June 5, 2006

MONTANA DEPARTMENT OF TRANSPORTATION

ROAD DESIGN MANUAL

Chapter Eighteen

SPECIAL DESIGN ELEMENTS

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Chapter Eighteen
SPECIAL DESIGN ELEMENTS

The designer must address numerous design elements which are not directly related to the geometric design of the roadway. Chapter Eighteen provides a discussion on these design elements including disabled accessibility requirements, bikeways, fencing, rest areas, temporary weigh stations, mail boxes, hazardous materials, cattle guards, retaining walls, bus stops/turn outs, snow fences, and railroads.

18.1 ACCESSIBILITY FOR DISABLED INDIVIDUALS

Many highway elements can affect the accessibility and mobility of disabled individuals. These include sidewalks, parking lots, buildings at transportation facilities, overpasses and underpasses. The Department's accessibility criteria comply with the 1990 *Americans with Disabilities Act* (ADA). The following sections present accessibility criteria which are based on information presented in the *ADA Accessibility Guidelines for Buildings and Facilities* (ADA Guidelines). Designers are required to meet the criteria presented in the following sections. Where other agencies or local codes require standards which exceed the ADA Guidelines, then the stricter criteria may be required. This will be determined on a case-by-case basis.

18.1.1 ADA Implementation

When implementing ADA criteria on highway projects, the designer should consider the following:

1. New Construction. ADA compliance will be measured against the new construction criteria in Section 18.1 and *ADA Guidelines*. For most projects, the designer will have the flexibility in the design to implement the new ADA construction criteria.

2. Alterations. Planned additions or alterations to existing facilities must be accomplished so that the altered facility will be accessible to and usable by persons with disabilities to the maximum extent feasible. Where existing conditions permit, new ADA construction criteria must be implemented. Also note that any element that can be made accessible should be (e.g., curb ramps), even if the facility as a whole cannot be made fully accessible. Changes that affect existing pedestrian facilities should include adjacent work as necessary to ensure that grades, finishes, and surfaces will meet or match those of the alterations.

3. Existing. For elements in existing right-of-way not otherwise being altered, the decision to upgrade individual accessibility elements will be determined on a case-by-case basis. If it is not practical to fully meet the *ADA Guidelines* criteria, each feature of accessibility should be maximized within the constraints of the site conditions at that location.

4. Temporary Access. Where a continuous route cannot be provided for pedestrians during construction, an alternative route should be available. This may require temporary walkways and curb ramps to maintain access. Sidewalk barriers should be detectable by pedestrians with low vision and pedestrians who are blind.

18.1.2 Survey and Design Considerations

18.1.2.1 Survey

During the Preliminary Field Review and field survey, locate items such as signal bases, fire hydrants, signs and drainage structures. Elevations at key points will also be needed to properly construct accessible facilities. Construction permits or right-of-way agreements may be required to transition the back of the sidewalk into approaches and features adjacent to the sidewalk.

18.1.2.2 Design

The *MDT Detailed Drawings* provide typical design options. However, items such as ramp orientation, sidewalk width and ramp width need to be shown in the plans to supplement the *MDT Detailed Drawings*. Providing individual details may be necessary for unique ramp configurations, particularly where existing sidewalks are being retrofitted with ramps. These details should include ramp width, length, orientation and location in addition to elevations and in place features that may affect ramp construction.

18.1.3 Buildings

For interior accessibility criteria, the following will apply:

1. New. All new buildings, airport terminals, rest areas, weigh stations and transit stations (e.g., stations for intercity bus, intercity rail, high-speed rail and other fixed guideway systems) shall meet the accessibility criteria set forth in the *ADA Guidelines*. The designer should review the *ADA Guidelines* to determine the

appropriate accessibility requirements for building interiors, including rest rooms, drinking fountains, elevators, telephones, etc.

2. Existing. In general, for alterations made to existing buildings or facilities, the designer must meet the accessibility requirements for the alteration made to the facility, unless it is prohibitively expensive to do so. The designer should review the *ADA Guidelines* to determine the appropriate criteria and, if required, where exceptions may be allowed.

18.1.4 Bus Stops

The following accessibility criteria apply to the construction of bus stops:

1. Bus Stop Pads. New bus stop pads constructed to be used in conjunction with a lift or ramp shall meet the following criteria:

    a. Provide a firm, stable, and slip resistant surface.

    b. Provide a minimum clear length of 8' (2.44 m) (measured from the curb or roadway edge) and minimum clear width of 5' (1.53 m) (measured parallel to the roadway) depending on the legal or site constraints.

    c. Connect the pad to streets, sidewalks or pedestrian paths by at least one accessible route.

    d. The slope of pad parallel to the roadway must be the same as the roadway to the maximum extent practical.

    e. For drainage purposes, provide a maximum cross slope of 2% perpendicular to the roadway.

2. Bus Shelters. Where new or replaced bus shelters are provided, install or position them to permit a wheelchair user to enter from the public way and reach a location within the shelter having a minimum clear floor area of 30" (760 mm) by 48" (1220 mm). An accessible route shall be provided from the shelter to the boarding area.

18.1.5 Parking

18.1.5.1 Off-Street Parking

The following criteria apply to off-street disabled parking spaces:

1. Minimum Number. Figure 18.1A provides the criteria for the minimum number of accessible spaces. A typical disabled stall layout is shown in Figure 18.1B.

   One out of every eight accessible spaces, but not less than one, shall have an access aisle 8’ (2.44 m) wide and must be designated as van accessible.

2. Location. Parking spaces for disabled individuals and accessible passenger loading zones that serve a particular building shall be the spaces or zones closest to the nearest accessible entrance on an accessible route. In separate parking structures or lots that do not serve a particular building, locate parking spaces for disabled individuals on the shortest possible circulation route to an accessible pedestrian entrance of the parking facility. In buildings with multiple access entrances with adjacent parking, accessible parking spaces shall be dispersed and located closest to the accessible entrances.

3. Signing and Pavement Markings. Designate parking spaces for the disabled with signs with white lettering against a blue background. These signs shall bear the international symbol of access; see the *MUTCD*. The sign shall not be obscured by a vehicle parked in the space. Van-accessible spaces shall have an additional sign stating the space is "Van-Accessible" below the symbol of accessibility. Pavement markings will comply with the *MUTCD*.

4. Dimensions. The parking spaces designated for the disabled shall be at a minimum 8’ (2.44 m) wide and desirably 9’ (2.75 m) wide with an additional 5’ (1.53 m) minimum access aisle or 8’ (2.44 m) next to van-accessible spaces, or the space should be parallel to a sidewalk on a public highway (see Figure 18.1B). Parking access aisles shall be part of an accessible route to the building or facility entrance. Parked vehicular overhangs shall not reduce the clear width of an accessible circulation route. Parking spaces and access aisles shall be level with surface slopes not exceeding 2% in all directions.

5. Parking Garages. Any parking garage or terminal should have a 9.5’ (2.90 m) vertical clearance at its entrance, exit, and along the route to and from at least two parking spaces which have a 9.5’ (2.90 m) vertical clearance. Note that the parking space itself may have a minimum vertical clearance of 8.17’ (2.49 m).

Total No. of Parking Spaces	Minimum Number of Accessible Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2% of total
1001 and over	20 plus 1 for each 100 over 1000

Notes:

a. *If one or more passenger loading zones are provided, then at least one passenger loading zone shall comply with Item # 6 in Section 18.1.5.1.*

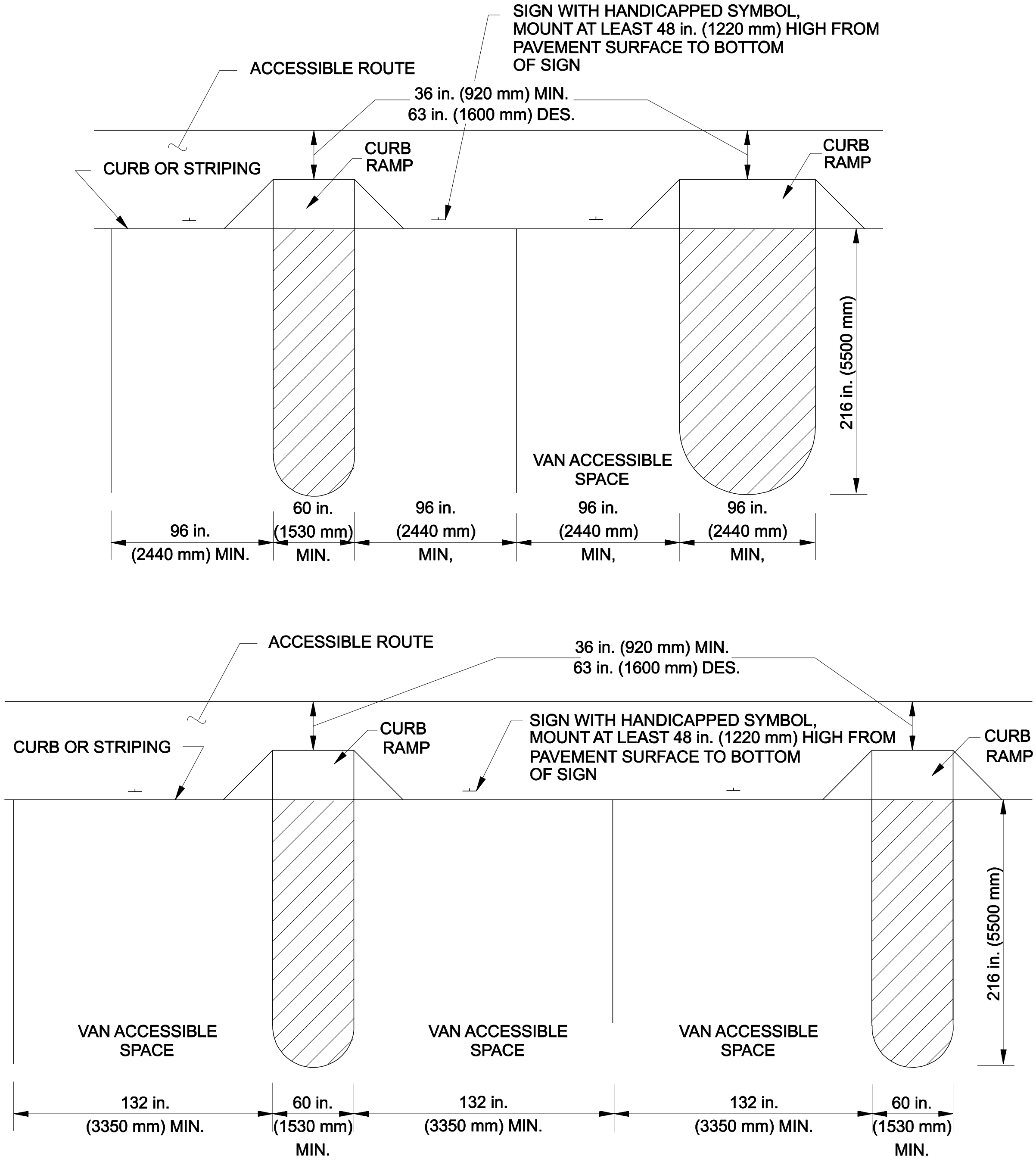
b. *Parking spaces for side-lift vans are accessible parking spaces and may be used to meet the requirements of this Section.*

c. *The total number of accessible parking spaces may be distributed among closely spaced parking lots, if greater accessibility is achieved.*

d. *At least one of every eight spaces, but not less than one shall be van accessible.*

MINIMUM NUMBER OF ACCESSIBLE SPACES FOR DISABLED USERS

Figure 18.1A



Notes:

1. *All dimensions are in both in/ft and mm.*
2. *Two accessible parking spaces may share a common access aisle.*

DISABLED PARKING STALL DIMENSIONS
(Off-Street Parking)

Figure 18.1B

6. Passenger Loading Zones. Passenger loading zones shall provide an access aisle at least 5’ (1.53 m) wide and 20’ (6.10 m) long adjacent and parallel to the vehicular pull-up space. If there are curbs between the access aisle and the vehicular pull-up space, provide a curb ramp complying with Section 18.1.11. Vehicular standing spaces and access aisles shall be essentially level. Surface slopes shall not exceed 2% in all directions.

18.1.5.2 On-Street Parking

Where new on-street paid or time-limited parking is provided and designated in districts zoned for business uses, the on-street parking design desirably should meet the following accessibility criteria:

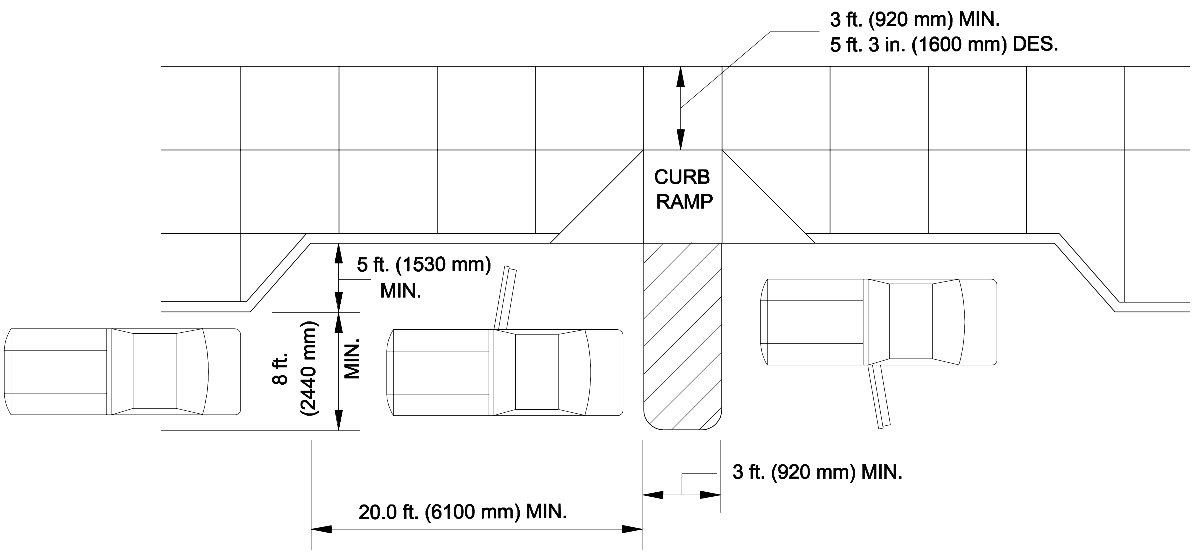
1. Minimum Number. Figure 18.1A provides the criteria for the minimum number of accessibility spaces that may also be applied to on-street parking. In general, provide one accessible space per block.

2. Location. On-street accessibility parking spaces will be dispersed throughout the project area. To the maximum extent feasible, accessible on-street parking should be located in level areas. The designer should seek input from the local governing agency early in the design process for information concerning local requirements and restrictions.

