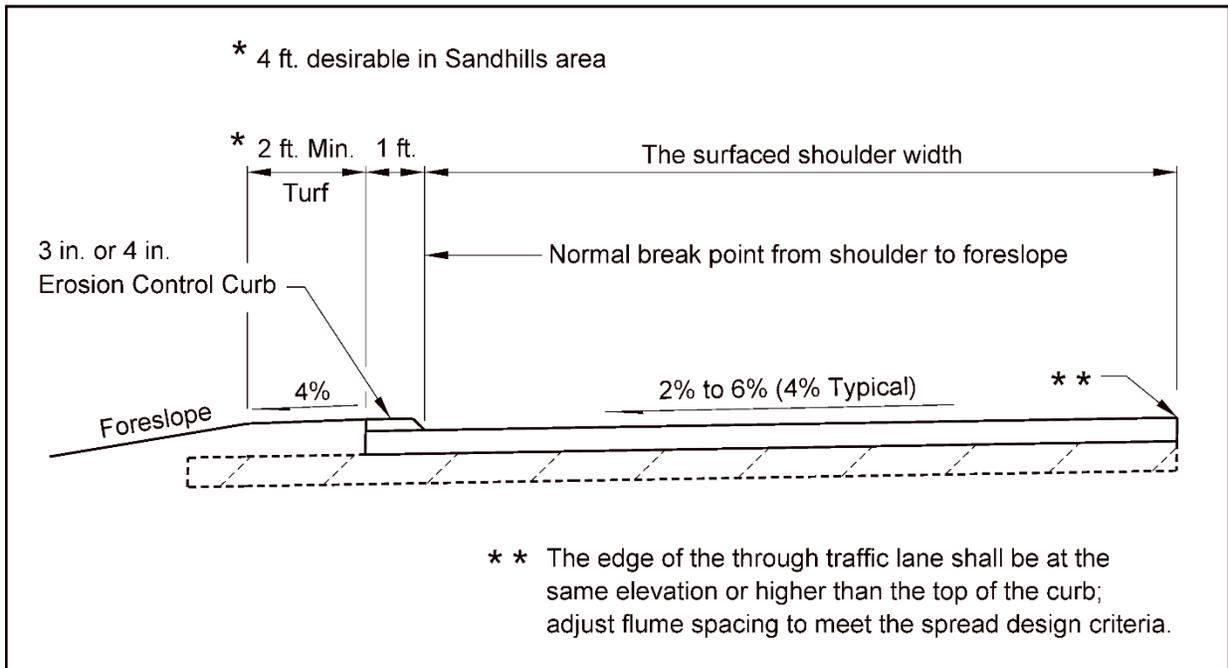
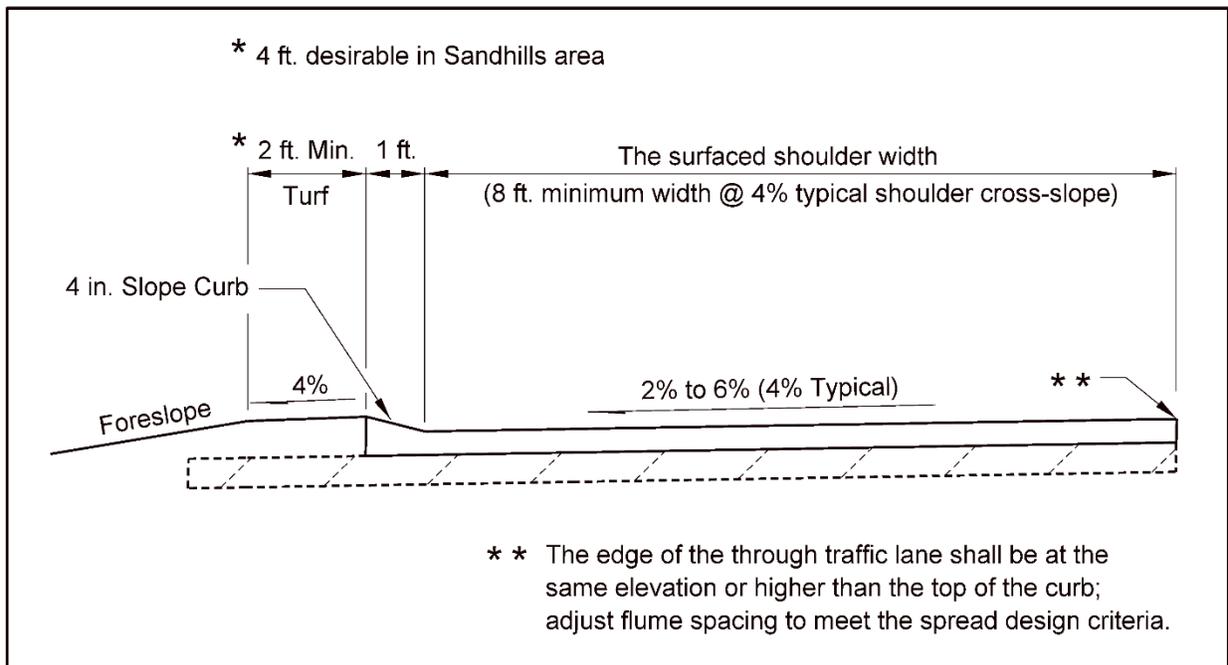


