## 9.1 FUNCTIONAL HIGHWAY SYSTEMS IN URBANIZED AREAS

The discussion in this Chapter relates to the recommended functional classification network for the Greater Bozeman area, not the Federally approved classification system. Bozeman has a local functional classification based on a future network that shows how the street network should develop over time and is intended to be used as a planning tool for planning future developments. The Federally approved functional classification is based on current conditions and reflects how roads currently function within the network and is used to determine federal funding eligibilities and design standards for federal-aid programs.

The roadways that make up the street network within a community can be subdivided into categories based upon the function of the road. Roadway functional classifications include interstate principal arterials; non-interstate principal arterials; minor arterials; collector routes; and local streets, however, there are two classes of collectors, major and minor. **Figure 9-17** shows rural standards. Although volumes may differ on urban and rural sections of a street it is important to maintain coordinated right-of-way standards. A description of these classifications is provided in the following text.

### 9.1.1 Principal Arterial – Interstate

The sole purpose of the interstate is to provide for regional and interstate travel. Interstate highways are access-controlled facilities with access provided only at a limited number of interchanges. The interstate system has been designed as a high-speed facility with all road intersections being grade separated. Interstate 90, which traverses the study area, is a four-lane divided highway with a posted speed limit of 75 miles per hour (mph) for automobiles, and 65 mph for trucks.

### 9.1.2 Principal Arterial – Non-Interstate

The purpose of the non-interstate principal arterial is to serve the major centers of activity, the highest traffic volume corridors, and the longest trip distances in an urban area. This group of roads carries a high proportion of the total traffic within the urban area. Most of the vehicles entering and leaving the urban area, as well as most of the through traffic bypassing the central business district, utilize principal arterials. Significant intra-area travel, such as between central business districts and outlying residential areas, and between major suburban centers, are served by principal arterials.

The spacing between non-interstate principal arterials may vary from less than one mile in highly developed areas (e.g., the central business district), to five miles or more on the urban fringes. The major purpose of the non-interstate principal arterial is to provide for the expedient movement of traffic. Service to abutting land is a secondary concern. On-street parking should not be allowed along this type of corridor.

### 9.1.3 Minor Arterial Street System

The minor arterial street system interconnects with and augments the urban principal arterial system. It accommodates trips of moderate length at a somewhat lower level of travel mobility than principal arterials, and it distributes travel to smaller geographic areas. With an emphasis on traffic mobility, this street network includes all arterials not classified as principal arterials while providing access to adjacent lands.

The spacing of minor arterial streets may vary from several blocks to a half-mile in the highly developed areas of town, to several miles in the suburban fringes. They are not normally spaced more than one mile apart in fully developed areas.

### 9.1.4 Collector Street System

The urban collector street network serves a joint purpose. It provides equal priority to the movement of traffic, and to the access of residential, business, and industrial areas. This type of roadway differs from those of the arterial system in that the facilities on the collector system may traverse residential neighborhoods. The system distributes trips from the arterials to ultimate destinations. The collector streets also collect traffic from local streets in the residential neighborhoods, channeling it into the arterial system. On-street parking is usually allowed on most collector streets if space is available.

The rural collector street network serves the same access and movement functions as the urban collector street network – a link between the arterial system and local access roads. Collectors penetrate but should not have continuity through residential neighborhoods. Some potential collector locations have been shown in the fringe area. The actual location of collectors should be flexible to best serve developing areas and the public. Several design guidelines should be kept in mind as new subdivisions are designed and reviewed. The most important concept is that long segments of continuous collector streets are not compatible with a good functional classification of streets. Long, continuous collectors will encourage through traffic, essentially turning them into arterials. This, in turn, results in the undesirable interface of local streets with arterials, causing safety problems and increased costs of construction and maintenance. The collector street system should intersect arterial streets at a uniform spacing of one-half to one-quarter mile in order to maintain good progression on the arterial network. Ideally, collectors should be no longer than one to two miles without discontinuities. Opportunities need to be identified through good design and review of subdivisions to create appropriate collector streets in developing areas.

### 9.1.5 Urban Local Street System

The local street network comprises all facilities not included in the higher systems. Its primary purpose is to permit direct access to abutting lands and connections to higher systems. Usually service to through-traffic movements is intentionally discouraged. On-street parking is usually allowed on the local street system.

## 9.2 Facility Size Versus Traffic Volume

The size of a roadway is based upon the anticipated traffic demand. It is desirable to size the roadways to comfortably accommodate the traffic demand that is anticipated to occur 20 years from the time it is constructed. The selection of a 20-year design period represents a desire to receive the most benefit from an individual construction project's service life within reasonable planning limits. The design, bidding, mobilization, and repair of affected adjacent properties can consume a significant portion of an individual project's budget. Frequent projects to make minor adjustments to a roadway can therefore be prohibitively expensive. As roadway capacity generally is provided in large increments, a long term horizon is necessary.

There are two measurements of a street's capacity, Annual Average Daily Traffic (AADT) and Peak Hour. AADT measures the average number of vehicles a given street carries over a 24- hour period. Since traffic does not usually flow continuously at the maximum rate, AADT is not a statement of maximum capacity. Peak Hour measures the number of vehicles that a street can physically accommodate during the busiest hour of the day. It is therefore more of a maximum traffic flow rate measurement than AADT. When the Peak Hour is exceeded, the traveling public will often perceive the street as "broken" even though the street's AADT is within the expected volume. Therefore, it is important to consider both elements during design of corridors and intersections.

Physical size of the roadway and the required right-of-way is a function of the land use that will occur along the street corridor. These uses will dictate the vehicular traffic characteristics, travel by pedestrians and bicyclists, and need for on-street parking. The right-of-way required should always be based upon the ultimate facility size.