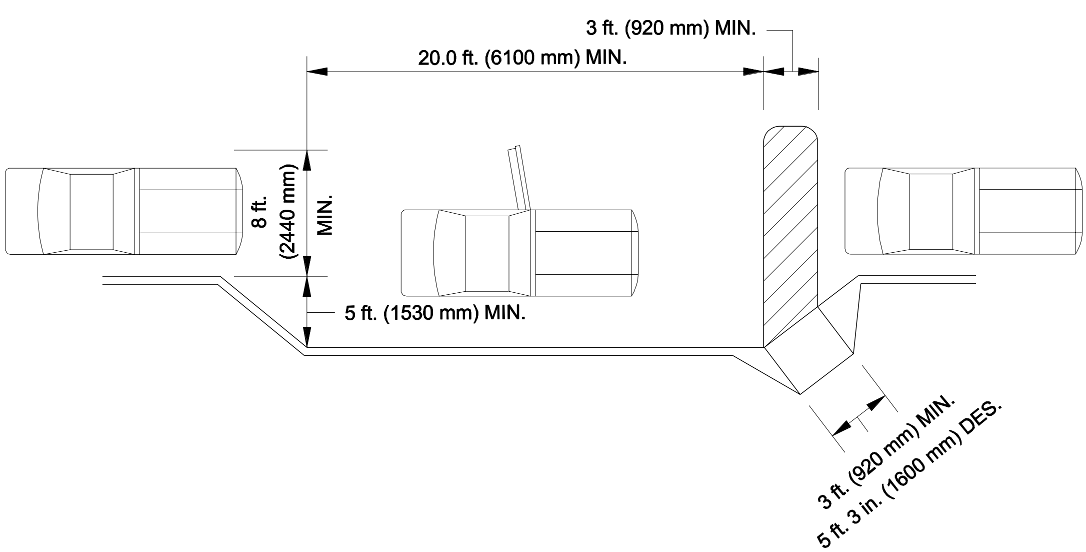
3. Dimensions. At a minimum, provide a 20’ (6.10 m) parking space with a 5’ (1.53 m) access aisle at the head or foot of the parking space. This is illustrated in Figure 18.1C. The traveled way shall not encroach into the access aisle.

4. Signing and Pavement Markings. Designate parking spaces for the disabled with ground-mounted signs with white lettering against a blue background. These signs shall bear the international symbol of access; see the *MUTCD*. Locate these signs so they are visible from a driver's seat. Pavement markings will conform to the *MUTCD*.

5. Curb Ramps. If there are curbs next to an on-street accessible parking space, provide a curb ramp complying with Section 18.1.11. Accessible parking spaces adjacent to intersections may be served by the sidewalk curb ramp at the intersection, provided that the path of travel from the access aisle to the curb ramp is within the pedestrian crossing area.



(a) TWO ACCESSIBLE PARALLEL PARKING SPACES IN SERIES, SEPARATED BY AN ACCESSIBLE AISLE, WITH BOTH DRIVER-SIDE AND PASSENGER-SIDE ACCESS DEMONSTRATED.



(b) SINGLE ACCESSIBLE PARALLEL PARKING SPACE WITH DRIVER-SIDE ACCESS DEMONSTRATED; PASSENGER SIDE ACCESS CAN BE PROVIDED BY PARKING IN LINE WITH STANDARD ON-STREET SPACES.

DESIRABLE DISABLED PARKING DESIGN
(On-Street Parking)

Figure 18.1C

6. Parking Meters. Where provided, parking meter controls shall be a maximum of 42” (1060 mm) above the sidewalk or pedestrian circulation path. Controls and operating mechanisms shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. The force required to activate controls shall be no greater than 5 lbs. (22.2 N). A firm, stable and slip-resistant area [30” (760 mm) by 48” (1220 mm)], with the least possible slope, shall be provided at the controls and shall be connected to the sidewalk by a continuous passage that is a minimum of 36” (920 mm) wide. For disabled parking stalls, the removal of parking meters, with concurrence of the local jurisdiction, is preferred.

18.1.6 Accessible Route

An accessible route is a continuous, unobstructed path connecting all accessible elements and spaces in a building, facility or site. A "site" is defined as a parcel of land bounded by a property line or a designated portion of a public right-of-way. A "facility" is defined as all or any portion of buildings, structures, site improvements, complexes, equipment, roads, walks, passageways, parking lots, or other real or personal property on a site. Interior accessible routes may include corridors, floors, ramps, elevators, lifts, and clear floor space at fixtures. Exterior accessible routes may include parking access aisles, curb ramps, crosswalks at vehicular ways, walks, ramps, and lifts.

Accessible routes must be provided as follows:

1. Provide at least one accessible route within the boundary of the site from public transportation stops, accessible parking, accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve. The accessible route shall, to the maximum extent feasible, coincide with the route for the general public.

2. At least one accessible route shall connect accessible buildings, facilities, elements, and spaces that are on the same site.

3. At least one accessible route shall connect accessible buildings or facility entrances with all accessible spaces and elements and with all accessible dwelling units within the building or facility.

For highway projects, the application of the accessible route criteria applies to rest areas, recreational areas, park-and-ride lots, sidewalks next to public roadways, etc. Section 18.1.8 provides the accessibility requirements for sidewalks.

18.1.7 <u>Non-Accessible Route</u>

A non-accessible route is any pedestrian facility which contains features that make it impractical to meet all the criteria for accessible routes described in Section 18.1.8.1. These features include terrain that results in steep grades on the facility and narrow sidewalks or stairs where adjacent development precludes widening or replacement with ramps. These features are typically associated with existing facilities. However, they may also affect the accessibility of routes on new construction.

18.1.8 <u>Sidewalks</u>

Section 11.2.7 presents the Department's warrants and design criteria for sidewalks. In addition, all sidewalks must comply with the ADA Guidelines presented in the following sections. Most sidewalks along public highways are considered to be accessible routes.

18.1.8.1 Criteria for Accessible Routes

For sidewalks on accessible routes, the following accessibility criteria shall be met:

1. <u>Width</u>. The minimum clear width at any isolated point along an accessible route shall be 36” (920 mm), except at doors which may have a minimum width of 32” (820 mm).

2. <u>Passing Space</u>. If the sidewalk has less than 5’ (1.53 m) clear width for an extended distance, then passing spaces at least 5’ (1.53 m) by 5’ (1.53 m) shall be located at reasonable intervals not to exceed 200’ (61 m). A T-intersection between two walks is an acceptable passing space. Paved driveways meeting ADA requirements also provide acceptable passing space in residential areas.

3. <u>Surface</u>. All sidewalk surfaces shall be stable, firm and slip resistant. The longitudinal gradient should be flush and free of abrupt changes. However, changes in level up to ¼” (6 mm) may be vertical and without edge treatment. Changes in level between ¼” (6 mm) and ½” (13 mm) shall be beveled with a slope no greater than 2:1. Changes greater than ½” (13 mm) shall be accommodated with a ramp; see Section 18.1.10.

4. <u>Drainage</u>. Gratings should not be placed within the walking surface. If, however, gratings must be located in walking surfaces, then they shall have spaces no greater than ½” (13 mm) wide in one direction. If gratings have elongated

openings, align the grate so that the long dimension is perpendicular to the dominant direction of travel.

5. Slopes. The sidewalk cross slope, including where laydown curb is provided for public and private approaches, shall not exceed 2%. If the longitudinal gradient exceeds 5%, the sidewalk must meet the accessibility criteria for ramps; see Section 18.1.10.

6. Protruding Objects. Objects projecting from walls (e.g., signs, telephones, canopies) with their leading edges between 27” (690 mm) and 6.67’ (2.03 m) above the finished sidewalk shall not protrude more than 4” (100 mm) into any portion of the sidewalk. Freestanding objects mounted on posts or pylons may overhang their mountings up to a maximum of 12” (300 mm) when located between 27” (690 mm) and 6.67’ (2.03 m) above the sidewalk or ground surface. Protruding objects less than 27” (690 mm) or greater than 6.67’ (2.03 m) may protrude any amount provided that the effective width of the sidewalk is maintained. Where the vertical clearance is less than 6.67’ (2.03 m), provide a barrier to warn the blind or visually-impaired person.

7. Bus Stops. Where bus passenger loading areas or bus shelters are provided on or adjacent to sidewalks, they must comply with the criteria in Section 18.1.4.

8. Curb Ramps. All curb ramps on an accessible route must comply with the criteria in Section 18.1.11.

9. Driveway. All driveways on accessible routes must comply with the criteria in Section 18.1.12.

18.1.8.2 Criteria for Public Sidewalks (Non-Accessible Routes)

In general, sidewalks on non-accessible routes along public rights-of-way should meet the criteria presented in Section 18.1.8.1. However, some flexibility is required to meet the adjacent roadway conditions and to provide practical designs. The project scoping team should identify and document all non-accessible routes and facilities during the Preliminary Field Review. The criteria in Section 18.1.8.1 should be implemented, unless noted as follows:

1. Slopes. Provide the flattest longitudinal slope practical. Preferably, the longitudinal slope should not exceed 5%. For slopes greater than 5%, consider providing level landing areas at regular intervals.

2. Cross Slopes. Cross slopes greater than 2% may be used provided adjacent portions are smoothly blended. The designer should strive to achieve the flattest cross slope practical.

3. Stairs. Sidewalks with stairs are allowed on non-accessible routes, provided an unobstructed route is available between accessible entrances. Section 18.1.9 presents criteria for stairs.

4. Separation. Sidewalks adjacent to the curb or roadway may be offset to avoid a non-conforming cross slope at driveway aprons by diverting the sidewalk around the apron.

5. Protruding Objects. Even for objects on or along a sidewalk which are not fixed (e.g., newspaper vending machines, trash receptacles), the sidewalk should still meet the minimum width requirements; see Section 18.1.8.1. Fixed items (e.g., signal controller cabinets, light standards, utility poles, mailboxes, sign supports) should not be placed within the sidewalk.

18.1.9 Stairs

Stairs shall not be part of an exterior accessible route because they cannot be safely negotiated by individuals in wheelchairs. Where stairs are used, they should be designed to be accessible by other disabled individuals. Therefore, the design of stairs must comply with Section 4.9 of the *ADA Guidelines*. This includes the provision of handrails.

18.1.10 Ramps

Any part of an accessible route with a slope greater than 5% shall be considered a ramp and shall conform to the *ADA Guidelines* for the design of ramps. This includes the provision of handrails. The following criteria must be met for ramps on accessible routes:

1. Slope and Rise. The least possible slope should be used for any ramp. Figure 18.1D provides the maximum allowable ramp slopes for new construction. Curb ramps and ramps to be constructed on existing sites or in existing buildings or facilities may have slopes and rises as shown in Figure 18.1E, if space limitations prohibit the use of a 12:1 slope or less.

2. Width. The minimum clear width of a ramp shall be 36” (920 mm).

3. Landings. Ramps shall have level landings at the bottom and top of each run and shall have the following features:

Slope	Maximum Rise	Maximum Run
Steeper than 16:1 but no steeper than 12:1	30” (760 mm)	30’ (9 m)
Steeper than 20:1 but no steeper than 16:1	30" (760 mm)	40’ (12 m)

Note: A slope steeper than 12:1 is not allowed.

ALLOWABLE RAMP DIMENSIONS
(New Construction)

Figure 18.1D

Slope	Maximum Rise	Maximum Run
Steeper than 10:1 but no steeper than 8:1	3” (75 mm)	24” (600 mm)
Steeper than 12:1 but no steeper than 10:1	6” (150 mm)	60” (1 530 mm)

Note: A slope steeper than 8:1 is not allowed.

ALLOWABLE RAMP DIMENSIONS
(Existing Sites, Buildings and Facilities)

Figure 18.1E

a. The landing shall be at least as wide as the ramp run leading to it.

b. The landing length shall be a minimum of 5’ (1.53 m) clear.

c. If ramps change direction at landings, the minimum landing size shall be 5’ (1.53 m) by 5’ (1.53 m).

4. Handrails. If a ramp run has a rise greater than 6” (150 mm) on a horizontal projection greater than 6’ (1.83 m), then it shall have handrails on both sides. Handrails are not required on curb ramps. Handrails shall have the following features:

a. Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback or dogleg ramps shall be continuous.

b. If handrails are not continuous, they shall extend at least 12” (300 mm) beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface.

c. The clear space between the handrail and the wall shall be 1-½” (40 mm).

d. Gripping surfaces shall be continuous.

e. Top of handrail gripping surfaces shall be mounted between 34” (870 mm) and 38” (960 mm) above ramp surfaces.

f. Ends of handrails shall be either rounded or returned smoothly to floor, wall or post.

g. Handrails shall not rotate within their fittings.

5. Cross Slope and Surfaces. The cross slope of ramp surfaces shall be no greater than 2%. Ramp surfaces shall comply with the criteria for "Surface" for sidewalks; see Section 18.1.8.

6. Edge Protection. Ramps and landings with dropoffs shall have curbs, walls, railings or projecting surfaces that prevent people from slipping off the ramp. Curbs shall be a minimum of 2” (50 mm) high.

7. Outdoor Conditions. Outdoor ramps and their approaches shall be designed so that water will not accumulate on walking surfaces.

18.1.11 Curb Ramps

Curb ramps and other provisions for the disabled are required on all projects involving the provision of curbs and sidewalks at all intersections. In addition, existing curbs and sidewalks will be modified to comply with ADA requirements even if a project has no other involvement with the curb and sidewalk. Curb ramps will be constructed of concrete to visually contrast with the adjoining sidewalk. Examples of curb ramp details can be found in the *MDT Detailed Drawings*.

18.1.11.1 Location

When determining the need for a curb ramp, the designer should consider the following:

1. Intersections. For all projects, include curb ramps at all crosswalks which provide pedestrian access in that intersection. Also provide curb ramps on all corners.

2. Opposing Ramps. Always provide opposing ramps on adjacent legs of an intersection even if outside project limits.

3. Parked Vehicles. The prohibition of parking at all curb ramps needs to be considered.

4. Crosswalks. Curb ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides. At intersections where there is no marked crosswalk, place the curb ramp within the area that would reasonably be expected to be used as a crosswalk.

5. Alignment. Curb ramps should be aligned with the cross walk.

6. Obstructions. The function of the curb ramp must not be compromised by other highway features (e.g., guardrail, catch basins, utility poles, signs).

7. Pedestrian Signals. The location of the curb ramp must be consistent with the operation of pedestrian-actuated traffic signals. In addition, the location of the pedestrian push-button must comply with Section 18.1.11.2.

8. Future Ramps. Curb ramps are required at all curbed intersections with sidewalks. Laydown curbs for future ramp installations are required at all curbed intersections without existing sidewalks.

18.1.11.2 Crossing Controls

If a pedestrian crosswalk and curb ramp are present at an intersection with a traffic signal that has pedestrian detectors (push buttons), the following will apply:

1. Location. Locate controls as close as practical to the curb ramp and, to the maximum extent feasible, permit operation from a level area immediately adjacent to the controls.
2. Surface. Provide a firm, stable and slip-resistant area, a minimum of 36" (920 mm) by 48" (1220 mm), to allow a forward or parallel approach to the controls.
3. Mounting Height. Place pedestrian-actuated crossing controls a maximum of 42" (1060 mm) above the sidewalk.
4. Controls. Push buttons shall be raised or flush and shall be a minimum of 2" (50 mm) in the smallest dimension. The force required to activate controls shall be no greater than 5 lbs. (22.2 N).

18.1.11.3 Types

There are two basic types of curb ramps — straight ramps, which include ramps perpendicular and parallel to the roadway, and diagonal ramps. Details for the construction of curb ramps are provided in the *MDT Detailed Drawings* and *MDT Standard Specifications*.

The following provides several suggestions for selecting the appropriate curb ramp:

1. Crosswalk Markings and Stop Bars. The placement of the crosswalk affects the placement of the curb ramps. First, determine the desired alignment of the crosswalk. Then, establish the placements of the curb ramps. Consider the following factors when establishing the location for the crosswalk and curb ramps:

    a. crosswalk visibility,
    b. size of the corner radius,
    c. right-of-way constraints,
    d. drainage,
    e. raised median ends,
    f. detector loop placement, and
    g. traffic signal pole locations.

The *MDT Detailed Drawings* and the *MUTCD* provide additional guidance for crosswalk markings and stop bars.

2. Obstructions. It is desirable to move any obstructions from curb ramps whenever practical. When this is not practical, the direction of traffic relative to the placement of the curb ramp must be considered. It is important that drivers can see pedestrians using the curb ramp.