Exhibit 6.12 Typical Curb Details



3-inch or 4-inch Erosion Control Curb



4-inch Slope Curb

Exhibit 6.13 Erosion Control Curb Location

4. ROLLOVER RATES

The rollover rate is defined as the algebraic difference in rate of cross slope between adjacent roadway surfaces. The maximum rollover rates used by **NDOT** are:

- 5% between adjacent lanes for facilities with a design speed \geq 50 mph
- 7% between the lane and shoulder
- 5% for gore areas

The treatment of rollover through superelevated sections is shown in Chapter Three: Roadway Alignment, EXHIBITS 3.3a, 3.4a, & 3.5a.

For additional information see the *Green Book* (Ref. 6.1), Chapter 4, Section 4.9.2, “Superelevated Sections”, and Chapter 9, Section 9.6.4, “Superelevation for Turning Roadways at Intersections”.

5. TRANSITION

Transition sections are required when one roadway cross-section changes to another roadway cross-section. Locations where transition sections are required include, but are not limited to:

- The change from standard roadway sections to roadway sections with auxiliary lanes
- The change from multilane facilities to two-lane facilities
- At narrow existing bridge structures
- At ramps and turning roadways
- The change from rural to urban sections

EXHIBIT 6.14 illustrates common lane transition configurations.

Transitions for auxiliary lanes, especially turning lanes, often depend on the space available for the transition. Specific criteria for auxiliary lane transition sections and taper rates are discussed in the *Green Book* (Ref. 6.1), Chapter 9, Section 9.7, “Auxiliary Lanes” and Chapter 10, Section 10.9.5.10, “Auxiliary Lanes”.