The actual amount of traffic that can be handled by a roadway is dependent upon the presence of parking, number of driveways and intersections, intersection traffic control, speed of the roadway, and roadway alignment. The data presented in **Table 9-1** indicates the approximate volumes that can be accommodated by a particular roadway. As indicated in the differences between the two tables, the actual traffic that a road can handle will vary based upon a variety of elements including: road grade; alignment; pavement condition; number of intersections and driveways; the amount of turning movements; and the vehicle fleet mix.

**Table 9-1**
**Approximate Volumes for Planning of Future Roadway Improvements**

| Road Segment | Volumes[1] | Volumes[2] |
|---|---|---|
| Two Lane Road | Up to 12,000 VPD | Up to 15,000 VPD* |
| Three Lane Road | Up to 18,000 VPD | Up to 22,500 VPD* |
| Four Lane Road | Up to 24,000 VPD | Up to 30,000 VPD* |
| Five Lane Road | Up to 35,000 VPD | Up to 43,750 VPD* |

[1]Historical management conditions
[2]Ideal management conditions
*Additional volumes may be obtained in some locations with adequate road design, access control, and other capacity enhancing methods.

## 9.3 RECOMMENDED MAJOR STREET NETWORK

The major street network consists of all interstate principal arterial, non-interstate principal arterial, minor arterial, and collector routes. Local streets are not included on the major street network. The major street network recommended in the *Greater Bozeman Area Transportation Plan – 2001 Update* was used as a basis, or starting point, in developing the major street network for this update.

Establishing a plan for a community's future street layout is essential to proper land development and community planning. It is important that planners, landowners, and developers know where the future road network needs to be located. With an approved major street network, everyone will know where the future arterials need to be located. This will assist everyone involved in anticipating right-of-way needs, and appropriate land-uses.

The study area was examined to determine the most appropriate placement for the future arterial network. The principal arterials were set in place first with two-mile spacing. The minor arterials were then inserted on a one-mile spacing to fill in between the principals. Some collector routes were also established. It is assumed that other collector routes would be established when the development patterns in an area are defined.

The recommended existing and future major street networks are shown in **Figure 9-1** and **Figure 9-2**. The future alignments shown are conceptual in nature and may vary based on factors such as topography, wetlands, land ownership, and other unforeseen factors. The purpose of these figures is to illustrate the anticipated network at full build-out. It is likely that many of the route corridors shown will not be developed into roads for many decades to come. On the other hand, if development is proposed in a particular area, the recommended major street network will insure that the arterial corridors will be established in a fashion that produces an efficient and logical future road network. It is important to note that presenting the major street network at this time is not intended to control or influence development. It is presented in an effort to help plan for the future development of the road system in the community.

The acquisition of right-of-ways for these future road corridors should be one of the community's highest priorities. It is essential that these corridors be dedicated for roadway use before an area develops. This action will insure that the roadway corridors remain clear and available for use when the future need arises.

In addition, a final "travel demand model" run of the recommended improvements has been made. **Figure 9-3** thru **Figure 9-6** show the future year (2030) travel demand model estimated traffic volumes and v/c ratios based on the recommended improvements discussed in **Chapter 5** and the Major Street Network.