3. Diagonal Curb Ramps. Avoid using diagonal curb ramps, especially in new construction. It is preferable to use the straight curb ramp or several straight ramps rather than to use a diagonal curb ramp.

4. Raised Medians. Where raised medians exist within a crosswalk, depress the median to the level of the crosswalk or provide curb ramps on both sides and a minimum level landing area 48' (1.22 m) long by 36" (920 mm) wide.

5. Design Restrictions. For curb ramps on non-accessible routes and where site restrictions (e.g., steeply sloped roadways, constrained right-of-way) preclude the use of a curb ramp, the designer may use one of the following designs:

    a. Where the sidewalk longitudinal slope precludes the installation of a perpendicular curb ramp, a parallel curb ramp, with its gradient measured relative to the sidewalk and street, may be used; see *MDT Detailed Drawings*. The maximum slope shall be 12:1. Provide a 5' (1.53 m) landing area at the bottom of the slope area. The cross slope of the slope area and landing area shall not exceed 2%.

    b. Where installation of a 48" (1220 mm) landing area on top of the curb ramp or other slope area is impractical, then a 36" (920 mm) landing may be provided.

    c. Another option is to lower the sidewalk to provide a shorter curb ramp distance.

    d. Where the minimum level landing areas discussed in 5a and 5b cannot be provided, the designer may provide a sloped area connecting to the street crossing with its gradients (i.e., running slope, cross slope, flare slope) measured from a plane parallel to that of the street; see *MDT Detailed Drawings*. The maximum slope shall be 12:1 and with a maximum cross slope of 2%.

18.1.12 Approaches (Driveways)

Where laydown curb rather than curb cuts are used for approaches in conjunction with sidewalks, taper the sidewalk similar to curb ramps to provide a maximum 2% slope through the approach width. Details for the tapers are provided in the *MDT Detailed Drawings*.

18.1.13 Truncated Domes

Truncated domes are a standardized detectable warning surface for sight-impaired pedestrians. The domes are installed in the sidewalk adjacent to the roadway and provide a cue that the pedestrian is moving from a pedestrian area to a vehicular area. We are required to install truncated domes on all new curb ramps and any project involving alterations to existing ramps. The truncated domes extend the width of the sidewalk and are located at the bottom of the curb ramp.

18.2 BIKEWAYS

The bicycle is classified as a vehicle according to the *Montana Codes Annotated*. Therefore, bicyclists are granted all of the rights and are subject to all of the duties applicable to the driver of any other vehicle. All State roadways can be expected to receive bicycle traffic. In rural areas, bicycling space, for the most part, will consist of a roadway shoulder. In more urban areas, bicycling space may be in the form of a shared roadway with wide curb lanes or dedicated space such as designated bicycle lanes. Separate bicycle facilities may be considered where children and casual bicyclists would be required to become involved with high traffic volume roadways. Due to pedestrian safety, sidewalks should not be considered as bicycle facilities except for child bicyclists along low-volume residential streets. This section primarily provides information on the development of new facilities to enhance and encourage safe bicycle travel.

18.2.1 Bikeway Classifications

The following bikeway definitions will apply:

1. Bikeway. Any road, path or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or will be shared with other transportation modes.

2. Widened Shoulder. Any roadway upon which a bicycle lane is not designated and which may be legally used by bicycles regardless of whether such facility is specifically designated as a bikeway.

3. Bicycle Path. A bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way. Bicycle paths may assume different forms, as conditions warrant. They may be 2-direction, multilane facilities or, where the path would parallel a roadway with limited right-of-way, a single lane on both sides of the road.

4. Bicycle Lane. A portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists. It is distinguished from the travel portion of the roadway by a physical or symbolic barrier. Bicycle lanes may also assume varying forms but are typically included in one of the following categories:

   a. bicycle lane between parking lane and travel lane, or

b. bicycle lane between roadway edge and travel lane, where parking is prohibited.

18.2.2 <u>Guidelines</u>

The function of a bikeway is to provide a safe and efficient transportation facility for bicyclists without impairing the movement of other modes of travel. Well conceived and designed bikeways have a positive effect on both bicyclist and motorist behavior. Poorly conceived and designed bikeways can be counterproductive to enhancement of transportation.

On-street facilities include the bike lane, the widened curb lane and the widened shoulder. The only type of off-street facility is the bike path. A shared lane is not considered a facility type. Appropriately designed on-street facilities are usually less expensive to build and maintain than off-street facilities. Well designed off-street facilities can provide direct, non-stop connections and a safer cycling environment for a greater variety of user types.

18.2.2.1 Urban/Rural

The facility selection will typically depend on the roadway environment. The facility selection for urban and rural areas should be determined as follows:

1. <u>Rural</u>. The rural roadway presents a consistent situation of high-vehicular speed and relatively low traffic volumes to the bicyclist. Consequently, the bicycle facilities that should be considered for rural roadways, will typically be limited to shared roadways and may include providing wider shoulders.

2. <u>Urban</u>. The conditions presented to bicyclists on urban roadways may have exceeding variation from site-to-site. The following sections should be utilized to determine which facility is most appropriate.

18.2.2.2 Bicycle Paths

Bicycle paths provide the cyclist with a clear-cut route and protection from many hazardous conflicts. However, bicycle paths are typically expensive to construct. The designer should recognize that the bike path often becomes a corridor for other users (e.g., walkers, joggers).

The following guidelines may be used to justify a bicycle path:

1. high vehicular speed on adjacent roadway;
2. high vehicular traffic volume on adjacent roadway;
3. high percentage of trucks on the adjacent roadway;
4. high bicycle traffic volume;
5. substantial anticipated increase in vehicular and/or bicycle traffic volume;
6. absence of suitable alternative routes;
7. around schools, playgrounds, parks or other areas where children are expected;
8. demonstration that the facility would serve a definite purpose; and
9. reasonable indication that the bicycle path would be the safest and most economical method of providing a bicycle facility.

18.2.2.3 Bicycle Lanes

Bicycle lanes are usually preferred in urban conditions where the available area is more restricted. The occupation of a portion of a roadway by a bicycle lane implies a reasonable degree of safety for the cyclist. Conditions must be generally less severe than those which recommend a bicycle path. The use of a bicycle lane is normally restricted to bicycles, but exceptions may be made. Some sort of physical or symbolic barrier must be employed to delineate the bicycle lane from the roadway. Commonly, this is a painted stripe and symbol on the roadway surface.

The cost of installing a bicycle lane is normally a fraction of the expense associated with bicycle paths. Other advantages of bicycle lanes are the relatively minor land requirements and ease of maintenance. They can be installed in many areas where the construction of paths would be impractical. In practice, bicycle lanes may be the most practical means of developing bikeways.

The following guidelines may be used to justify a bicycle lane:

1. moderate to low vehicular speed on adjacent roadway;
2. moderate to low vehicular traffic volume on adjacent roadway

3. moderate bicycle traffic volume;

4. anticipated increase in bicycle traffic volume;

5. insufficient land to construct bicycle paths without major disruptions on the surroundings;

6. demonstration that the facility would serve a definite purpose; and

7. indication that the bicycle lane would be the safest and only feasible method of providing a bicycle facility.

Bicycle lanes should always be one-way facilities and carry traffic in the same direction as the adjacent motor vehicle traffic. If the roadway includes a parking lane, the bicycle lanes should always be placed between the parking lane and the motor vehicle lane. The minimum bicycle lane width is 4’ (1.2 m) when the lane is adjacent to the parking lane. Bicycle lanes adjacent to the curb should have a minimum width of 5’ (1.5 m).

18.2.2.4 Widened Shoulder

Widened shoulders are the most practical method of providing a bicycle facility on rural routes. Like bicycle lanes, widened shoulders can be provided at a much lower cost and can be maintained much more easily than bicycle paths. There is nothing to delineate the widened shoulder nor is its use restricted in any way.

The following guidelines may be used to justify a widened shoulder:

1. moderate bicycle traffic volume;

2. anticipated increase in bicycle traffic volume;

3. demonstration that the facility would serve a definite purpose; and

4. indication that the widened shoulder would be a safe and feasible method of providing a bicycle facility.

18.2.3 Selection

The Rail, Transit and Planning Division may determine the bikeway type and location for the bicycle facility during the planning stages. However, the Scoping Team, in conjunction with the District Office, Bicycle and Pedestrian Coordinator and local officials, will generally determine the bikeway type and location. If during the design of a project, it is determined that a bicycle facility is warranted, the designer should coordinate with the District and local officials to determine the most appropriate bikeway type.

18.2.4 Design

For design criteria of bicycle facilities, the designer is referred to the AASHTO publication *Guide for the Development of Bicycle Facilities*. The following offers a few guidelines that should be considered in the design of bicycle facilities:

1. Rumble Strips. The designer should evaluate bicycle usage to determine if rumble strips should be installed or if additional widening should be done in conjunction with rumble strip installation. Where additional shoulder widening is provided in conjunction with rumble strips, at least a 4' (1.2 m) wide shoulder should be provided beyond the outside edge of the rumble strip.

2. Drainage Grates/Utility Covers. Drainage grates and utility covers should be kept out of the expected bicycle path wherever practical. If this cannot be accomplished, these elements should be made bicycle safe.

3. Railroad Crossings. Ideally bicycle facilities should approach at-grade railroad crossing at right angles to the rails.

4. Intersections. Bicycle lanes tend to complicate turning movements at intersections. Adequate signing and pavement markings should be provided to minimize the conflicts; see Chapter Eighteen of the *Montana Traffic Engineering Manual*.

5. Width. The desirable width of a bike lane or widened shoulder should vary with traffic volumes, percentage of trucks and running speeds on a route.

6. Geometric Design. The design of bicycle paths should address geometric issues with bicycle specific criteria. These issues are similar to the geometric issues that are addressed in the design of roads (e.g., stopping sight distance, clear zones, vertical grades, horizontal alignment).

18.3 FENCING

Fencing will be provided along rural highways to protect the driver from unexpected intrusions from outside of the right-of-way line. Requests by landowners to remove fencing will be evaluated on a case-by-case basis. Fencing prevents unauthorized and unsafe entry to the highway by vehicles, pedestrians or animals. The following sections apply to all new or rebuilt fencing with respect to highway construction projects.

18.3.1 Warrants

The need for a fence will be determined during the Alignment and Grade Review and documented in the Alignment and Grade Report. The type of fence and specific fencing issues will be resolved at the Plan-In-Hand. Continuous fencing is generally provided at the following locations:

1. along the right-of-way (R/W) line for all rural highway projects, except where it is determined to be unnecessary (e.g., absence of livestock, presence of natural barriers);

2. along all access-controlled highways;

3. near schools and residential or commercial areas to prevent children and pedestrians from entering the highway or protect them from a precipitous slope or drop off; and

4. where an agreement has been made to provide fencing between the landowner and the Department.

18.3.2 Types

The Department uses several fence types in its design. Construction details are provided in the *MDT Detailed Drawings*. The fence types used by the Department and typical applications are as follows:

1. Farm Fence. The typical farm fence is a 48” (1220 mm) tall fence with 3 to 6 barbed wire strands on wood or steel posts. This fence is commonly used along all rural non-Interstate highways. An alternative farm fence is the 48” (1220 mm) tall combination woven and barbed wire fence. Where new fencing is required, the minimum fence should be a four-strand, barbed-wire fence (Type F4). In general, use wood posts unless soil conditions, adjoining landowner preferences or other factors dictate the use of steel posts.

2. Interstate Fence. The Interstate fence is a 48” (1220 mm) tall combination woven and three-barbed wire fence on wood or steel posts. This fence is used along Interstates and other access-controlled facilities or where an agreement for its use has been made between the adjacent landowner and the Department.

3. Chain Link Fence. Chain link fencing uses steel posts embedded in concrete and may vary from 36” (915 mm) to 60” (1525 mm) tall. The chain link fence is used in place of farm fence and Interstate fence near residential areas, schools, commercial districts or other areas where pedestrians are typically present. Note that a top metal brace rail should not be used when the fence is less than 50’ (15 m) from the edge of the travel lane.

4. Temporary Fence. The contractor is typically required to provide a temporary fence at the construction site to maintain the enclosure. Selection of the fence type is typically designated in the R/W Agreement but, at minimum, should be a Type F4. The amount of temporary fence required should typically be determined by measuring the length and two times the width of the construction permit area.

5. Gates/Cattle Guards. The *MDT Detailed Drawings* illustrate the design for several gates used by the Department. The Type G2 should be specified unless otherwise noted in the R/W Agreement. Section 18.10.1 provides information on the usage and placement of cattle guards.

18.3.3 Design/Placement

The *MDT Detailed Drawings* provide the details for locating a fence at underpasses, stockpasses, steep slopes and changes in R/W widths. In addition, the designer should consider the following:

1. R/W Agreement. The R/W Agreement with the landowner will generally include the location and type of fence to be constructed, the need for a gate or cattle guard, the need to reset or to use new materials, etc. Note that, with the exception of Interstate R/W fence, the fence will become the property of the landowner and, after construction, will be responsible for its maintenance. For Interstate R/W fence, the State will retain ownership of the fence and will be responsible for its maintenance. Where an agreement cannot be reached with the landowner, the Field R/W Supervisor will make all necessary fencing determinations. In environmentally sensitive areas the designer and negotiator will coordinate with the District biologist to determine the appropriate type of fence.

2. R/W Line. The fence will follow the R/W line including all indentations and protrusions.

3. Materials. In general, the fence will be constructed of new materials, unless otherwise noted in the R/W agreement with the landowner. Existing fences should be replaced in-kind, except that the minimum replacement design will be the Type F4 barbed-wire fence. Figure 18.3A presents the criteria for where fence panels should be used. Dead men should be used to support the fence where it crosses ravines or other ground depressions.

4. Quantities. Chapter Five presents the criteria for determining project quantities for deadmen and dozer hours based on terrain. Figure 18.3A should be used to determine panel placement. For parcels where R/W agreements have not been secured when a project is submitted to the Contract Plans Section, the designer will provide an estimate of fencing quantities based on the existing fence.

5. Access-Control Facilities. Place access-control fencing along the R/W line except where noted below. Additional fencing placed outside the access-control fence will be as described in the R/W agreements. The following will apply to the placement of fencing along access-control facilities (including Interstates):

   a. Frontage Roads. Place the fence between the frontage road and the access-control facility.

   b. Stockpasses/Drainage Pipes. The fencing should tie into the ends of stockpasses or drains 60” (1500 mm) or larger in diameter and to the ends of irrigation culverts 30” (750 mm) or greater.

   c. Grade Separated Structures. The fence should tie into the grade-separated structure or may run underneath the structure.

   d. Utilities. Where utilities remain within the R/W, the fence may run between the roadway and utility to allow access from outside the R/W to the utility line.

   e. Rural Interchanges. At all rural interchanges, access-control fencing should be extended 300’ (90 m) along the crossroad from the ramp termini.

6. Stockpasses. Do not indicate the removal of stockpasses (or other large drainage pipes used by farmers for stock passages) on the plans until a copy of the signed landowner agreement permitting their removal is received by the Road Design Section. Use the *MDT Stockpass Guidelines* to determine if a new

stockpass is warranted. The Project Design Manager will coordinate the need for stockpasses with the Right-of-Way Bureau.

18.3.4 Fencing Plans

Fencing plans should be prepared on a set of full-size, white prints of the right-of-way plans. Fencing plans will be transmitted to the District Office at the time of project letting. Show the following information on the fencing plans:

1. limits of each fence type and post type,
2. locations and type of each gate, and
3. placement and type of panels (see Figures 18.3A and 18.3B).