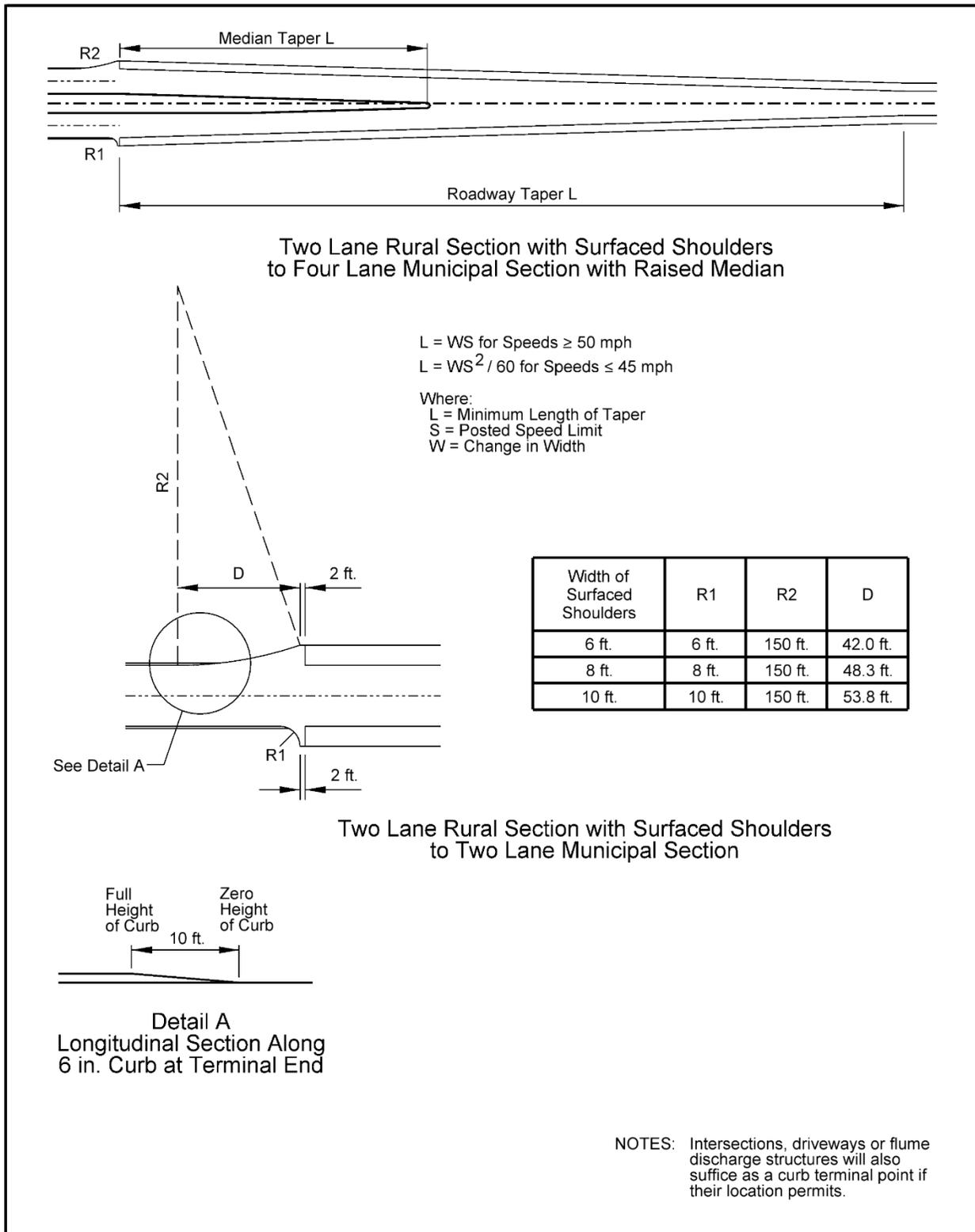


Exhibit 6.14 Examples of Rural to Urban Roadway Transitions

6. AUXILIARY LANES

Auxiliary lanes may be added to a roadway for various reasons, including:

- Turn lanes at intersections
- Two-way left-turn lanes
- Truck climbing/ passing lanes
- Acceleration/ deceleration lanes
- Continuous auxiliary lanes between two closely spaced interchanges

For further information, see Chapter Three: Roadway Alignment, Section 3.A.4 and Chapter Four: Intersections, Driveways and Channelization, Section 1.D of this manual and Chapter 9, Section 9.7, “Auxiliary Lanes”, and Chapter 10, Section 10.9.5.10, “Auxiliary Lanes”, of the *Green Book* (Ref. 6.1).

7. ROADWAY CHANNELIZATION

See Chapter Four: Intersections, Driveways and Channelization, Section 5, of this manual and the *Green Book* (Ref. 1.1), Sections 4.11, “Medians”, and 9.6.3, “Islands”.

8. NEW FOUR-LANE DIVIDED HIGHWAY USING EXISTING TWO-LANE HIGHWAY (2 + 2 PROJECTS)

The following guidance should be followed when designing a four-lane divided highway which utilizes the existing two-lane roadway:

1. The new lanes and median will be designed to expressway or major arterial crowned standards (See EXHIBIT 6.1).
2. For existing crowned sections with eight foot wide surfaced shoulders which are in relatively good condition, the inside (median) eight foot wide surfaced shoulder should be removed or reduced to four feet in width if required to provide sufficient median width for proper drainage.
3. The location of the axis of rotation and the profile grade point through superelevated sections of the new lanes is illustrated in Chapter Three: Roadway Alignment, EXHIBITS 3.3, 3.4, 3.5, & 3.6.
4. A depressed median should have sufficient width (edge of the driving lane to edge of the driving lane) to provide for proper drainage. The desirable depressed median width for an Interstate is 64 feet and the desirable depressed median width for a 4-lane freeway or expressway is 54 feet. For additional information, see Chapter Four: Intersections, Driveways and Channelization, Section 5, of this manual.

For additional guidance, see Chapter Seventeen: Resurfacing, Restoration and Rehabilitation (3R) Projects, Section 1.E, of this manual.

9. ROADSIDE DESIGN

9.A The Clear Zone

In the late 1960's the forgiving roadside concept was introduced, recognizing that motorists do run off of the roadway and that the number of serious accidents and injuries might be lessened if a traversable recovery area were provided. Ideally this recovery area, the clear zone, should be free of obstacles such as unyielding sign and luminaire supports, trees, non-traversable drainage structures, utility poles, steep slopes, etc. Design options for the treatment of these features have generally been considered in the following order:

- Remove the obstacle or redesign it so it can be traversed
- Relocate the obstacle to outside of the clear zone or to where it is less likely to be struck
- Reduce impact severity by using an appropriate breakaway device
- Redirect a vehicle by shielding the obstacle with a longitudinal traffic barrier and/ or impact attenuator
- Delineate the obstacle if other alternatives are not practicable

Clear zone width varies with the roadway functional classification, project type, traffic volume, design speed, roadway location, and the grading section of the roadway. The *MDS* (Ref. 6.2) provides **NDOT** minimum clear zone requirements for various roadway types. For additional information, see Appendix H, "AASHTO Minimum Design Guidance" of this manual and Chapter 3 of the Roadside Design Guide (Ref. 6.6).