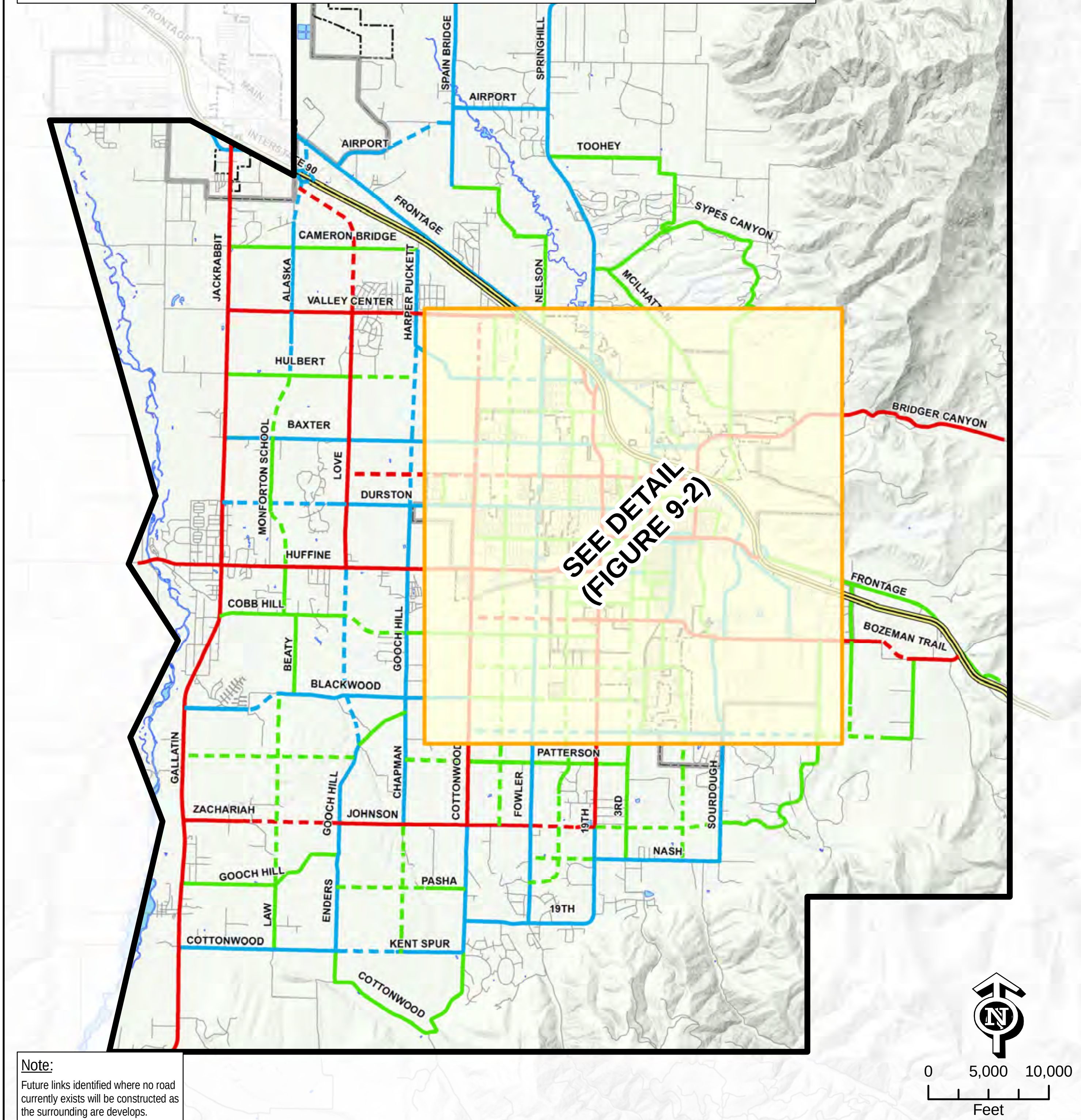
## Interpretation of Map

This map presents the Recommended Major Street Network. It shows how the street network should develop over time and is intended to be used as a planning tool. It will assist in the evaluation of long-term traffic needs when planning future developments. The route alignments shown are conceptual in nature.

The actual alignments may vary based on development patterns, geographic features, and other issues unknown at this time. The community planners will strive to design the roads to fit the character of the landscape and minimize impacts on natural features such as wetlands, mature trees, and riparian corridors.

Most of these routes are not recommended for construction at this time. The development of these conceptual routes will take decades to become reality, and will only become roads if traffic needs materialize as a result of development in the area. Many of the existing roads identified as arterial routes are currently functioning as collectors or local streets and will be upgraded as traffic needs increase.

It is important to note that although this major street network is recommended as part of the Transportation Plan, it does not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.




Note:
Future links identified where no road currently exists will be constructed as the surrounding are develops.

### Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Future Principal Arterial*
- Future Minor Arterial*
- Future Collector*
- Local Roadway
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

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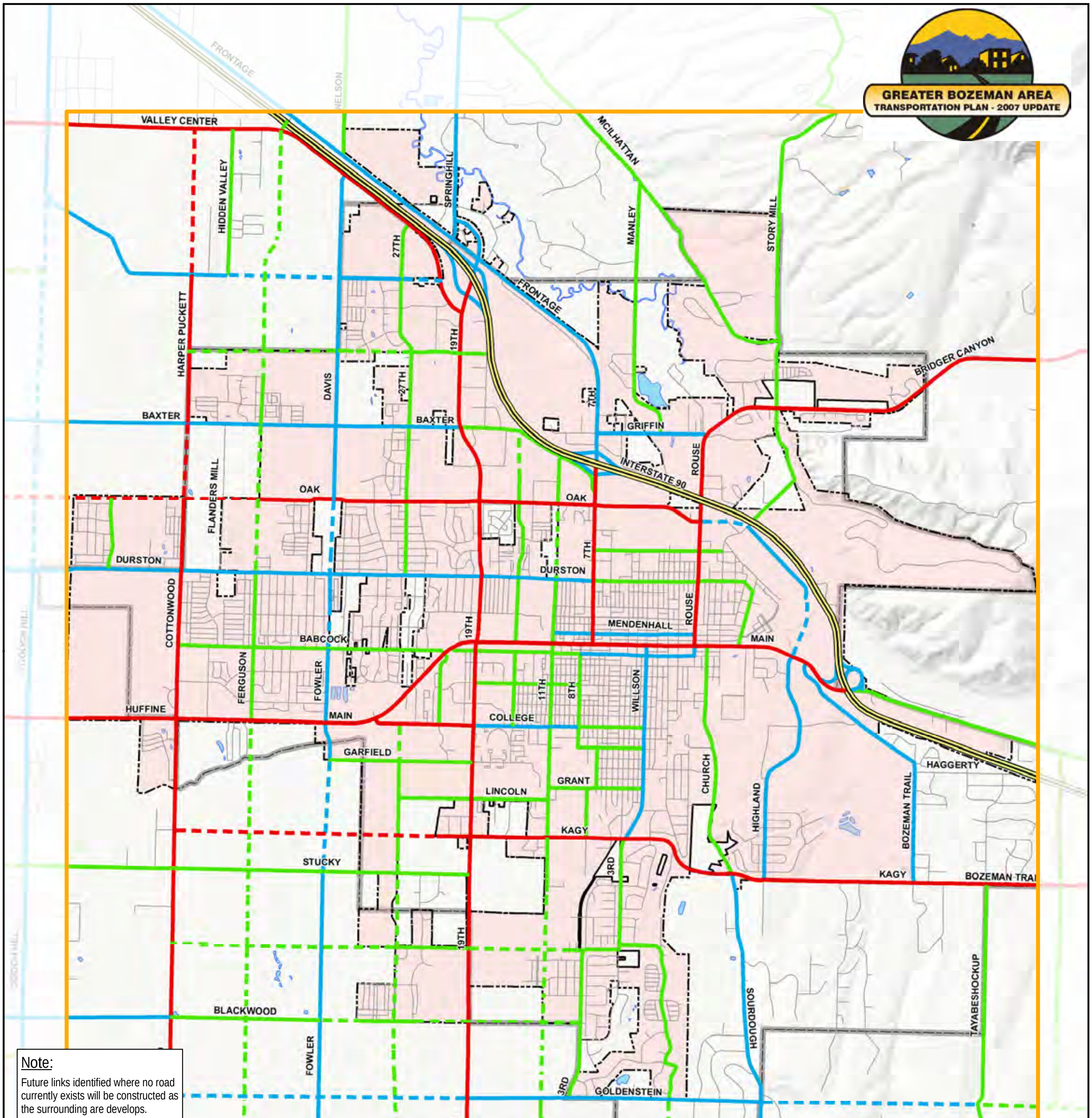
## Existing Major Street Network and Future Right-Of-Way Corridor Needs

## Figure 9-1




Note:

Future links identified where no road currently exists will be constructed as the surrounding are develops.