An example of the fencing plan is shown in Figure 18.3B.

18.3.5 Snow Fences

Snow fences should be provided along portions of the roadway experiencing problems with blowing and drifting snow. Snow fences improve driver visibility and reduce the accumulation of snow and ice on the roadway. Design snow fences according to the following criteria:

1. Fences should be a minimum of 8’ (2.4 m) tall.

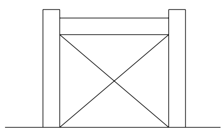
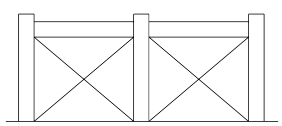
2. The snow fence should extend lengthwise 20 times the height of the fence beyond both sides of the area to be protected.

3. The distance between the fence and the shoulder of the road should be at least 35 times the height of the fence.

4. Ideally, fences should be perpendicular to the prevailing wind direction, but the angle can vary as much as 25°.

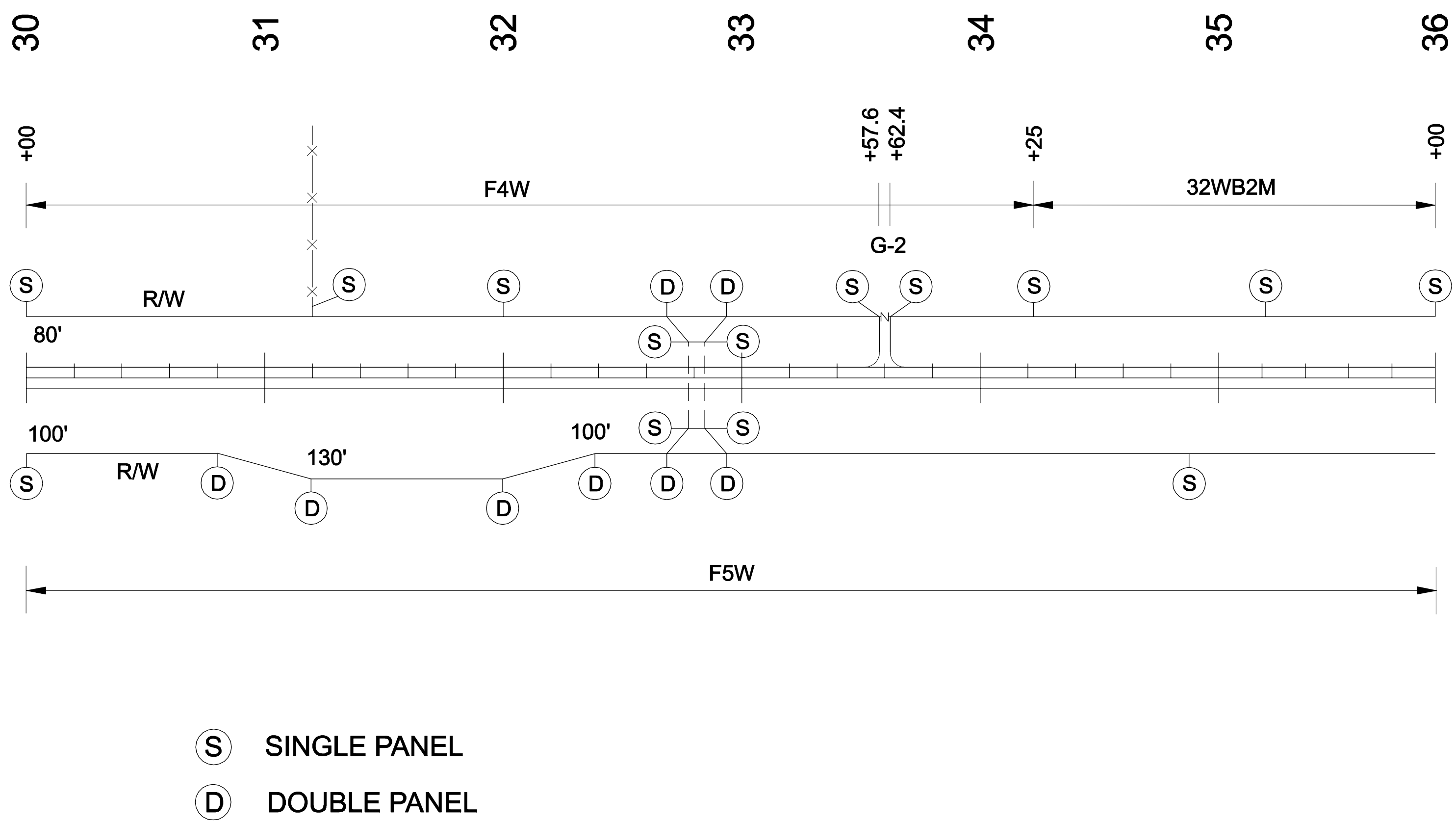
5. Fences should have a gap at the bottom equal to 10% of the height of the fence.

See the *MDT Detailed Drawings* for fence assembly.

PANEL TYPE	DESCRIPTION	APPLICATION	
		BARBED	COMBINATION WOVEN/BARBED
Single Panel	2 Posts 1 Brace Rail 2 Brace Wires 	1. Beginning or end of fence when run is 66' (20 m) – 660' (200 m). 2. Each side of gate or cattle guard when run is 66' (20 m) – 660' (200 m). 3. Runs of 66' (20 m) – 660' (200 m) for rolling or rough terrain. 4. For each intersecting side fence.	1. Beginning or end of fence when run is 33' (10 m) – 330' (100 m). 2. Each side of gate or cattle guard when run is 33' (10 m) – 330' (100 m). 3. Runs of 33' (10 m) – 330' (100 m) for rolling or rough terrain. 4. For each intersecting side fence.
Double Panel	3 Posts 2 Brace Rails 4 Brace Wires 	1. Beginning or end of fence when run is 690' (200 m)-990' (300 m). 2. Each side of gate or cattle guard when run is 660' (200 m)-990' (300 m). 3. Runs of 660' (200 m)-990' (300 m). for flat terrain. 4. All corners or change in horizontal alignment.	1. Beginning or end of fence when run is 330' (100 m)-660' (200 m). 2. Each side of gate or cattle guard when run is 330' (100 m)-660' (200 m). 3. Runs of 330' (100 m)-660' (200 m). for flat terrain. 4. All corners or change in horizontal alignment.
No Panel Required		1. Runs less than 66' (20 m).	1. Runs less than 33' (10 m).

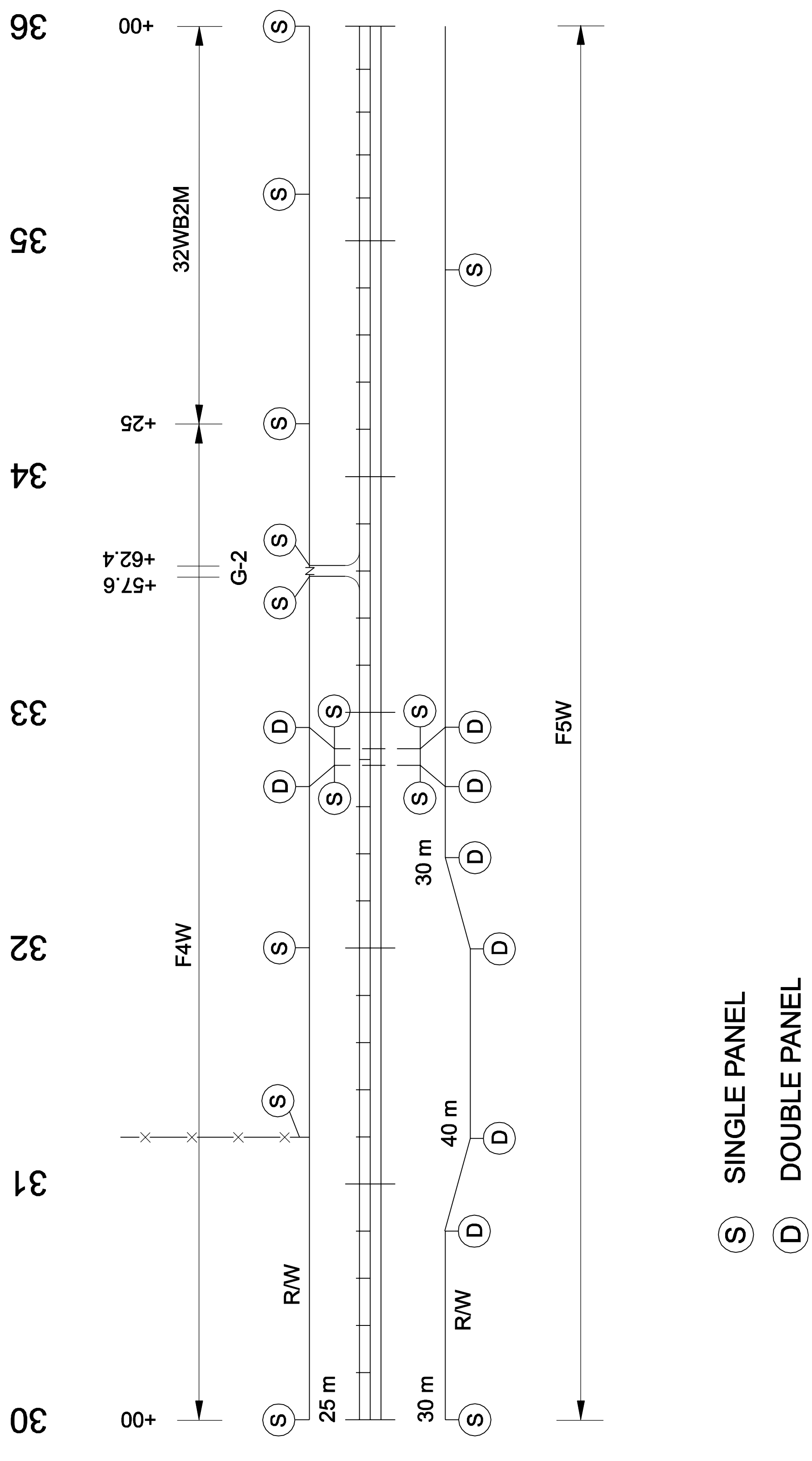
PANEL APPLICATIONS

Figure 18.3A



SAMPLE FENCING PLAN

Figure 18.3B (U.S. Customary)



SAMPLE FENCING PLAN

Figure 18.3B (Metric)

18.4 REST AREAS

Rest areas, information centers, and scenic overlooks are functional and desirable elements of the complete highway development and are provided for the safety and convenience of the highway user. Many have been constructed along freeways and other major arterials in Montana. The location and design of rest areas are based on individual highway facility and site needs. The need for a new rest area will be determined by the Rail, Transit and Planning Division in conjunction with the District Offices.

The MDT Facilities Bureau Chief will be responsible for the layout and design of all rest area structures. The Facilities Bureau Chief is also responsible for the coordination with consultants who are contracted to design rest area structures.

18.4.1 Location

Rest areas may be located on freeways or other major arterials. Along freeways, they are usually paired together (i.e., one on each side of the freeway). At the State line, only one rest area or welcome center for the incoming traffic may be provided. The Rail, Transit and Planning Division, in coordination with the Montana Rest Area Plan, will determine the general location for rest areas. The designer, in conjunction with the Districts, will be responsible for the final location of the rest area.

18.4.2 Preliminary Layout

Once it has been determined that a rest area is required and the general area has been selected, the designer is responsible for the preliminary layout. The purpose of the preliminary layout is to define the location, approximate geometrics, and determine if the proposed design is both feasible and cost effective. The following provides several site considerations the designer should review:

1. Appeal. Rest areas are show places for out-of-state visitors to Montana. If practical, locate them to take advantage of natural features (e.g., lakes, scenic views, points of special or historic interest).

2. Welcome Centers. These centers provide the opportunity to personally present information on the State of Montana and local attractions.

3. Geometrics. Locate the site away from any other interference, such as interchanges and bridges. Desirably, the rest area entrance should be at least 2 miles (3 km) from the nearest interchange.

4. Environmental. Locate and design the site so that surface runoff or treatment plant discharges will not adversely affect streams, lakes, wetlands, etc.

5. Size. The rest area should be large enough to provide sufficient parking capacity, needed facilities, picnic and stretch areas and to retain existing landscaping features.

6. Right-of-way. Factor right-of-way costs and room for future expansion into the location decision.

7. Topography. Locate rest areas where the natural topography is favorable to their development.

8. Development. Do not place rest areas adjacent to or near areas zoned residential.

9. Emergency. The location choice should consider the proximity to emergency services.

10. Water/Sewer. The area should have an adequate water supply. If commercial sanitary treatment plants are unavailable, the site must be large enough to provide for adequate sewage treatment facilities. Any proposed water/sewer facility must be designed and constructed in accordance with Department of Health and Environment Sciences regulations.

11. Additional Utilities. Other utilities, such as telephone and electricity, should be provided, if practical.

12. Other Sections. The designer will need to coordinate the design with the Traffic Engineering Section, Environmental Services and, where necessary, the FHWA.

18.4.3 Design

The following sections present criteria which should be considered in the design of the rest area.

18.4.3.1 Exits and Entrances

Access to and from rest areas along freeways will be designed by the Traffic Engineering Section. Access to rest areas along other facilities will be designed as an at-grade intersection, see Chapter Thirteen.

For more information, the designer should contact the Traffic Engineering Section.

18.4.3.2 Buffer Separation

The separation between the rest area facilities and the highway mainline should be wide enough to discourage individuals from stopping on the mainline and crossing over to the facilities. At a minimum, a 30’ (10 m) buffer area should be provided between the mainline pavement and parking areas. A buffer separation of 165’ (50 m) or more is preferable.

18.4.3.3 Rest Area Usage

Predicting the rest area usage is the key factor in determining the location and sizing of a rest area. The designer must first determine the proportion of mainline traffic that will be using the rest area. This determination is dependent upon numerous factors — rest area spacing, trip lengths, rest area locations, time of year, traffic composition, highway classification, etc. Desirably, the designer should use data from nearby and/or similar rest areas to estimate the expected traffic entering the rest area. Traffic counts can be obtained from the Rail, Transit and Planning Division. In the absence of historical data, Figure 18.4A and the following may be used:

1. Design Year. The typical design year for traffic projections should be 20 years.

2. Highway Characteristics. Rest areas on highways that pass though recreational or historic areas tend to have fewer trucks and a higher percentage of passenger cars and RV's with trailers. Where the general purpose of the highway is to move commercial traffic between cities, rest areas tend to have a higher truck usage.

3. Trip Length. On highways where the trip lengths are typically less than 100 mi. (160 km) (e.g., between two major cities), there is a significant reduction in the proportion of the passing traffic using the facility.

4. Temporal Factors. In recreational areas, rest area usage commonly is the highest during summer weekends. During the day, passenger cars tend to make

up a higher percentage of the rest area usage. At night, trucks and RV's tend to make up the higher percentage of rest area usage.

18.4.3.4 Parking

Rest area parking capacity depends upon the type of usage expected for the rest area. Figure 18.4A provides the formula and other factors to consider when determining the appropriate design hourly volume for passenger cars, recreational vehicles and trucks. Figure 18.4B illustrates a typical parking design for rest areas. Angular parking is preferred versus parallel parking because it requires less time to enter and exit. For more information on rest area parking, the designer should review the *Montana Traffic Engineering Manual* and/or contact the Traffic Engineering Section.

18.4.3.5 Pavement Design

Pavement designs for exit and entrance ramps, parking areas and connector roadways will be provided by the Pavement Management Section. All ramps and connector routes should have a 2% cross slope. Parking areas typically should be designed with a 2% cross slope; however, a 5% maximum grade may be used.