9.A.1 Horizontal Clear Zone

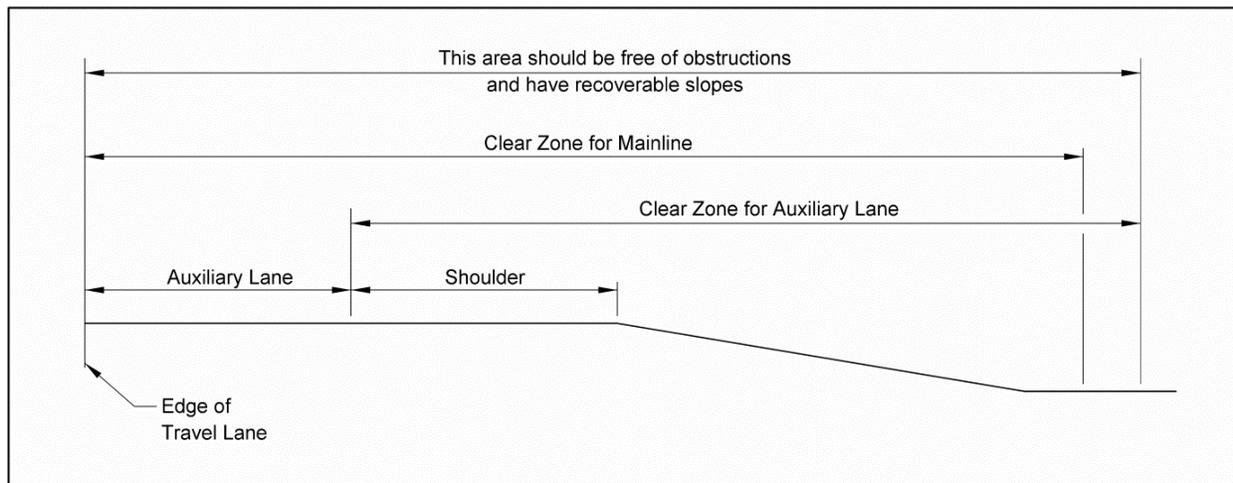
For New and Reconstructed projects, the Horizontal Clear Zone is the roadside area, starting at the edge of the travel lane, which is available for the recovery of errant vehicles. It consists of the shoulder, a recoverable slope, a non-recoverable but traversable slope, and/ or a clear runout area. The required Horizontal Clear Zone will vary depending upon the roadway classification (See the *MDS*, Ref. 6.2). Prior to 2016, the *MDS* (Ref. 6.2) referred to the Horizontal Clear Zone as the Lateral Obstacle Clearance.

9.A.2 Fixed Obstacle Clearance

For 3R projects the Fixed Obstacle Clearance, as given in the *MDS* (Ref. 6.2), provides an obstacle free zone in the roadside environment. For additional information see Chapter Seventeen: Resurfacing, Restoration and Rehabilitation (3R) Projects, Section 6.D, of this manual.

9.A.3 Clear Zone Requirements for Auxiliary Lanes

In some instances, it will be necessary to calculate clear zone requirements for both the mainline driving lane and for an auxiliary lane. The clear zone must be calculated for each lane independently, based on the projected traffic volumes and design speeds of the individual lanes (See **TABLE 3.1** of the Roadside Design Guide, Ref. 6.6). The clear zone will be set at the greater of the two distances from the edge of travel way, as shown in EXHIBIT 6.15.



Note: Use the larger clear zone as measured from the edge of the travel lane or from the edge of the auxiliary lane.

Exhibit 6.15 Clear Zone Application for Auxiliary Lanes Adjacent to Mainline

9.B Roadside Geometry (Side Slopes)

The roadside geometry (foreslopes and backslopes) depends on many factors, including:

- The functional classification of the roadway
- Topography
- Urban/ rural location
- The presence of curbs
- Snow Control

Criteria for roadside geometry for municipal highways are illustrated in [EXHIBITS 6.8, 6.9 AND 6.10](#). The grading typical sections for rural projects are illustrated in [EXHIBIT 6.16](#). Variations from the typical grading section will require the approval of the **ADE** and the reasons for the variation will be documented in the project file. For additional information regarding roadside geometry, see Section 3.2 of the [Roadside Design Guide](#) (Ref. 6.6).

9.B.1 Fill Slopes (Parallel)

Fill slopes within the clear zone should be recoverable slopes (1:4 or flatter) with no protruding fixed objects. Motorists on recoverable slopes generally can either stop their vehicles or slow them sufficiently to enable a return to the roadway. For New and Reconstructed projects, **NDOT** requires 1:6 or flatter slopes to the outside edge of the Horizontal Clear Zone (which is also known as the hinge point).

A non-recoverable traversable slope is defined as a slope which is steeper than 1:4 but equal to or flatter than 1:3. Motorists on non-recoverable traversable slopes generally will not be able to stop their vehicles or return to the roadway but should be able to reach the bottom of the slope without overturning. A section of non-recoverable traversable slope may be contained within the clear zone as long as an unobstructed runout area (which is 1:4 or flatter) is provided beyond the non-recoverable slope (this runout width will be included in the total recovery area).