Interpretation of Map

This map presents the Recommended Major Street Network. It shows how the street network should develop over time and is intended to be used as a planning tool. It will assist in the evaluation of long-term traffic needs when planning future developments. The route alignments shown are conceptual in nature.

The actual alignments may vary based on development patterns, geographic features, and other issues unknown at this time. The community planners will strive to design the roads to fit the character of the landscape and minimize impacts on natural features such as wetlands, mature trees, and riparian corridors.

Most of these routes are not recommended for construction at this time. The development of these conceptual routes will take decades to become reality, and will only become roads if traffic needs materialize as a result of development in the area. Many of the existing roads identified as arterial routes are currently functioning as collectors or local streets and will be upgraded as traffic needs increase.

It is important to note that although this major street network is recommended as part of the Transportation Plan, it does not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

**Legend**

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Future Principal Arterial*
- Future Minor Arterial*
- Future Collector*
- Local Roadway
- Detail Area
- City Boundary
- Urban Boundary

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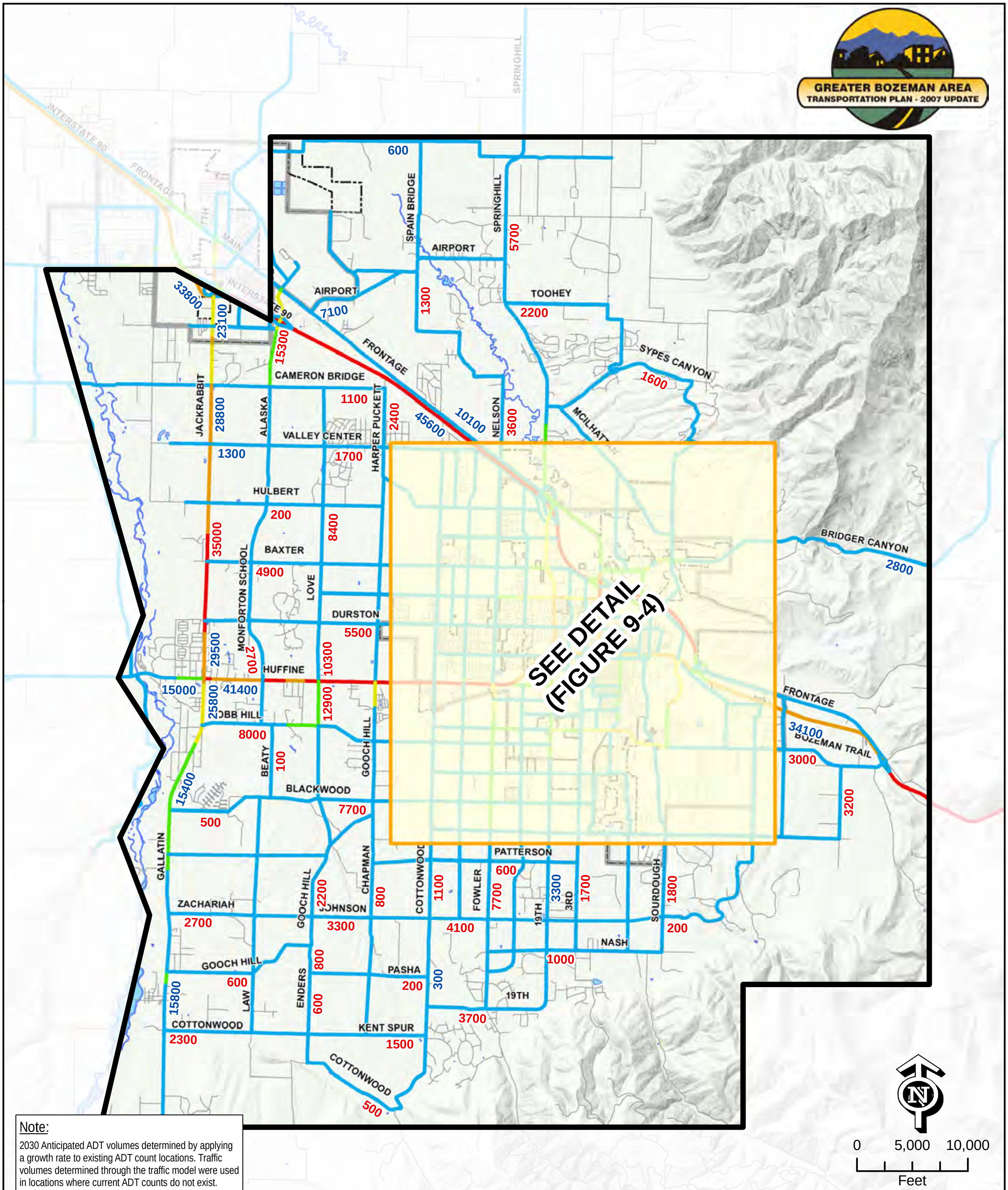
**Existing Major Street Network and Future Right-Of-Way Corridor Needs**