18.4.3.6 Facilities

Rest areas typically provide a building with rest rooms and public information services, picnic tables and shelters, benches, sidewalks, drinking fountains and litter receptacles. The designer should ensure that sufficient facilities are available to accommodate the expected usage of the rest area. Figure 18.4C provides the recommended number of comfort facilities that should be provided. The rest area building must meet all State and local building codes.

18.4.3.7 Utilities

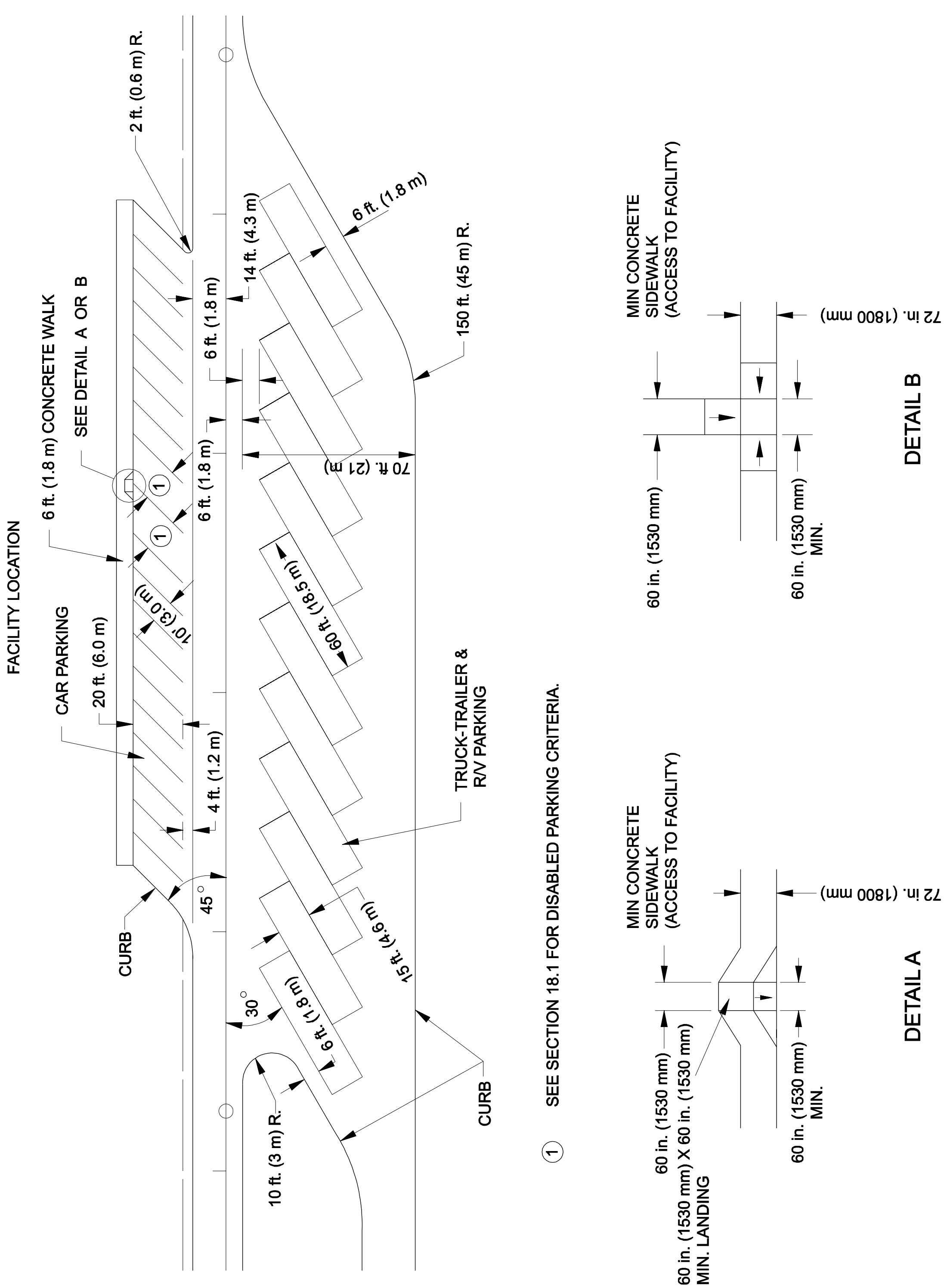
Where permanent sanitary facilities are provided, an adequate water supply, sewage disposal system and power supply will be required. Where practical, connection to existing water supplies and sewage treatment facilities is the most desirable option. The Hydraulics Section will be responsible for providing the design for an adequate water supply and sewage treatment in rest areas. The Utilities Section will be responsible for coordinating the power and telephone services at the rest area. Proper lighting provides the patron an added sense of security and safety. The Traffic Engineering Section will be responsible for the rest area lighting design.

Design Element	Factor	Cars	RV's	Trucks	Total
Mainline Traffic Data					
20 Year ADT (A)					
20 Year ADT, Directional (B)	A x 0.60				
DHV, Directional (DHV)	B x 0.135				
Mainline Traffic Composition	*(D_1)*_____Cars *(D_2)*_____RV's *(D_3)*_____Trucks	C_1=DHV x D_1	C_2=DHV x D_2	C_3=DHV x D_3	C=C_1+C_2+C_3
Vehicles Per Hour @ Rest Area (VPH)					
Cars Stopping Metropolitan Routes..................05 Normal Routes..........................09 Tourist Routes..........................13 Information & Welcome Centers ....15 RV's Normal Stopping ....09 to .15 Trucks Normal Stopping ....09 to .15	(*E_1*)_____Cars (*E_2*)_____RV's (*E_3*)_____Trucks	VPH_1=E_1 x C_1	VPH_2=E_2 x C_2	VPH_3=E_3 x C_3	VPH=VPH_1+VP H_2+VPH_3
Parking Spaces					
Cars - Average Stop .25 to .33 hr. @ info. centers .... .33 to .50 hr. RV's .... .33 to .50 hr. Trucks .... .25 to .50 hr.	(T1) Cars (T2) RV's (T3) Trucks	P_1=VPH_1 x T_1	P_2=VPH_2 x T_2	P_3=VPH_3 x T_3	P=P_1+P_2+P_3
Facility Design (see Section 18.4.3.6)					
Persons/Hour (PH)	VPH x 3.0 occupancy x .75 use				
Number of Men	PH x 0.5				
Number of Women	PH x 0.5				
Other Facilities					
Picnic Tables.......................0.3 to 0.5	(PT)______	P x PT			
Litter Receptacles ....0.2 to 0.4	(LR)______	P x LR			
Drinking Fountains 0.1	(DF)______	P x DF			

***Note to Reviewers**: The Department is to provide revisions to this figure.*

DESIGN GUIDE FOR REST AREA FACILITIES

Figure 18.4A



SAMPLE PARKING DESIGN FOR REST AREA PARKING

Figure 18.4B

(Men) Persons/hour Using Rest Room During Design Hours	Number of Facilities - Men's Room				
				Hand Dryers	
	Urinals	Toilets	Wash Basins	Paper Towels	Air Dryers
0-105	2	2	2	2	2
106-225	3	3	4	3	4
226-315	4	4	5	4	6
316-375	5	4	5	4	7
376-435	7	4	5	5	7
436-500	9	5	7	5	8

(Women) Persons/Hour Using Rest Room During Design Hours	Number of Facilities - Women's Room			
			Hand Dryers	
	Toilets	Wash Basins	Paper Towels	Air Dryers
0-105	4	3	2	2
106-225	6	4	3	4
226-315	9	6	4	6
316-375	10	6	4	7
376-435	12	8	5	7
436-500	14	8	5	8

Note to Reviewers: *The Department is to provide revisions to this figure.*

GUIDELINES FOR COMFORT FACILITIES

Figure 18.4C

18.4.3.8 Landscaping

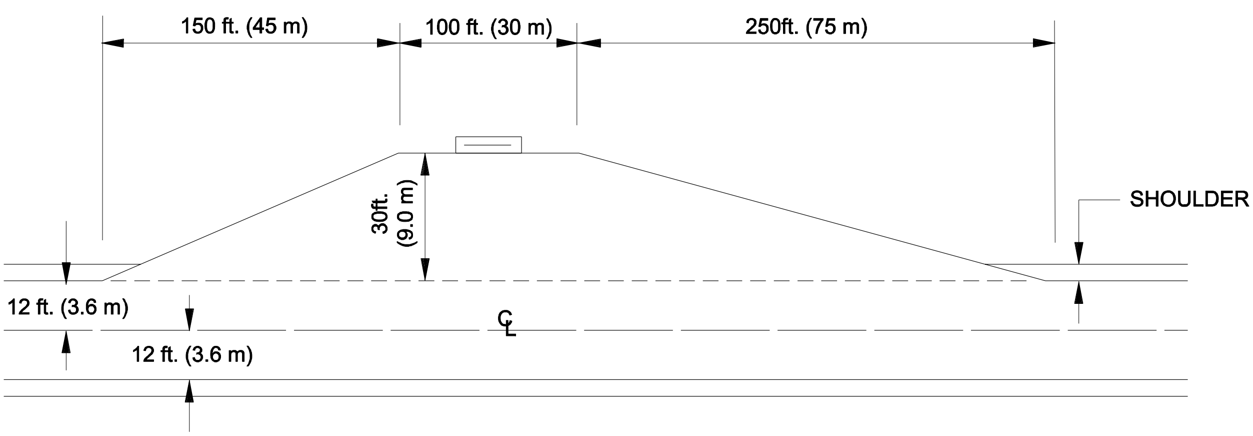
Landscape the rest area to take advantage of existing natural features and vegetation. Paths, sidewalks, and architectural style should fit naturally into the existing surroundings. Avoid deep cuts and fills. Where practical, grades should be splined to fit the natural terrain.

18.4.3.9 Accessibility for the Disabled

Design all rest areas to properly accommodate disabled individuals, including grounds, picnic areas, ramps to picnic areas, buildings, automatic door openers, sidewalk ramps and signage. The designer must realize that an accessible route is required between the truck and RV parking area to the rest area facilities. Section 18.1 provides the disabled accessibility criteria for exterior features within rest areas. The *ADA Accessibility Guidelines for Buildings and Facilities* provides the accessibility criteria for interior features.

18.4.4 Historical Markers

Historical markers provide visitors a chance to learn more about the history of Montana. These are common attractions on the highway system. Where historical markers are erected along the roadside, they should be placed where they will not interfere with through traffic. On Interstates, place historical markers at rest areas or on local roads near interchanges. On other facilities, historical markers may be designed as shown in Figure 18.4D. For details on the construction and erection of historical markers, the designer should contact the Traffic Engineering Section.



TYPICAL HISTORICAL MARKER TURNOUT
(2-Lane Highway)

Figure 18.4D

18.5 PORTABLE SCALE SITES

Truck weigh station installations are used to weigh trucks, to provide for vehicular safety inspection, and/or to provide a source of data for planning and research.

18.5.1 Location

Montana has adopted the portable scale concept for its weigh stations on 2-lane highways. This allows the MDT Motor Carrier Services to move the scales from site to site.

The Motor Carrier Services is responsible for the general location of portable scale sites. The designer, in conjunction with the District, is responsible for the actual selection of a site. It is desirable to select a site in a location where there is adequate right-of-way and where geometric (e.g., at the crest of a hill), topographic and environmental features lend themselves to the most economical development without undue site preparation and expense. The possibility of truck traffic circumventing the facility is also considered in locating the portable scale site.

18.5.2 Design

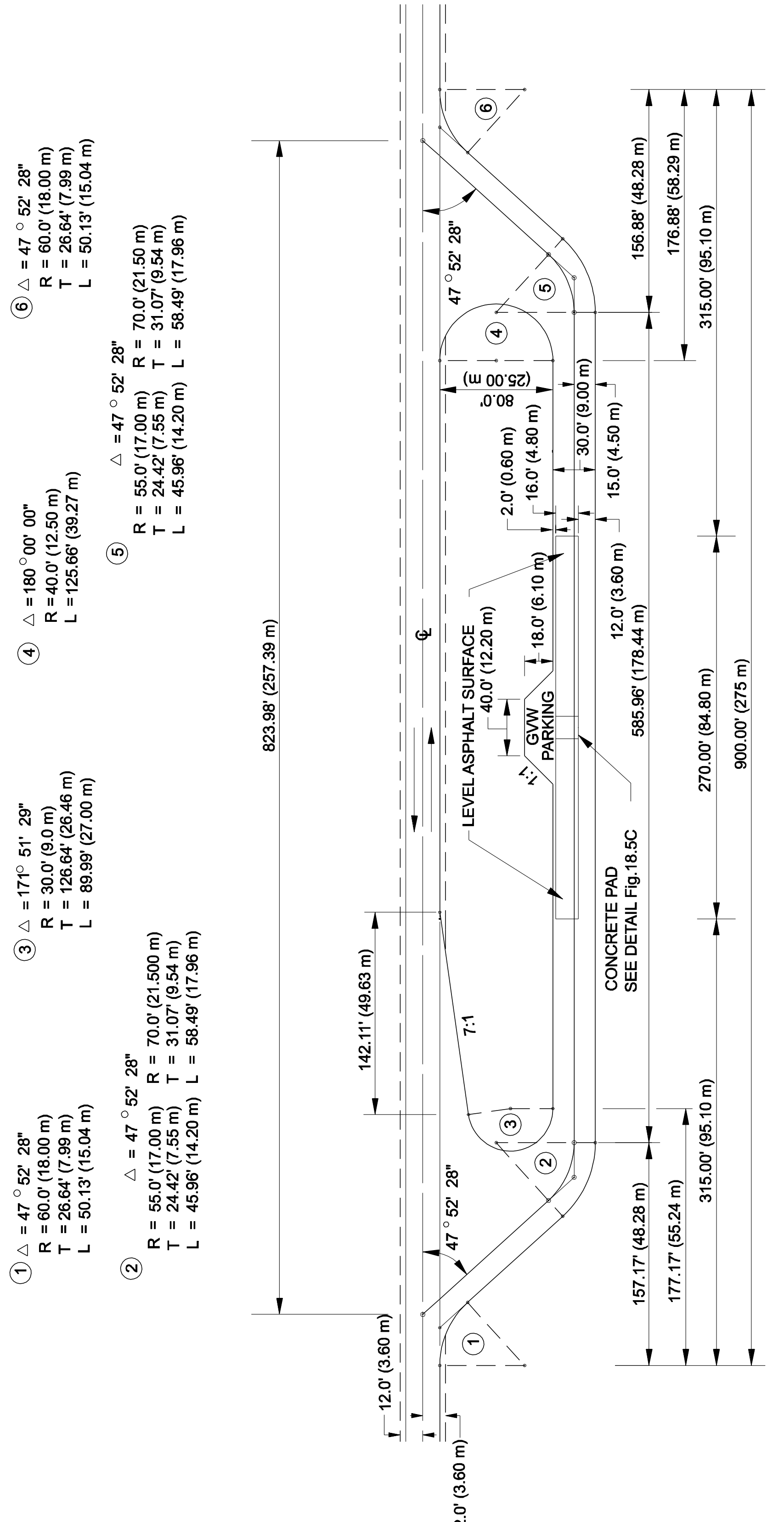
Figures 18.5A and 18.5B illustrate a Type "A" and Type "B" portable scale site design, respectively. Motor Carrier Services will be responsible for determining the appropriate Type. In addition, the designer should consider the following:

1. Exits/Entrances. Figures 18.5A and 18.5B illustrate the typical exit and entrance designs. The Traffic Engineering Section will be responsible for determining alternative exit and entrance designs.