A side slope which is steeper than 1:3 is considered to be a critical slope (non-recoverable and non-traversable, one on which a vehicle is more likely to overturn). A critical slope should not be included within the clear zone. If a critical slope cannot be eliminated from the clear zone an analysis of the slope will be performed using an applicable computer program (such as RSAP) to determine the economic benefit of installing a roadside barrier system (See Chapter Nine: Guardrail and Roadside Barriers, Section 1.D, of this manual).

For additional information, see Appendix H, "AASHTO Minimum Design Guidance", **Figure 3.2**, of this manual.

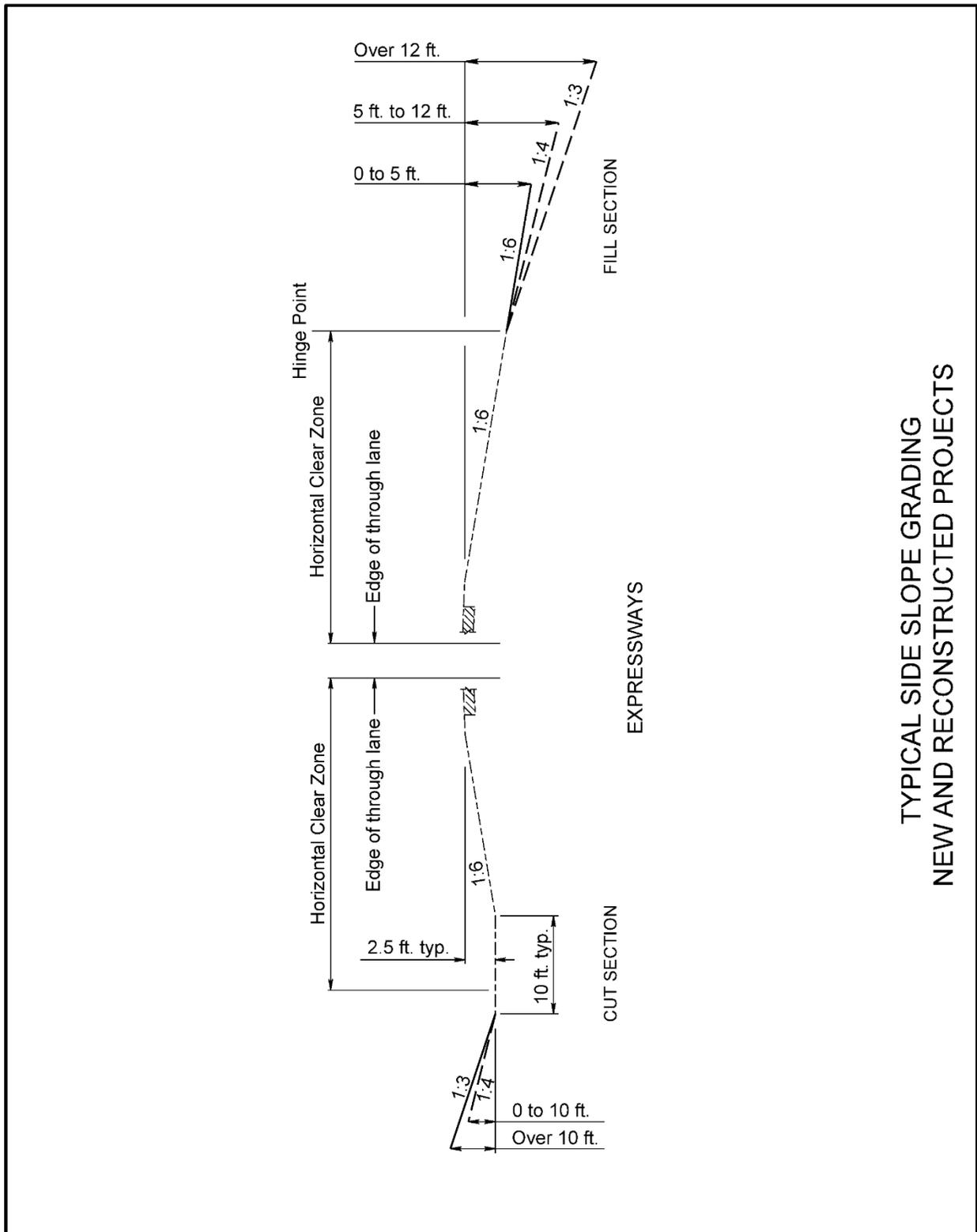
9.B.2 Fill Slopes (Transverse)

Transverse fill slopes caused by the grading at crossroads, driveways/ field entrances, median crossings, dikes, etc. are generally more critical to vehicles traveling on the mainline than parallel slopes since the transverse slope is head on to an errant vehicle. Transverse fill slopes of 1:6 or flatter are required within the clear zone on high-speed roadways (≥ 50 mph). The transverse fill slope will be carried to the outside edge of the clear zone and may then be warped to a 1:3 foreslope in a minimum distance of 15 feet (See EXHIBITS 4.14, 4.15 & 4.18). Dikes and median turnarounds in depressed medians will have fill slopes of 1:10.