**Figure 9-2**




Note:
2030 Anticipated ADT volumes determined by applying a growth rate to existing ADT count locations. Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

**Legend**

- < 12,000
- 12,000 - 18,000
- 18,000 - 24,000
- 24,000 - 35,000
- > 35,000
- 1200 2030 Anticipated Average Daily Traffic (ADT)*
- 1200 2030 Model Traffic Volume*
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

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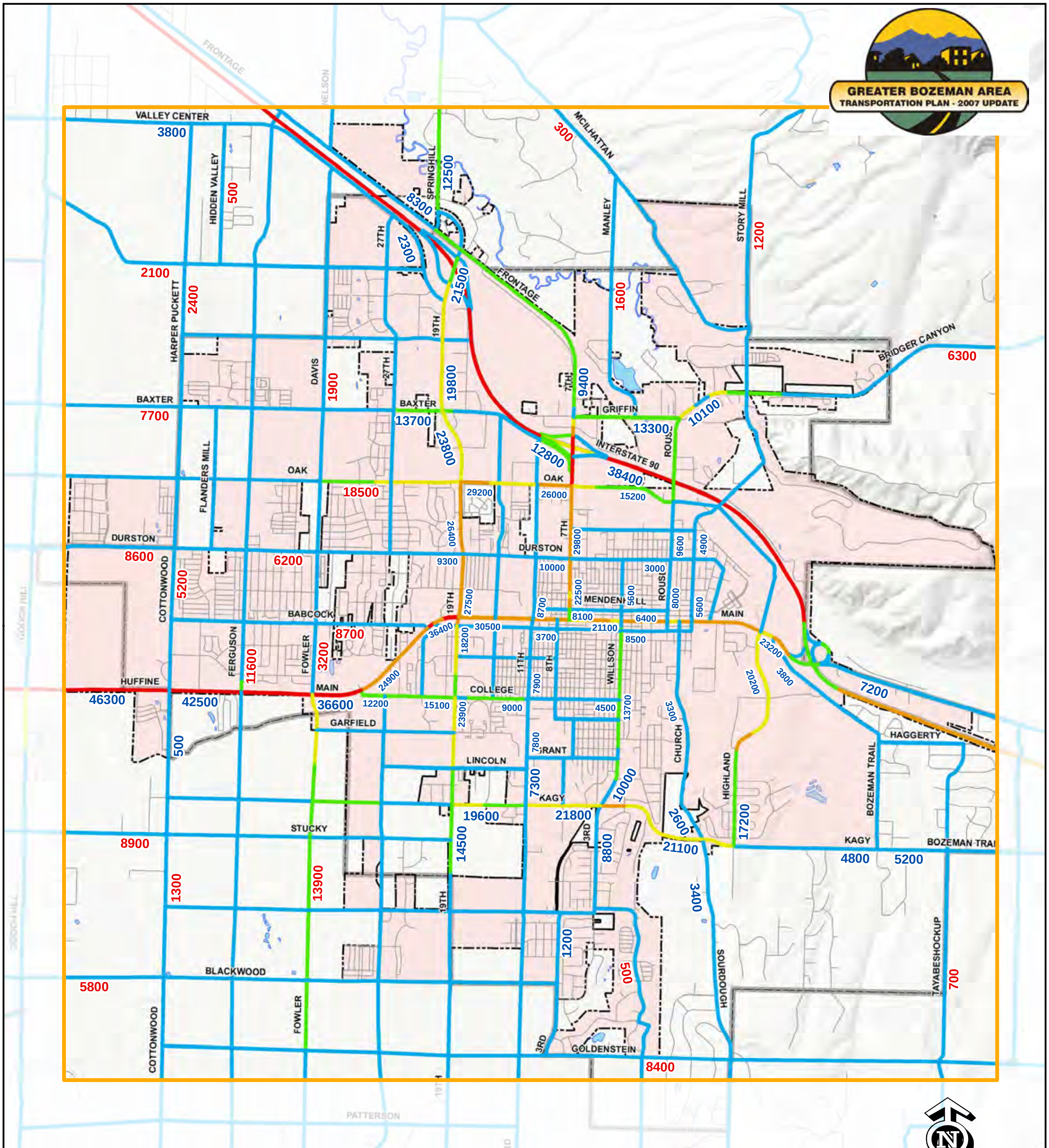
**Future (2030) MSN ADT Traffic Volumes**

**Figure 9-3**




Note:
2030 Anticipated ADT volumes determined by applying a growth rate to existing ADT count locations. Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

**Legend**

| | | | |
|---|---|---|---|
| < 12,000 | | Detail Area | |
| 12,000 - 18,000 | | City Boundary | |
| 18,000 - 24,000 | | Urban Boundary | |
| 24,000 - 35,000 | 1200 | 2030 Anticipated Average Daily Traffic (ADT)* | |
| > 35,000 | 1200 | 2030 Traffic Model Volume* | |