2. Pavement Design. Pavement designs for ramps, by-pass areas and connecting roadways will be provided by the Pavement Management Section. Figure 18.5C illustrates the concrete slab design for both Type "A" and Type "B" portable scales.

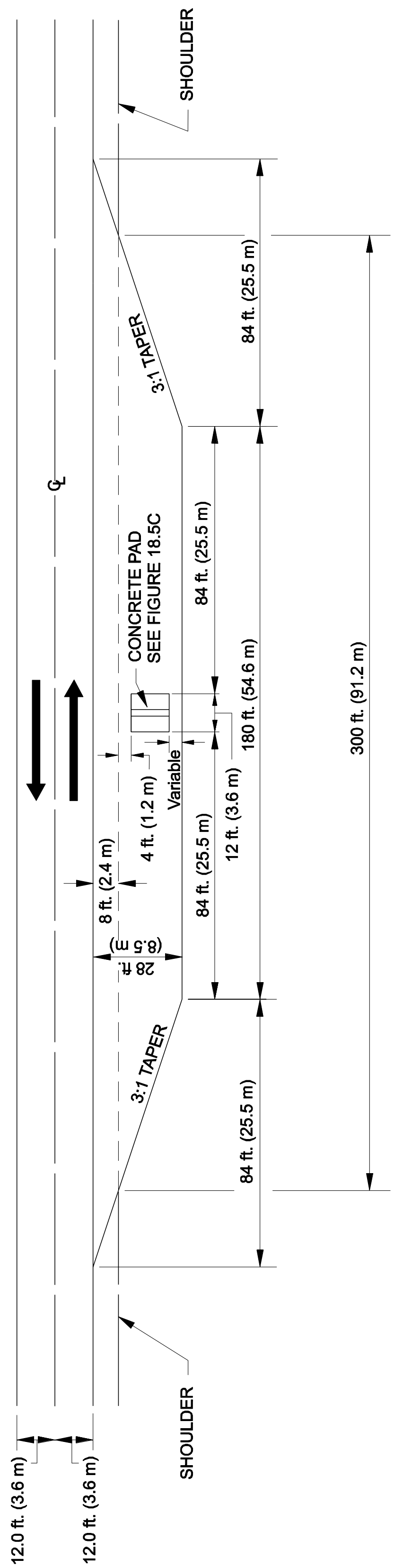
3. Geometrics. Design the scale site area so that backing maneuvers are not required (e.g., pull-through parking). Design all pavement geometrics to accommodate off tracking for the selected design vehicle.

4. Maximum Grade. Short upgrades of as much as 3%-5% do not unduly interfere with truck and bus operations. Consequently, for new construction it is desirable to limit the grade to 3%, although a maximum of 5% is allowable. Grades across the Type "A" scale must be level for 130’ (40 m) before and after the scale.



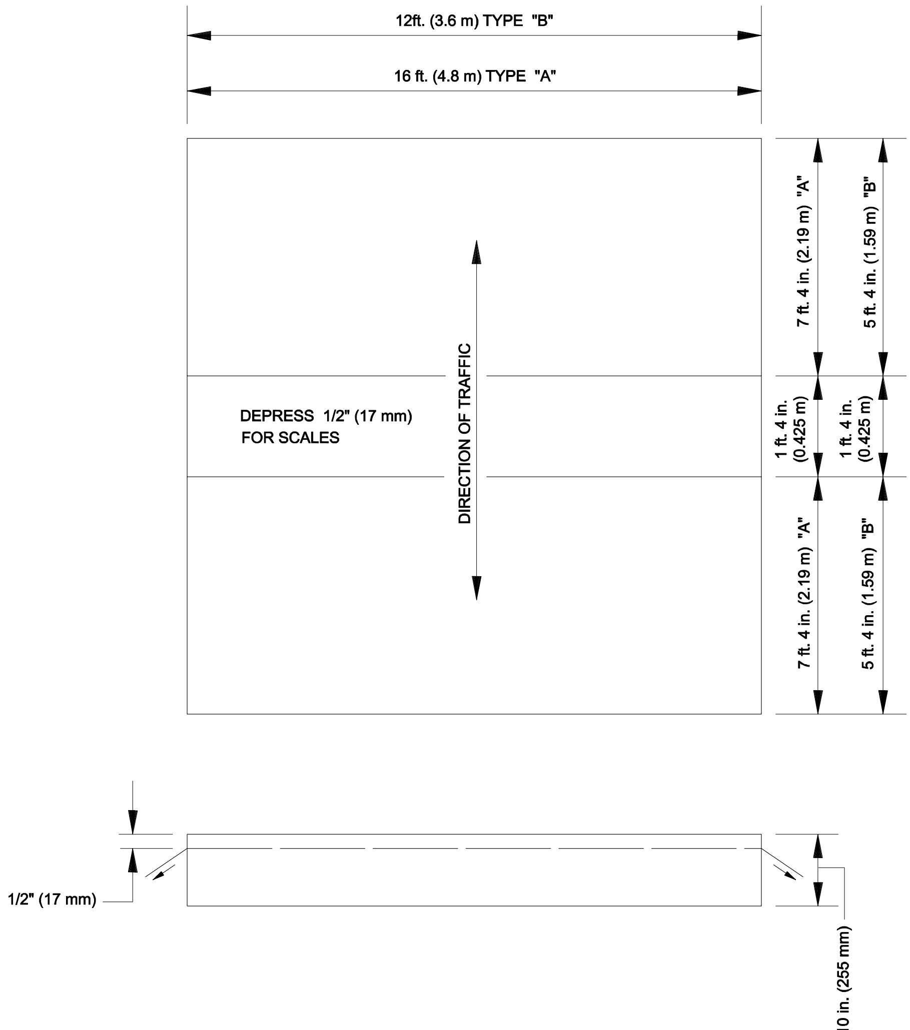
TYPICAL PORTABLE SCALE SITE
(Type "A")

Figure 18.5A



TYPICAL PORTABLE SCALE SITE
(Type "B")

Figure 18.5B



CONCRETE SLAB FOR PORTABLE SCALE SITES
(Types "A" and "B")

Figure 18.5C

5. Storage for Scales. There should be sufficient space to queue trucks waiting for the scales without backing up onto the mainline. This distance will be based on the number of trucks on the mainline, length of trucks, expected hours of operation and time required for actual weighing. The designer should check with the MDT Motor Carrier Services to determine the most appropriate time factor.

6. Traffic Control Devices. Adequate signing and pavement markings should be provided prior to and at the scale site. These traffic control devices should be designed and placed according to the *MUTCD* and the *MDT Detailed Drawings*. The designer should review the *Montana Traffic Engineering Manual* and/or contact the Traffic Engineering Section for additional details.

7. Landscaping. Design the scale site to minimize the effect on existing vegetation. The designer should also ensure that any new or existing plants will not affect the driver's sight distance to the scale site or any critical point within the scale site.

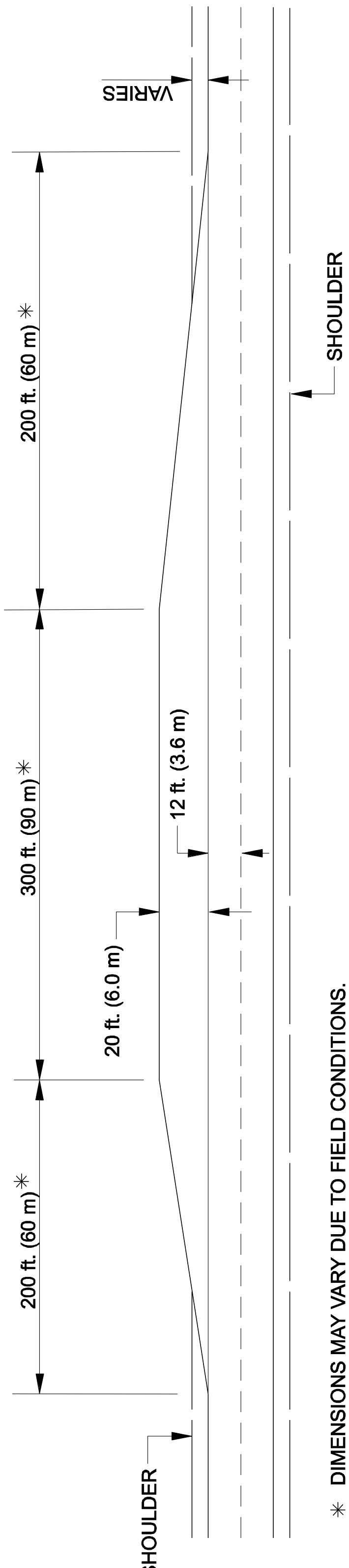
18.6 CHAIN-UP AREAS AND TRUCK TURNOUTS

Chain-up areas are used to allow trucks or vehicles to install chains in inclement weather prior to sustained upgrades. Truck turnouts allow trucks to test their brakes prior to steep downgrades. For new or reconstruction projects, chain-up areas or truck turnouts should be installed where there is a demonstrated or anticipated need. The designer should consider the following:

1. Location. Chain-up areas are located at the bases of sustained upgrades. The location of truck turnouts may depend on the amount of available right-of-way. Specific locations for both the chain-up areas and truck turnouts should be determined at the Preliminary Field Review or the Alignment Review.

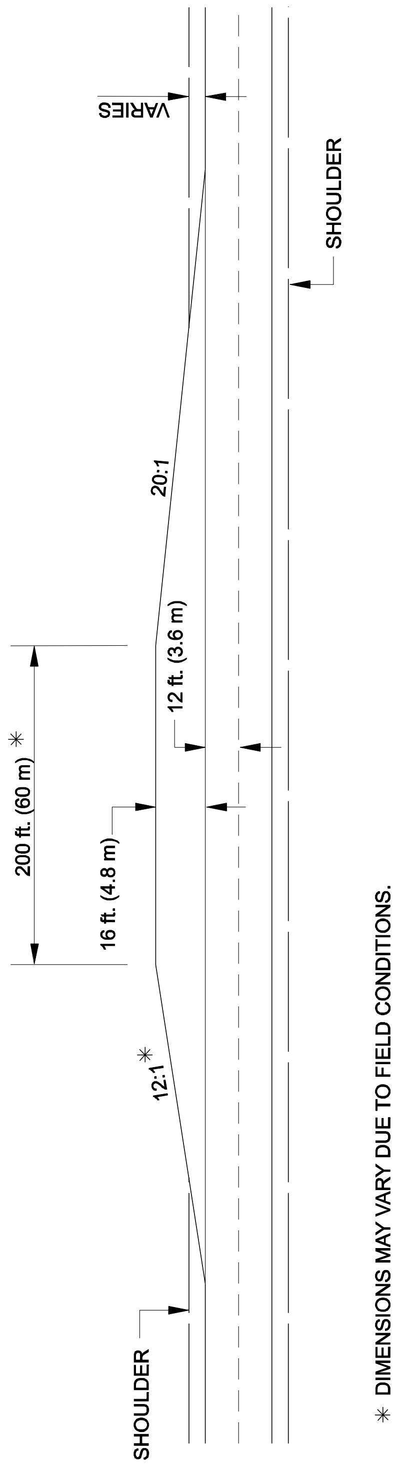
2. Geometrics. The chain-up areas and the truck turnouts should be designed according to Figures 18.6A and 18.6B, respectively. Final dimensions may be dictated by site conditions; however, every attempt should be made to provide the tapers indicated. The amount of storage may vary depending on truck volumes and overall use.

3. Pavement Design. The surfacing for the chain-up areas and truck turnouts should match the surfacing recommended for the project. Where these facilities are installed independently of a project, the surfacing should match the existing surfacing of the adjacent roadway.



CHAIN-UP AREA

Figure 18.6A



TRUCK TURNOUT

Figure 18.6B

18.7 MAILBOXES

Mailboxes and newspaper tubes served by carriers in vehicles may constitute a safety hazard, depending upon the placement of the mailbox. The designer should make every reasonable effort to replace all non-conforming mailboxes with designs that meet the criteria in *A Guide for Erecting Your Mailbox in the State of Montana*, the *AASHTO A Guide for Erecting Mailboxes on Highways*, and the *MDT Detailed Drawings*. Removal and replacement of mailboxes can be a sensitive issue and should be reviewed with the postal patron prior to their removal or replacement.

18.7.1 Rural Mailboxes

Mailboxes should be placed for maximum convenience to the patron, consistent with safety considerations for highway traffic, the carrier, and the patron. Consideration should be given to the minimum walking distance in advance of the mailbox site and possible restrictions to corner sight distance at intersections and driveway entrances. New installations should, where feasible, be located on the far right side of an intersection with a public road or private driveway entrance.

Boxes should be placed only on the right-hand side of the highway in the direction of travel of the carrier, except on one-way streets where they may be placed on the left-hand side. It is undesirable to require pedestrian travel along the shoulder. However, this may be the preferred solution for distances up to 200’ (60 m) when compared to the alternatives, such as constructing a turnout in a deep cut, placing a mailbox just beyond a sharp crest vertical curve (poor sight distance), or constructing two or more closely spaced turnouts.

Avoid placing mailboxes along high-speed, high-volume highways if other practical locations are available. Do not locate mailboxes where access, stopping or parking is otherwise prohibited by law or regulation. No mailbox should be at a location that would require a patron to cross the lanes of a divided highway to deposit or retrieve mail.

Placing a mail stop near an intersection will have an effect on the operation of the intersection. The nature and magnitude of this impact depends on traffic speeds and volumes on each of the intersecting roadways, the number of mailboxes at the stop, type of traffic control, how the stop is located relative to the traffic control, and the distance the stop is from the intersection. The *MDT Detailed Drawings* show possible locations of mail stops at typical rural intersections and approaches.

MDT policy is that mailbox turnouts are to be provided on all projects where the width of the shoulder is less than 6’ (1.8 m) and the ADT is greater than 300 vehicles per day. For facilities with ADTs of 300 vehicles per day or less, provide mailbox turnouts where the mailbox cannot be practically relocated to a location which at least meets the project's desirable stopping sight distance.

18.7.2 Urban Mailboxes

Urban mail delivery requires special consideration during the design process. Following these procedures during design will help minimize construction issues regarding mail delivery:

1. During the preliminary field review, make a special point of looking for mailboxes or other mail delivery features. Businesses and residences may have different considerations.
    a. Is mail delivered through slots, by hand (inside the businesses), or to mailboxes (individual or clusters)?
    b. If there are mailboxes in place, where are they located and how are they mounted?
    c. Are there conflicts with ADA requirements?
    d. Is sidewalk work going to be included in the project and will construction conflict with the current mail delivery?
2. Include a specific reference for mailboxes in the survey request. Ask for locations, types, condition, and mounting methods.
3. Discuss mail delivery at the public informational meeting. Be sure to ask the business owners and residents for comments regarding mail delivery, especially if there are mailboxes in the existing sidewalk or in an area that will become a new sidewalk section.
4. At the Alignment and Grade stage, discuss proposed mailbox placement with the postmaster. Specifically address the locations, distance from curb, and the potential for cluster boxes.
5. If mailboxes will be perpetuated or placed in new sidewalk, provide mounting information in the plan package. The detailed drawings may or may not be adequate for construction, depending on the project.
    a. Include an additional detail if necessary to ensure that the mailboxes are mounted properly.

b. Ensure adequate ADA clearance around mailboxes placed in the sidewalk.

c. Include the distance from curb and stationing for each mailbox listed in the mailbox summary frame. If special mounting methods are needed, include a note in the summary frame.

18.8 HAZARDOUS MATERIALS

Hazardous waste sites can impact all phases of highway activities, including project development, design, right-of-way, construction, and maintenance. These impacts can increase costs and delay highway projects. Ownership of a site from which there has been a release, or a threat of a release of a hazardous substance may indicate liability whether the contamination is the result of the agency's actions or those of others.