9.B.3 Cut Slopes

Typical cross-sections of cut slopes can be found in EXHIBIT 6.16. The 10-foot ditch bottom should be considered as the desirable ditch width. This width may be reduced when encountering front yards, mature shelterbelts or trees, center pivots and at other locations where there would be major damages to the property if right-of-way would be acquired based on the 10 foot ditch width. The designer may consider installing curb and/ or culvert pipe, when practicable, to reduce right-of-way damages; however, right-of-way should be acquired to or beyond the limits of the clear zone.

The foreslope of a cut section with a special ditch (See Section 10.B of this chapter) should meet the same slope and height criteria as the fill slope requirements presented in EXHIBIT 6.16. Ditches with steep backslopes, such as bench cuts through rock, should be designed so that the backslope is outside of the clear zone.



TYPICAL SIDE SLOPE GRADING
 NEW AND RECONSTRUCTED PROJECTS

Exhibit 6.16a Typical Side Slopes for New and Reconstructed Projects

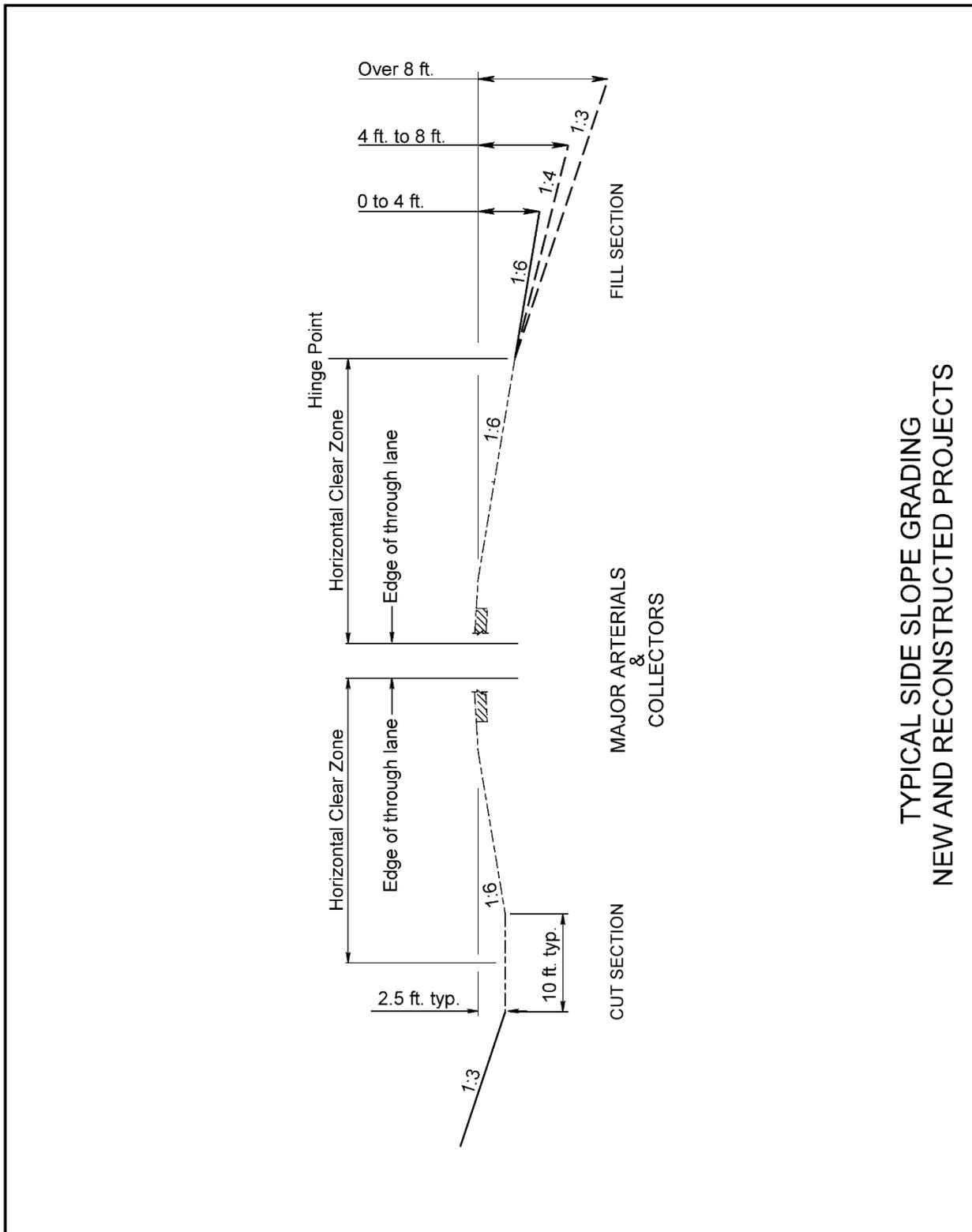


Exhibit 6.16b Typical Side Slopes for New and Reconstructed Projects

10. OTHER ELEMENTS AFFECTING THE ROADWAY CROSS-SECTION

10.A Right-of Way

Right-of-way requirements for street and highway design are discussed in Section 2 of the Right-of-Way Design Manual (<http://www.roads.nebraska.gov/media/5012/row-manual.pdf>). Right-of-way considerations which may impact the design of the roadway cross-section include, but are not limited to:

- Restricted Right-of-Way - Areas where right-of-way is restricted (e.g. environmental considerations, buildings) may require the use of steeper side slopes, retaining walls, adjustments to the vertical grade to reduce fill heights, and/ or the provision of roadside barriers.
- Sight Distance - The purchase of additional right-of-way may be warranted at horizontal curves and intersections to provide and/ or maintain the required horizontal sight distances.
- Constructability – Construction easements may be required for construction of bridge structures, for construction equipment access and storage, for materials storage and for other activities required for the construction of the project.

10.B Drainage

A roadside ditch will be of sufficient depth to meet the maximum allowable headwater (D + 1) policy (See the *Drainage Manual* (Ref. 6.4), Chapter One: Drainage, Section 8.G).

Ditches which are greater than the normal depths shown in EXHIBITS 6.1 THROUGH 6.6 AND 6.16 are referred to as special ditches. When placing a special ditch, the designer should use a 1:6, 1:4, or a 1:3 foreslope as specified in EXHIBIT 6.16; the grading may go directly to a 1:3 foreslope from the hinge point with **Unit Head** approval and a decision letter to the project file. The minimum special ditch length that will be shown on the Plan and Profile Sheet is 150 feet (See Chapter Eleven: Highway Plans Assembly, Section 4.L, of this manual); the grading contractor will build shorter special ditches based on the project slope stake data. The roadway designer will inform the **Roadside Development Unit** in the **Project Development Division (PDD)** of the location and slope of all ditches for their use in the design of the erosion control.

For curbed facilities, the type of facility limits the maximum width or spread of stormwater from the curb onto the roadway (See EXHIBIT 1.37 of the *Drainage Manual*, Ref. 6.4). Curb height, superelevation, and longitudinal slope all impact drainage design for curbed facilities.

Drainage design is discussed in Chapter One: Drainage of the *Drainage Manual* (Ref. 6.4).

10.C Environmental Considerations

It may be necessary to adjust the project side slopes to avoid impacting environmentally sensitive areas. The **Environmental Section** of **PDD** should be consulted about specific problem areas associated with the roadside landscape. Typical environmental considerations that may impact cross-section design include:

- Rare and/ or endangered plant species (e.g. Prairie Fringed Orchid)
- Saving established vegetation on existing slopes, where practicable, in the Sandhills Region
- Saving existing trees which are outside of the clear zone but are within the project construction limits, where desired
- Avoiding excavation inside the dripline of a tree, which will damage its roots, if the tree is to be saved (the dripline is the perimeter of the area directly under the crown of the tree)

See Chapter Ten: Miscellaneous Design Issues, Section 4, of this manual for further information.

Changes to the roadway cross-section as it is described in the approved environmental (NEPA) document shall be submitted to the **Environmental Section** in **PDD** for review. For additional information, see Chapter Thirteen: Planning and Project Development of this manual.

10.D Erosion Control

Erosion control considerations which may impact the design of the roadway cross-section include, but are not limited to, the following:

- Building curb and flume (See Section 3.C of this chapter)
- Providing flatter side slopes, where practicable, in the Sandhills Region and other areas where roadway side slopes are susceptible to erosion
- MS4 grass swales

See Chapter Two: Erosion and Sediment Control and Chapter Three: Stormwater Treatment of the *Drainage Manual* (Ref. 6.4) for additional information.

10.E Geotechnical Features

Geotechnical features within a project may impact cross-section design. The designer should review the soil, subgrade, and materials surveys from the **Materials and Research Division (M&R)** (See Chapter Seven: Earthwork, Section 8, of this manual). Some features which may require special consideration include:

1. Cut or fill sections where the maximum height of cut or fill exceeds 20 feet or where embankment is to be constructed on a weak and compressible foundation material. These concerns are generally discussed in the foundation report and will affect construction phasing.
2. Soil and rock instability in cut/ fill sections or natural slopes which are presently or potentially unstable, slide areas, slip plains, and unusual groundwater conditions. Mitigations for unstable conditions, such as geotextile soil reinforcement, permanent ground anchors, wick drains, stone columns, etc. may warrant special consideration.
3. Retaining walls where the maximum height along the length of a geotechnical feature exceeds four feet. Retaining wall design is discussed in Chapter Ten: Miscellaneous Design Issues, Section 8).