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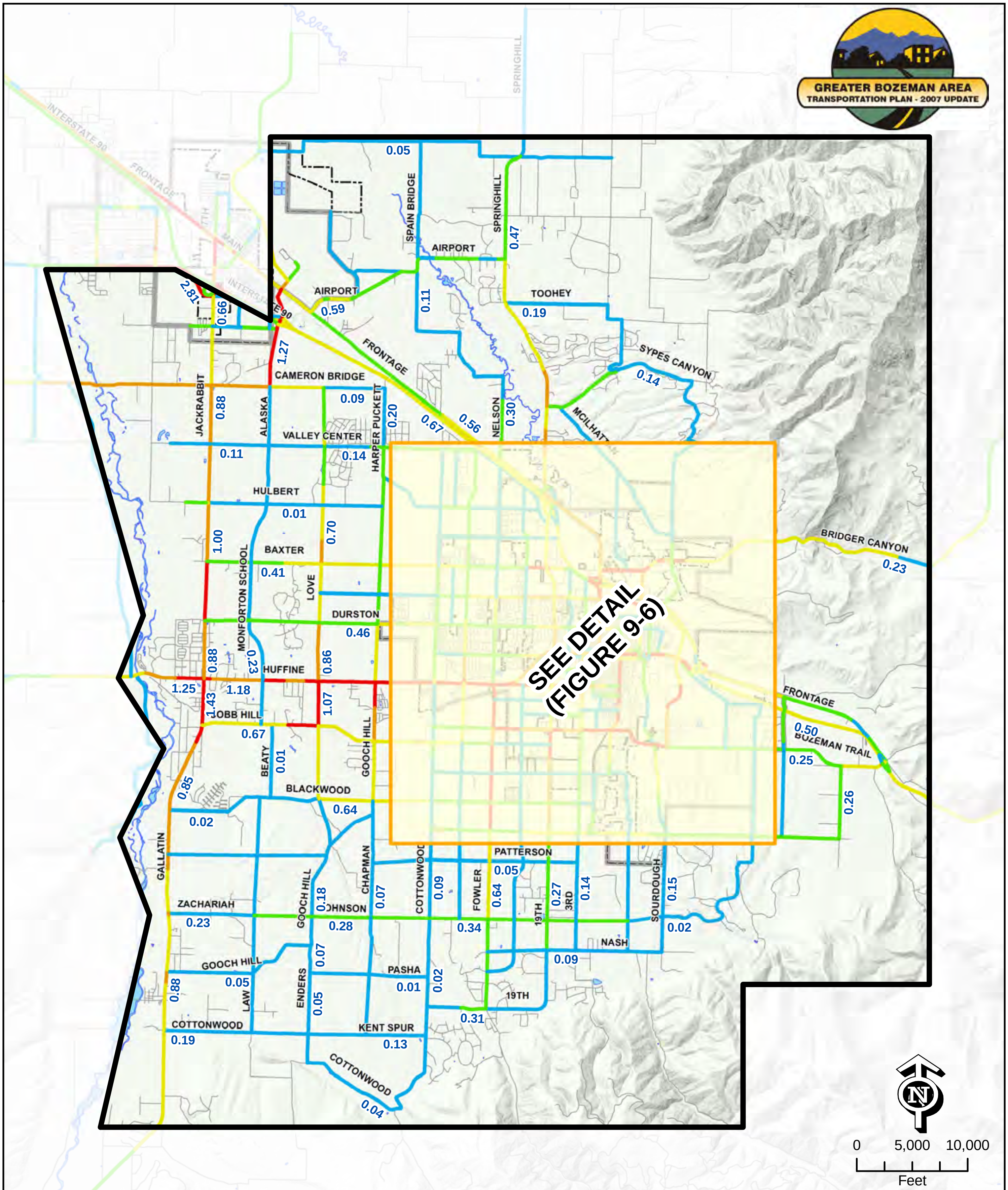
# Future (2030) MSN ADT Traffic Volumes

## Figure 9-4




**Legend**

Volume to Capacity Ratio (V/C)

- <0.25
- 0.25-0.49
- 0.50-0.74
- 0.75-1.00
- >1.00

- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary
- 0.25 Volume / Capacity Ratio

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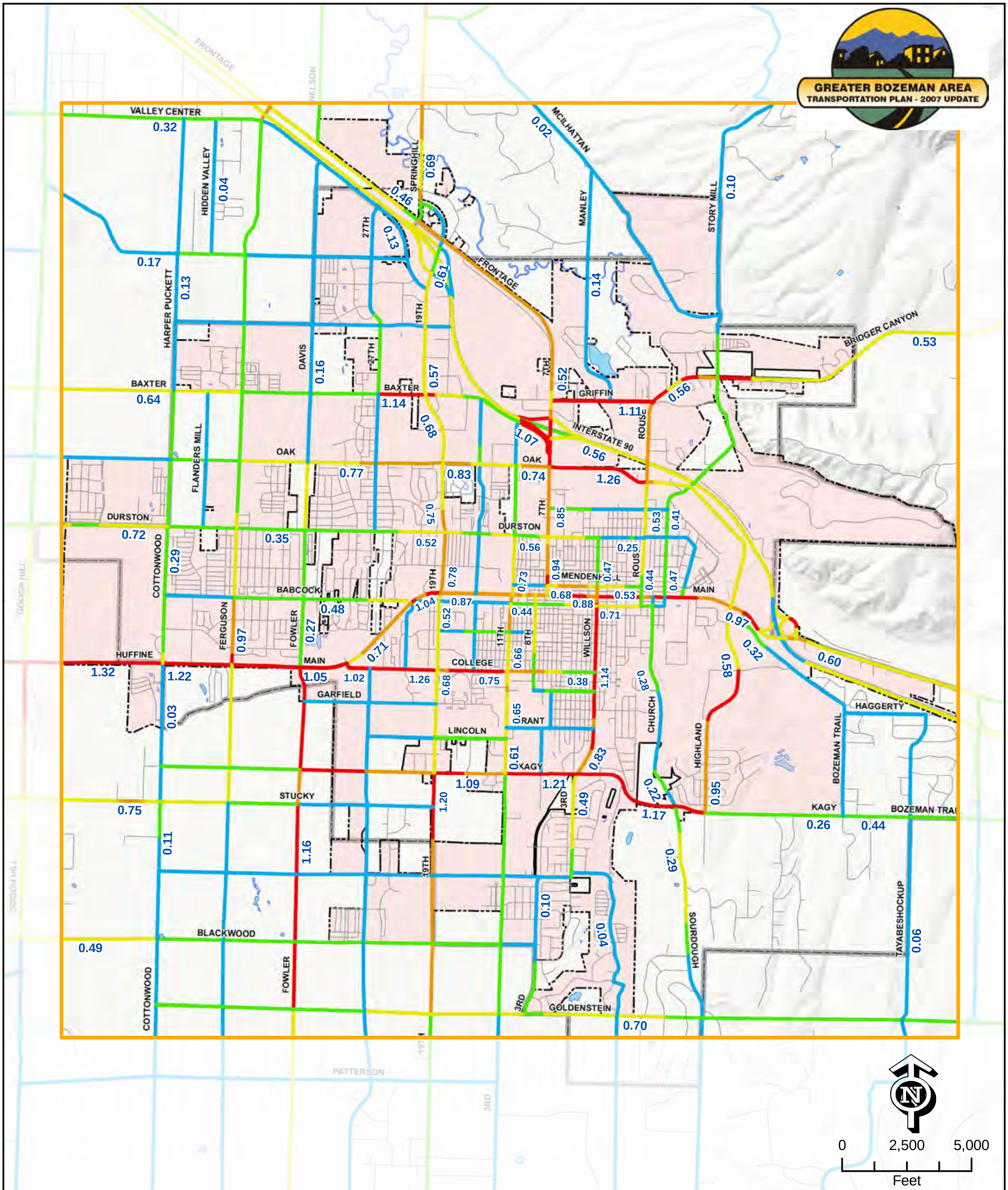
**Future (2030) MSN V/C**
**Volume to Capacity Ratio**
**Figure 9-5**