18.8.1 Responsibility

The Project Scoping Team will be responsible for identifying possible hazardous waste locations during the Preliminary Field Review. A list of these locations will be provided to the Hazardous Waste Bureau. The Hazardous Waste Section, or its consultant, will complete the Hazardous Material Review. After the Hazardous Material Review is completed, decisions then can be made regarding the site. This may include requiring the present owner to reclaim the site prior to acquisition, redesigning the project to avoid the site, or delaying or dropping the project from further development due to significant hazardous waste considerations. Preferably, all reclamation will take place before acquisition or construction; see Section 18.8.3.

18.8.2 Location

Hazardous materials can emerge almost anywhere. However, common possible locations include near storage tanks, oil wells, oil lines, illegal dumping sites, abandoned chemical plants, coal fields, service stations, paint companies, machine shops, metal processing plants, electronic facilities, dry cleaning establishments, old railroad yards, auto junkyards, landfills, or near bridges with lead base paints. Early indicators of contamination include ground water contamination of nearby wells, soil discolorations, barrels, liquid discharges, odors, abnormalities in vegetation, and extensive filling and regrading. If there is a reasonable chance a site may contain hazardous materials, contact the Hazardous Waste Section to determine if detailed testing of the site is warranted.

18.8.3 Cleanup

The Hazardous Waste Section and the District Office will be responsible for ensuring the site is free of contamination prior to acquisition of the right-of-way, or for State properties, prior to construction.

Certain special reclamation sites or materials may require a specialist contractor to determine the location and size of the contaminated area and to provide for the proper removal and disposal of the contaminated materials. .

18.8.4 Milled Material

Material milled from existing pavements is considered a solid waste. On projects that include milling, the designer should attempt to utilize the milled material on the project. The preferred uses include recycled asphalt pavement (RAP) and base gravel. Milled material can also be used to resurface frontage roads, stockpiled for later use by MDT Maintenance or given to counties for their use. The use of the material should be addressed at the Preliminary Field Review.

The milled material can be used as fill if the only other viable option is to dispose of the material. If the material is used as fill, it must be placed above the seasonally high water table and not in proximity to standing water. It must also be covered with a least 20” (0.5 m) of fill. Disposal is expensive as it requires a Class II landfill.

18.9 BUS STOPS AND TURNOUTS

18.9.1 Location

18.9.1.1 Bus Stops

If local bus routes are located on an urban or suburban highway, the designer should consider their impact on normal traffic operations. The stop-and-go pattern of local buses will disrupt traffic flow, but certain measures can minimize the disruption. The location of bus stops is particularly important. These are determined not only by convenience to patrons, but also by the design and operational characteristics of the highway and the roadside environment. If the bus must make a left-turn, for example, do not locate a bus stop in the block preceding the left turn.

There are three basic bus stop designs — far-side or near-side of an intersection, and mid-block. Advantages and disadvantages for each of these bus-stop locations are listed in Figure 18.9A. In addition, consider the following:

1. Far-Side Stops. For capacity and other reasons, far-side stops are generally preferred to near-side or mid-block bus stops.

2. Near-Side Stops. Near-side stops must be used where the bus will make a right turn at the intersection.

3. Mid-Block Stops. Mid-block bus stops may be considered where right turns at an intersection are high (250 in peak hour) and far-side stops are not practical.

18.9.1.2 Bus Turnouts

Interference between buses and other traffic can be reduced significantly by providing bus turnouts. Turnouts remove stopped buses from the through lanes and provide a well-defined user area for bus stops. Consider bus turnouts where the following conditions exist:

1. The street provides arterial service with high-traffic speeds [(e.g., greater than 35 mph (60 km/h)].

2. Bus volumes are 10 or more during the peak-hour.

3. Passenger volumes exceed 20 to 40 boardings an hour.

	Advantages	Disadvantages
Far-Side Stop	• Minimizes conflicts between right-turning vehicles and buses. • Provides additional right-turn capacity by making the curb lane available for traffic. • Minimizes sight distance problems on approaches to the intersection. • Encourages pedestrians to cross behind the bus. • Creates shorter deceleration distances for buses because the bus can use the intersection to decelerate. • Results in bus drivers being able to take advantage of the gaps in traffic flow that are created at signalized intersections.	• Multiple stopped buses may block the intersection during peak periods. • May obscure sight distance for crossing vehicles. • May increase sight distance problems for crossing pedestrians. • Can cause a bus to stop twice, first for the traffic signal and then for the far-side stop, which interferes with both bus operations and all other traffic. • May increase number of rear-end accidents because drivers do not expect buses to stop again after stopping at a red signal. • Could result in traffic queued into intersection when a bus is stopped in travel lane.
Near-Side Stop	• Minimizes interference when traffic is heavy on the far side of the intersection. • Allows passengers to access buses closest to crosswalk. • The width of the intersection allows easier re-entry into the traffic stream where curb parking is allowed. • Eliminates the potential of double stopping. • Allows passengers to board and alight while the bus is stopped at a red signal. • Provides driver with the opportunity to look for oncoming traffic, including other buses with potential passengers.	• Increases conflicts with right-turning vehicles. • May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians. • May cause sight distance to be obscured for cross vehicles stopped to the right of the bus. • May block the through lane during peak period with queuing buses. • Increases sight distance problems for crossing pedestrians.
Mid-block Stop	• Minimizes sight distance problems for vehicles and pedestrians. • May result in passenger waiting areas experiencing less pedestrian congestion. • Desirable if a large generator is located mid-block. • Less walking for passengers where the distance between intersections is large. • May be appropriate where there is a fairly heavy and continuous transit demand throughout the block.	• Requires additional distance for no-parking restrictions. • Encourages patrons to cross street at mid-block (jaywalking). • Increases walking distance for patrons crossing at intersections.

COMPARISON OF BUS STOP LOCATIONS

Figure 18.9A

4. The average bus dwell time generally exceeds 30 seconds per stop.
5. During peak-hour traffic, there are at least 250 vehicles per hour in the curb lane.
6. Buses are expected to layover at the end of the trip.
7. Potential vehicular/bus conflicts warrant the separation of transit and other vehicles.
8. There is a history of traffic and/or pedestrian accidents that can be resolved by a bus turnout.
9. Right-of-way width is sufficient to prevent adverse impact on sidewalk pedestrian movements.
10. Curb parking is prohibited, at least during peak hours.
11. Sight distances prevent traffic from stopping safely behind the bus.
12. Other improvements (e.g., widening) are planned for the major roadway.
13. At location where specially equipped buses are used to load and unload disabled individuals.

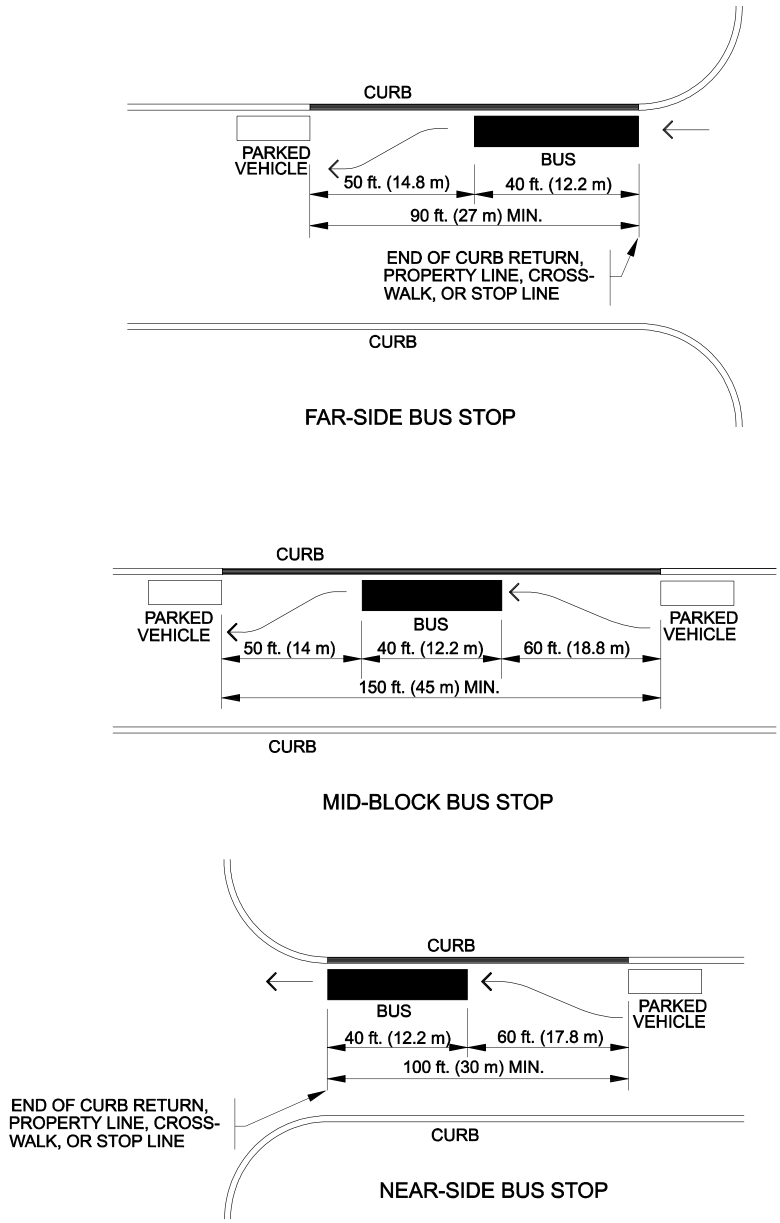
18.9.1.3 Selection

The Project Scoping Team, in conjunction with the District Office and the local transit agency, will determine the location of the bus stop or bus turnout. However, the designer usually has some control over the best placement of a bus stop or turnout location when considering layout details, intersection design and traffic flow patterns.

18.9.2 Design

18.9.2.1 Bus Stops

Figure 18.9B provides the recommended distances for the prohibition of on-street parking near bus stops.



Notes:

1. *Where articulated buses are expected to use these stops, add an additional* 20' (6 m) *to the bus distances.*

2. *Provide an additional 50' (15.2 m) of length for each additional bus expected to stop simultaneously at any given bus stop area. This allows for the length of the extra bus [40' (12.2 m)] plus 10' (2.8 m) between buses.*

ON-STREET BUS STOPS

Figure 18.9B

18.9.2.2 Bus Turnouts

Desirably, the total length of a bus turnout will allow for an entrance taper, a deceleration length, a stopping area, an acceleration length, and an exit taper. Figure 18.9C illustrates the design details for bus turnouts. Providing separate deceleration and acceleration lengths are desirable in suburban and rural areas. However, common practice is to accept deceleration and acceleration in the through lanes and only build the tapers and stopping area. In addition, consider the following:

1. Far-Side Turnouts. Typically, far-side intersection placement is desirable. Placing turnouts after signal-controlled intersections allows the signal to create gaps in traffic.

2. Near-Side Turnouts. Avoid using near-side turnouts because of conflicts with right-turning vehicles, delays to transit services as buses try to re-enter the traveled way and obstructions to traffic control devices and pedestrian activities.

3. Mid-Block Turnouts. Only use mid-block turnouts in conjunction with major traffic generators.

4. Tapers. Figure 18.9C provides information on taper lengths that may be used for entrance and exit tapers. To improve traffic operations, use short horizontal curves [100’ (30 m) radius] on the entry end and 50’ (15 m) to 100’ (30 m) curves on the re-entry end. Where a turnout is located at a far-side or near-side location, the cross street area can be assumed to fulfill the need for the exit or entry area, whichever applies.

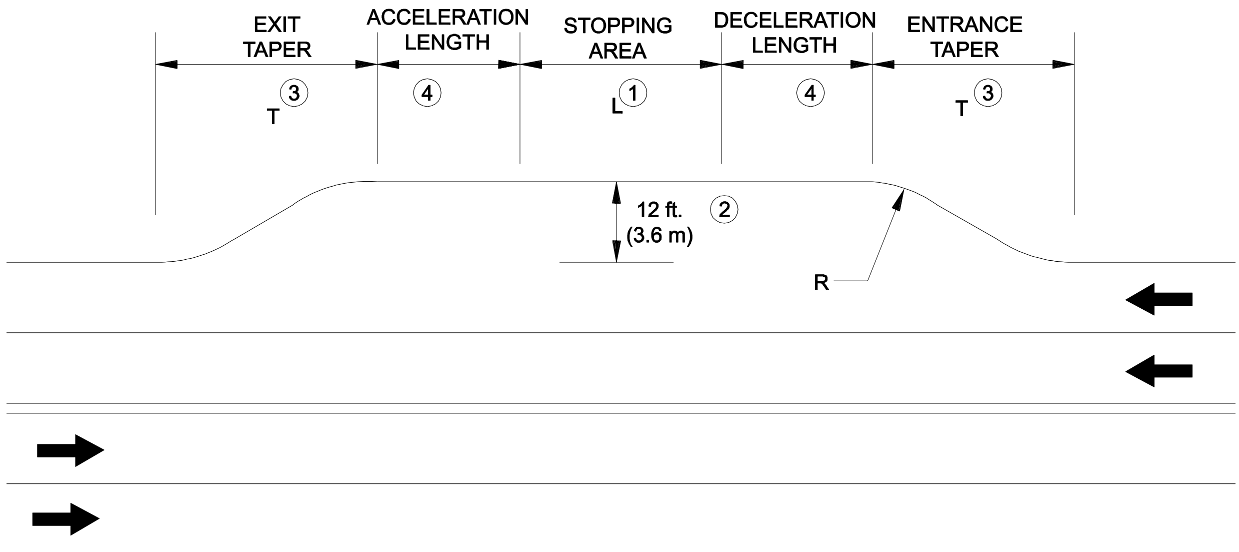
18.9.2.3 Bus Stop Pads

All new bus stops which are constructed for use with lifts or ramps must meet the disabled accessibility criteria in Section 18.1.4.

18.9.2.4 Bus Shelters

The need for bus shelters will be determined by the District Office in conjunction with the local transit agency. The designer should consider the following in the design of bus shelters:

1. Visibility. To enhance passenger safety, the shelter sides should provide the maximum transparency as practical. In addition, do not locate the shelter such that it limits the general public's view of the shelter interior.



Notes: Table and notes taken from NCHRP Report 414, High Occupancy Vehicle Systems Manual p 8-35

① *Stopping area length consists of 50' (15.2 m) for each standard 40' (12.2 m) bus and 70' (21.3 m) for each 60' (18.3 m) articulated bus expected to be at the stop simultaneously.*

② *Bus turnout width is desirably 12' (3.6 m). For traffic speeds under 30 mph (48 km/h), a 10' (3.0 m) minimum bay width is acceptable. These dimensions do not include gutter width.*

③ *Suggested taper lengths are listed below. A minimum taper of 5:1 may be used for an entrance taper from the street for a bus turnout while the merging or re-entry taper should not be sharper than 3:1*

④ *The minimum design for a bus turnout does not include acceleration or deceleration lengths. Recommended acceleration* and deceleration lengths are listed below.