10.F Snow Control

Ditches may be widened and the backslope laid back from its normal 1:3 slope to provide more area for snow accumulation. See Chapter Ten: Miscellaneous Design Issues, Section 5, of this manual for a discussion of snowdrift abatement techniques.

10.G Earthwork Balances

Ditches or shoulders may be widened to provide for additional excavation or fill in order to balance the project earthwork (See Chapter Seven: Earthwork, Section 1, of this manual).

10.H Daylighting

Daylighting occurs when the roadway backslope is flattened to intersect with the natural ground at a lower elevation than the typical backslope (See EXHIBIT 6.17). Daylighting may be used in order to gain excavation, to improve sight distance, or to eliminate snow drifting. When daylighting is used the following considerations should be taken into account:

- The consequences of removing the earth barrier related to impacts to environmentally sensitive areas, noise pollution, off-roadway glare, driver distraction, view from the roadway and from off of the roadway, and other aesthetic considerations
- Additional right-of-way may be required
- Current drainage patterns will be maintained

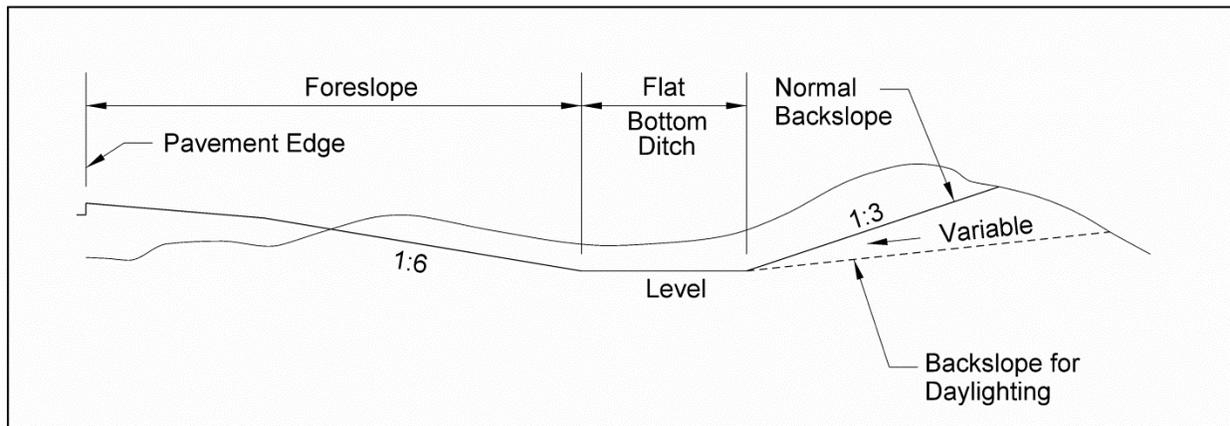


Exhibit 6.17 Daylighting

10.I Utilities

Highway and street improvements, whether within the existing right-of-way or on new right-of-way, generally entail adjustments of utility facilities. See Chapter Ten: Miscellaneous Design Issues, Section 11, of this manual for further information.

10.J Guardrail

Grading for guardrail may affect the roadway cross-section. See Chapter Nine: Guardrail and Roadside Barriers, Section 3.F, of this manual and the *Standard Plans* (Ref. 6.3) for further information.

10.K Bridges

The **Bridge Division (Bridge)** is responsible for the design of bridges and bridge-sized structures; the designer will coordinate with **Bridge** on projects involving bridges and bridge-sized structures (See Chapter Ten: Miscellaneous Design Issues, Section 2, of this manual). Minimum bridge widths may be found in the *MDS* (Ref. 6.2).

10.K.1 Underpasses

The cross-section through an underpass should be the same as the approach roadway cross-section, including the clear zone or roadside barriers. Future widening of the roadway should be considered if significant traffic volume increases are anticipated in the foreseeable future (provide sufficient additional width for an additional lane in each direction to be added at a later date).

11. REFERENCES

- 6.1 American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets (*Green Book*), Washington D.C., 2018.
- 6.2 Board of Public Roads Classifications and Standards, Nebraska Minimum Design Standards (*MDS*), Current Edition.
(<http://www.roads.nebraska.gov/media/5593/nac-428-rules-regs-nbcs.pdf>)
- 6.3 Nebraska Department of Transportation, Standard/Special Plans Book (*Standard Plans*), Current Edition. (<http://www.roads.nebraska.gov/business-center/design-consultant/stand-spec-manual/>)
- 6.4 Nebraska Department of Transportation, Drainage Design and Erosion Control Manual (*Drainage Manual*), Current Edition.
(<http://www.roads.nebraska.gov/business-center/design-consultant/rd-manuals/>)
- 6.5 Federal Highway Administration, Manual on Uniform Traffic Control Devices, (*MUTCD*) 2009. (<http://www.roads.nebraska.gov/business-center/contractor/mutcd/>)
- 6.6 American Association of State Highway and Transportation Officials, Roadside Design Guide, Washington D.C., 2011.