**Legend**

Volume to Capacity Ratio (V/C)
- <0.25
- 0.25-0.49
- 0.50-0.74
- 0.75-1.00
- >1.00

- Detail Area
- City Boundary
- Urban Boundary
- 0.25 Volume / Capacity Ratio

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**Future (2030) MSN V/C**
**Volume to Capacity Ratio**
**Figure 9-6**

## 9.4 RIGHT-OF-WAY NEEDS

The recommended road standards identify the amount of right-of-way that is necessary to accommodate the full build-out of each type of facility. The desired right-of-way for principal arterials is 120 feet, 100 feet for minor arterials, 90 feet for collectors, and 60 feet for local roads.

Many existing roads within the community do not have the necessary right-of-way based on these standards. Apparently there are also public roads within the study area that traverse parcels of private property without any formal right-of-way agreements or easements.

It is recommended that both the city and county establish a policy to review all existing roadways and identify roads that are located within right-of-way corridors that are less than the desirable width. Additional right-of-way should be acquired in these areas where possible. The city and county should attempt to acquire the right-of-way for both existing and future roads where the opportunity exists. It is recommended that the right-of-way necessary for all future road segments be acquired through the development process as undeveloped areas develop. Even though the initial road may only be a two-lane or three-lane facility, providing the full amount of right-of-way will enable the corridor to be expanded at a later date while avoiding an expensive and disruptive land acquisition process at some time in the future.

Nothing in the *Greater Bozeman Area Transportation Plan - 2007 Update* should be read as an encouragement of the use by the County of its power of eminent domain.

## 9.5 ROUNDABOUT CONCEPTUAL DESIGNS

The FHWA publication *Roundabouts: An Informational Guide* categorizes roundabouts into six categories according to size, number of lanes, and environment. These categories, along with design features specific to the design type, are listed below:

**Mini-roundabouts**

- Low-speed urban environments
- Environments with right-of-way constraints
- Maximum recommended entry speed of 15 mph
- Inscribed diameter of 45-80 feet
- 10,000 vpd volume for 4-legged intersection

**Urban compact roundabouts**

- Pedestrian and bicyclist friendly compared to other types of roundabouts
- Low vehicle speeds with maximum recommended entry speed of 15 mph
- Inscribed diameter of 80-100 feet
- Capacity should not be a critical issue
- 15,000 vpd volume for 4-legged intersection

**Urban single-lane roundabouts**

- Consistent entering and exiting speeds
- Slightly higher speeds and capacities than urban compact roundabouts
- Less pedestrian friendly than other types of roundabouts due to the higher speeds
- Maximum recommended entry speed of 20 mph
- Inscribed diameter of 100-130 feet
- 20,000 vpd volume for 4-legged intersection

**Urban double-lane roundabouts**

- At least one entry with two lanes
- Require wider circulatory roadways with inscribed diameter of about 150-180 feet
- Similar speeds to urban single-lane roundabouts with maximum recommended entry speed of 25 mph
- May need special design considerations for high volumes of bikes and pedestrians
- Volume varies with design

**Rural single-lane roundabouts**

- Higher approach speeds require additional attention
- May have larger diameters than urban roundabouts to allow for higher speeds
- Inscribed diameter of 115-130 feet with maximum recommended entry speed of 25 mph
- 20,000 vpd for 4-legged intersection

**Rural double-lane roundabouts**

- Higher entry speeds and larger diameters than urban double-lane roundabouts

- Inscribed diameter of 180-200 feet with maximum recommended entry speed of 30 mph
- Recommended supplementary approach treatments
- Volume varies with design

The FHWA guide does not discuss roundabouts with more than two lanes; however, they are possible and have been constructed in numerous locations. The guide does discuss each of the roundabout categories listed above and gives design principles and concepts that relate to each category.

Conceptual plan view graphics for each of these design categories can be found in **Figures 9-7** thru **9-12**.