TYPICAL BUS TURNOUT DIMENSIONS (Part 1)

Figure 18.9C

U.S. Customary

Through Speed mph	Entering Speed[a] mph	Acceleration Lane ft.	Deceleration Lane[b] ft.	Taper Length ft.
30	20	158	118	150
35	25	250	184	170
40	30	400	265	190
45	35	700	360	210
50	40	975	470	230
55	45	1400	595	250
60	50	1900	735	270

Metric

Through Speed km/h	Entering Speed[a] km/h	Acceleration Lane m	Deceleration Lane[b] m	Taper Length m
48	32	48	36	46
56	40	76	56	52
64	48	122	81	58
72	56	213	110	64
80	64	297	143	70
88	72	427	181	76
97	80	580	224	82

[a] *Desirably, the bus speed at the end of taper should be within 10 mph(16 km/h) of the design speed of the traveled way.*
[b] *Based on 2.5 mph/sec(4km/h/sec) deceleration speed.*

TYPICAL BUS TURNOUT DIMENSIONS (Part 2)

Figure 18.9C

2. Selection. Contact the local transit agency to determine if they use a standardized shelter design.

3. Appearance. Shelters should be pleasing and blend with their surroundings. Shelters should also be clearly identified with "bus logo" symbols.

4. Disabled Accessibility. Design the new bus shelters to meet the accessibility criteria presented in Section 18.1.4.

5. Placement. Do not place the shelter where it will restrict vehicular sight distance, pedestrian flow or disabled accessibility. It should also be placed so that waste and debris are not allowed to accumulate around the shelter.

6. Responsibility. The local transit agency is responsible for providing and maintaining the shelter.

7. Capacity. The maximum shelter size is based upon the maximum expected passenger accumulation at a bus stop between bus runs. The designer can

assume approximately 2.7 to 5.4 ft^2 (0.25 to 0.5 m^2) per person to determine the appropriate shelter size. See Section 18.1.4 for minimum disabled accessibility requirements.

18.10 MISCELLANEOUS ELEMENTS

18.10.1 Cattle Guards

The locations of cattle guard installations are typically specified in the right-of-way agreements, except for those installed on interchange ramps. All existing cattle guards should be reviewed for removal or replacement. Existing cattle guard installations which are no longer necessary should be removed, and those installations which do not meet the criteria below should be considered for relocation. In addition, the designer should consider the following:

1. R/W Line. Where used, locate cattle guards at the right-of-way line on all public or private approaches, except where it will interfere with the requirements in Comment #'s 2 and 3.

2. Ramps. Where cattle guards are required on interchange ramps, they should be located 145' (45 m) to 165' (50 m) from the ramp terminal, except where they may interfere with the requirements in Comment #3.

3. Width. The cattle guard should extend across the full pavement width including both shoulders. Do not reduce the paved roadway width.

4. Bases. All bases for cattle guards on public roads, including interchange ramps, should use cast-in-place concrete bases as shown in the *MDT Detailed Drawings*. Field and other private approaches may use the precast concrete base.

5. Details. The *MDT Detailed Drawings* provide the construction details for the installation of cattle guards.

18.10.2 Retaining Walls

Retaining walls often provide a desirable solution to problems related to limited right-of-way, environmental impacts, steep embankments and cuts, etc. The following describes MDT policy for the selection and design of retaining walls:

1. Need. Generally, the need for a retaining wall will be determined by the Project Scoping Team during the Preliminary Field Review. However, as the project design develops, the designer may later determine that there is a need for a retaining wall. The need for a wall should be carefully assessed as retaining walls are very expensive.

2. Location. The actual location for the retaining wall will typically be determined during the Alignment and Grade Review. The designer may make adjustments to this location depending on the project design.

3. Options. The Geotechnical Section will perform a foundation investigation of the site and will determine which retaining wall system would be acceptable for the site.

4. Design. The designer will be responsible for showing the wall location and elevation and other pertinent details of a proposed retaining wall. A listing of all acceptable retaining wall systems, as provided by the Geotechnical Section, should be provided in the plans. The Bridge Bureau will provide the design for concrete retaining walls.

5. Selection. The Contractor will select a wall system from the acceptable retaining wall list in the plans. The Contractor will be responsible for submitting detailed shop plans for the selected retaining wall design.

6. Plan Review. The Bridge Bureau will be responsible for reviewing the shop plans for any concrete retaining walls selected by the Contractor. The Geotechnical Section will be responsible for reviewing the shop plans for all other wall types.

18.10.3 Parking

Section 11.2.5 provides the warrants and design criteria for on-street parking. For design criteria on off-street parking (e.g., park-and-ride lots, rest areas), see Chapter Thirty-one of the *MDT Traffic Engineering Manual* and/or contact the Traffic Engineering Section.

18.10.4 Highway/Railroad Grade Crossings

In general, the following will apply where there is a highway/railroad grade crossing:

1. Design. The road designer is responsible for coordinating with the Utilities Section to provide the necessary information on the proposed project to the affected railroads. The road designer is also responsible for incorporating, as necessary, the information from the railroad company into the design plans.

2. Agreements. The Utilities Section in the Right-of-Way Bureau is responsible for contacting the railroad company and negotiating all agreements with the railroad companies. The Contract Plans Section is responsible for preparing the maintenance agreement for signing and other related items if the facility is

maintained by some other entity (e.g., State Secondary Route maintained by a county).

3. Signing and Pavement Markings. The Signing and Pavement Marking Unit in the Traffic Engineering Section is responsible for the signing and pavement markings on the approach to the railroad crossing. The railroad company will be responsible for the traffic control devices at the crossing.

4. Electrical. The Electrical Unit in the Traffic Engineering Section is responsible for working with the railroad to coordinate nearby traffic signals and active traffic crossing controls.

18.10.5 In-Pavement Systems

To reduce the number of pavement cuts after resurfacing and other new pavement projects are completed, the designer should contact the MDT Motor Carrier Services, the Maintenance Division, the Rail, Transit and Planning Division and the Electrical Unit in the Traffic Engineering Section to determine if they plan, in the near future, to install weigh-in-motion detectors, permanent traffic counters, weather sensors, traffic signal loop detectors, etc., into the pavement. If practical, these systems should be incorporated into the project.

The sensors for the Remote Weather Information System (RWIS) must be replaced each time any work is done on the paved surface. The sensors may be located up to 0.3 miles (0.5 km) from the RWIS tower. Consequently, if an RWIS tower is located in the vicinity of the project, contact MDT Maintenance to determine the location of the sensors. The cost of furnishing the sensors will be included in the project, but the installation will be accomplished by MDT Maintenance personnel.

18.10.6 Interchange Grading and Landscaping

Consider the grading around an interchange early in the design process. Alignment, fill and cut sections, median widths, lane widths, drainage, structural design, and infield contour grading all affect the function and aesthetics of the interchange. Properly graded interchanges allow the overpassing structure to blend naturally into the terrain. In addition, ensure that the crossroad and ramp slopes are not too steep to compromise safety and that they can support plantings that prevent erosion and enhance the appearance of the area. Flatter slopes also allow easier maintenance. Transitional grading between cut and fill slopes should be long and natural in appearance. The designer also must ensure that plantings will not affect the sight distance within the interchange and that larger plantings are a significant distance from the traveled way.

Include a contour grade detail in the plans.

18.11 FRONTAGE ROADS

18.11.1 General

Frontage roads serve numerous functions, depending on the type of facility served and the character of the surrounding area. They may be used to control access to the facility, to function as a street serving adjoining property, and to maintain circulation of traffic on each side of the main highway. Frontage roads segregate local traffic from the higher speed through traffic and serve driveways of residences and commercial establishments along the highway. Connections between the main highway and frontage roads, usually provided at crossroads, furnish access between through roads and adjacent property. Thus, the through character of the highway is preserved and is unaffected by subsequent development along the roadsides.

Frontage roads may be used on all types of highways. Their greatest use is adjacent to freeways where their primary function is to distribute and collect traffic between local streets and the freeway interchanges. In some circumstances, frontage roads are also desirable on arterial streets both in urban and suburban areas.

Despite their advantages, the use of continuous frontage roads on relatively high-speed arterial streets with intersections at grade may be undesirable. At the cross streets, the various through and turning movements at several closely spaced intersections greatly increase the accident potential. The multiple intersections are also vulnerable to wrong-way entrances. Traffic operations are improved if the frontage roads are located a considerable distance from the main highway at the intersecting crossroads in order to lengthen the spacing between successive intersections along the crossroads. See Section 18.11.3.

Frontage roads generally are parallel to the roadway for through traffic. They may or may not be continuous, and they may be provided on one or both sides of the arterial.

For private frontage or access roads, prepare an economic analysis to ensure that construction of the frontage road will be cost effective versus acquiring the property.

18.11.2 Functional Classification

The normal design elements of pavement width, cross slope, horizontal and vertical alignment, etc., should be provided consistent with the functional operation of the frontage road. That is, the same considerations relative to functional classification, design speed, traffic volumes, etc., apply to frontage roads as they apply to any other highway. The functional classification of the frontage road will be determined on a case-by-case basis.

18.11.3 Design

In the design of frontage roads, consider the following:

1. Design Criteria. The selection of the appropriate design criteria is based on the functional classification of the frontage road. Once the functional classification has been determined, select the appropriate design speed, lane and shoulder widths, etc., from the tables in Chapter Twelve.

2. One-Way/Two-Way. From an operational and safety perspective, one-way frontage roads are much preferred to two-way especially in urban areas. One-way operations may inconvenience local traffic to some extent, but the advantages in reducing vehicular and pedestrian conflicts at intersecting streets often fully compensate for this inconvenience. In addition, there is some savings in pavement and right-of-way width. Two-way frontage roads at high-volume, at-grade intersections complicate crossing and turning movements.

   Two-way frontage roads may be considered for partially developed urban areas where the adjoining street system is so irregular or so disconnected that one-way operation will introduce considerable added travel distance and cause undue inconvenience. Two-way frontage roads may also be appropriate for suburban or rural areas where points of access to the through facility from the frontage road are widely spaced.

3. Outer Separation. The area between the main highway and a frontage road or street is the outer separation. The separation functions as a buffer between the through traffic on the main highway and the local traffic on the frontage road. This separation also provides space for shoulders and ramp connections to or from the through facility.

   The wider the outer separation, the less influence local traffic will have on through traffic. Wider separations lend themselves to landscape treatments and enhance the appearance of both the highway and the adjoining property. Desirably, the outer separation between the mainline facility and the frontage road will be 100’ (30 m) in rural areas and 65’ (20 m) in urban areas. This distance is measured between the edges of the traveled ways for the mainline highway and frontage road. The minimum width of outer separation will be that which is required for the shoulder adjacent to the main highway, the frontage road shoulder (or shoulder offset) and for a median type barrier.

A substantial width is particularly advantageous at intersections with cross streets. A wide outer separation minimizes vehicular and pedestrian conflicts. At intersections, the outer separation should also be based on future traffic considerations.

A frontage road too close to the mainline highway and on the same level may justify the need for a headlight glare screen.

4. Access. Connections between the main highway and the frontage road are an important design element. On facilities with lower operational speeds and one-way frontage roads, slip ramps or simple openings in a narrow outer separation may work reasonably well. Slip ramps from one-way frontage roads and freeways are acceptable. However, slip ramps from a freeway to two-way frontage roads are undesirable because they tend to induce wrong-way entry onto the freeway and may cause accidents at the intersection of the ramp and frontage road. Therefore, on freeways and other arterials with high operating speeds and two-way frontage roads, the access to the freeway must be provided at interchanges. Figure 18.11A illustrates details for the ramp/frontage road design with one-way frontage roads.

The design in Figure 18.11A may only be used in restricted urban areas. The critical design element is the distance "A" between the ramp/frontage road merge and the crossing road. This distance must be sufficient to allow traffic weaving, vehicular deceleration and stopping, and vehicular storage to avoid interference with the merge point. Figure 29.4B also presents general guidelines which may be used to estimate this distance during the preliminary design phase. A number of assumptions have been made including weaving volume, operating speeds and intersection queue distance. Therefore, a detailed analysis will be necessary to firmly establish the needed distance to properly accommodate vehicular operation. Additional information can be found in a Transportation Research Record 682 paper entitled, "Distance Requirements for Frontage-Road Ramps to Cross Streets: Urban Freeway Design."

Distance "B" in Figure 18.11A is determined on a case-by-case basis. It should be determined based on the number of frontage road lanes and the intersection design. This distance is typically determined by the weaving distance from the intersection to ramp entrance. For capacity analysis of the weaving section, see the *Highway Capacity Manual*. Under some circumstances this distance may be 0.0.

The following summarizes the available options for coordinating the design of the interchange ramps, frontage road and crossing road:

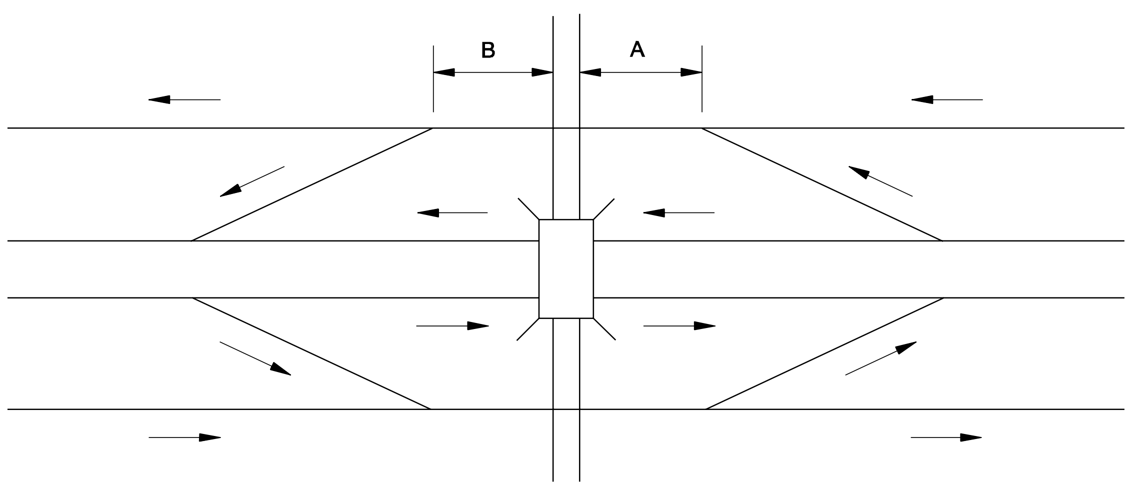
Frontage Road Volume (vph)[1]	Exit Ramp Volume (vph)[2]	"A"					
		Typical Minimum		Typical Desirable		Special Conditions	
		ft	m	ft	m	ft	m
200	140	375	115	490	150	260	80
400	275	460	140	560	170	360	110
600	410	490	150	625	190	395	120
800	550	540	165	690	210	425	130
1000	690	590	180	755	230	460	140
1200	830	640	195	870	265	475	145
1400	960	690	210	970	295	490	150
1600	1100	770	235	1065	325	525	160
1800	1240	855	260	1180	360	560	170
2000	1380	970	295	1295	395	590	180

1 *Total frontage road and exit ramp volume between merge to intersection with minor road.*

2 *Assumed to be 69% of total volume in first column.*

Note: Table values are acceptable for planning purposes; final dimensions will be based on a detailed operational analysis. This design may be used where necessary in restricted urban areas.

Distance B is typically determined by the weaving distance from the intersection to the ramp entrance, see Chapter Twenty-nine of the Montana Traffic Engineering Manual.



RAMP/CONTINUOUS FRONTAGE ROAD INTERSECTION

Figure 18.11A

1. Slip Ramps. Slip ramps may be used to connect the freeway with one-way frontage roads before (or after) the intersection with the crossing road.

2. Separate Intersections. Separate ramp/crossing road and frontage road/crossing road intersections may be accomplished by curving the frontage road away from the ramp and intersecting the frontage road with the crossing road outside the ramp limits of full access control. Figure 18.11A provides an illustration of this separation. This treatment allows the two intersections to operate independently, and it eliminates the operational and signing problems of providing the same point of exit and entrance for the frontage road and freeway ramp.