### 9.5.1 Pedestrian Challenges

Roundabouts can present difficult challenges for blind and visually impaired pedestrians. The design of the roundabout needs to go to great length to minimize the hazard to those pedestrians. That includes having the roundabout itself and the approached to the roundabout well lit both to enable the pedestrian to see as much as possible and so motorists approaching a crosswalk can see the pedestrian.

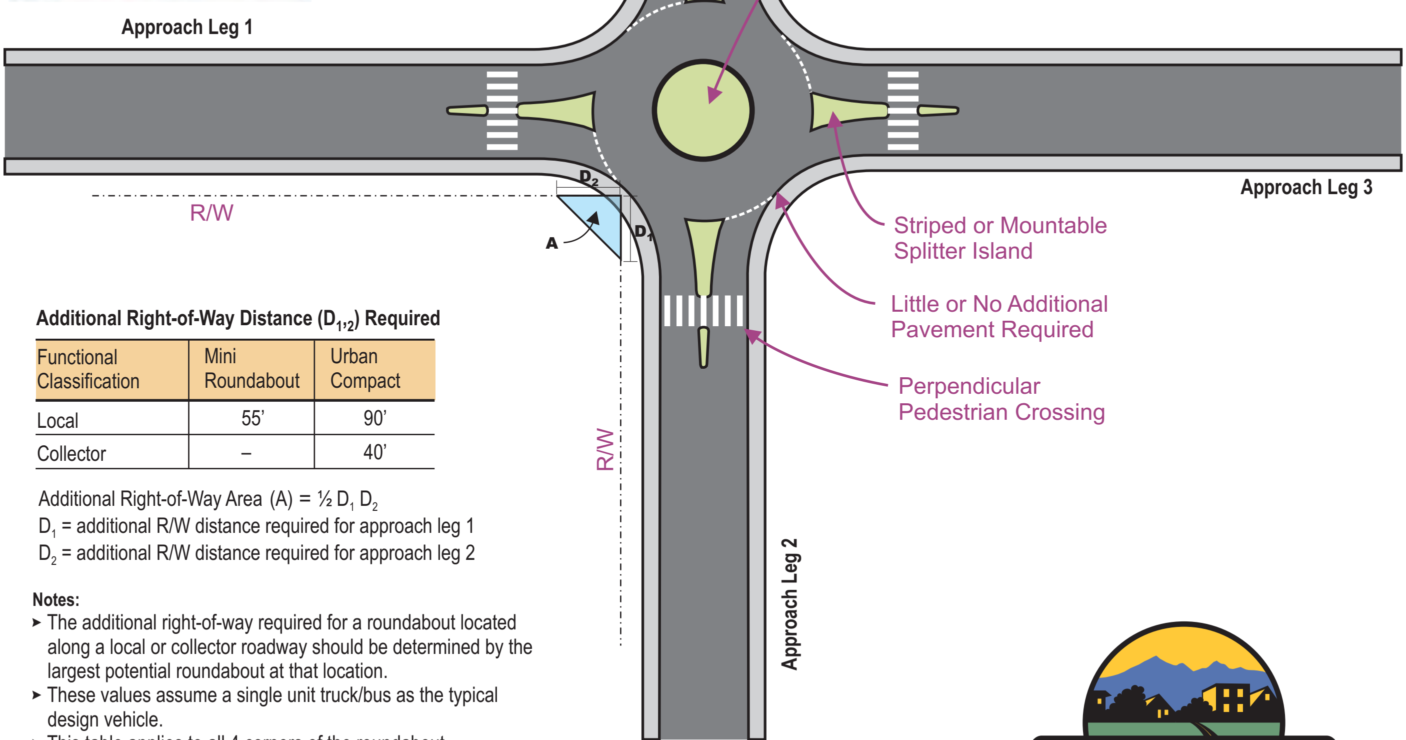
Particularly for roundabouts in locations where relatively large numbers of teenage and/or college-age pedestrians are anticipated, special care should be taken to incorporate design features that discourage pedestrians from taking a shorter route right across the traffic lanes instead of circling around the traffic lanes on the sidewalk.

It is critical that the width of the refuge islands in the middle of the pedestrian crosswalks be wide enough to adequately protect both the front and rear ends of persons pushing long, multi-child baby carriages, persons pushing wheelchairs, and cyclists walking their bicycle.

| Design Element | Mini Roundabout | Urban Compact |
|---|---|---|
| Recommended maximum entry design speed | 25 km/h (15 mph) | 25 km/h (15 mph) |
| Maximum number of entering lanes per approach | 1 | 1 |
| Typical inscribed circle diameter* | 13 to 25m (45 ft to 80 ft) | 25 to 30m (80 ft to 100 ft) |
| Splitter island treatment | Raised if possible, crosswalk cut if raised | Raised with, crosswalk cut |
| Typical daily | | 15,000 |

*Assumes 90-degree entries and no more than four legs.

**Mini-Roundabout Examples**




**Additional Right-of-Way Distance ($D_{1,2}$) Required**

| Functional Classification | Mini Roundabout | Urban Compact |
|---|---|---|
| Local | 55’ | 90’ |
| Collector | – | 40’ |

Additional Right-of-Way Area (A) = ½ $D_1$ $D_2$
$D_1$ = additional R/W distance required for approach leg 1
$D_2$ = additional R/W distance required for approach leg 2

**Notes:**
- The additional right-of-way required for a roundabout located along a local or collector roadway should be determined by the largest potential roundabout at that location.
- These values assume a single unit truck/bus as the typical design vehicle.
- This table applies to all 4 corners of the roundabout.

**Example:**
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Local roadway and the largest potential roundabout at that location is an Urban Compact roundabout, then $D_1$= 40’ and $D_2$= 90’.

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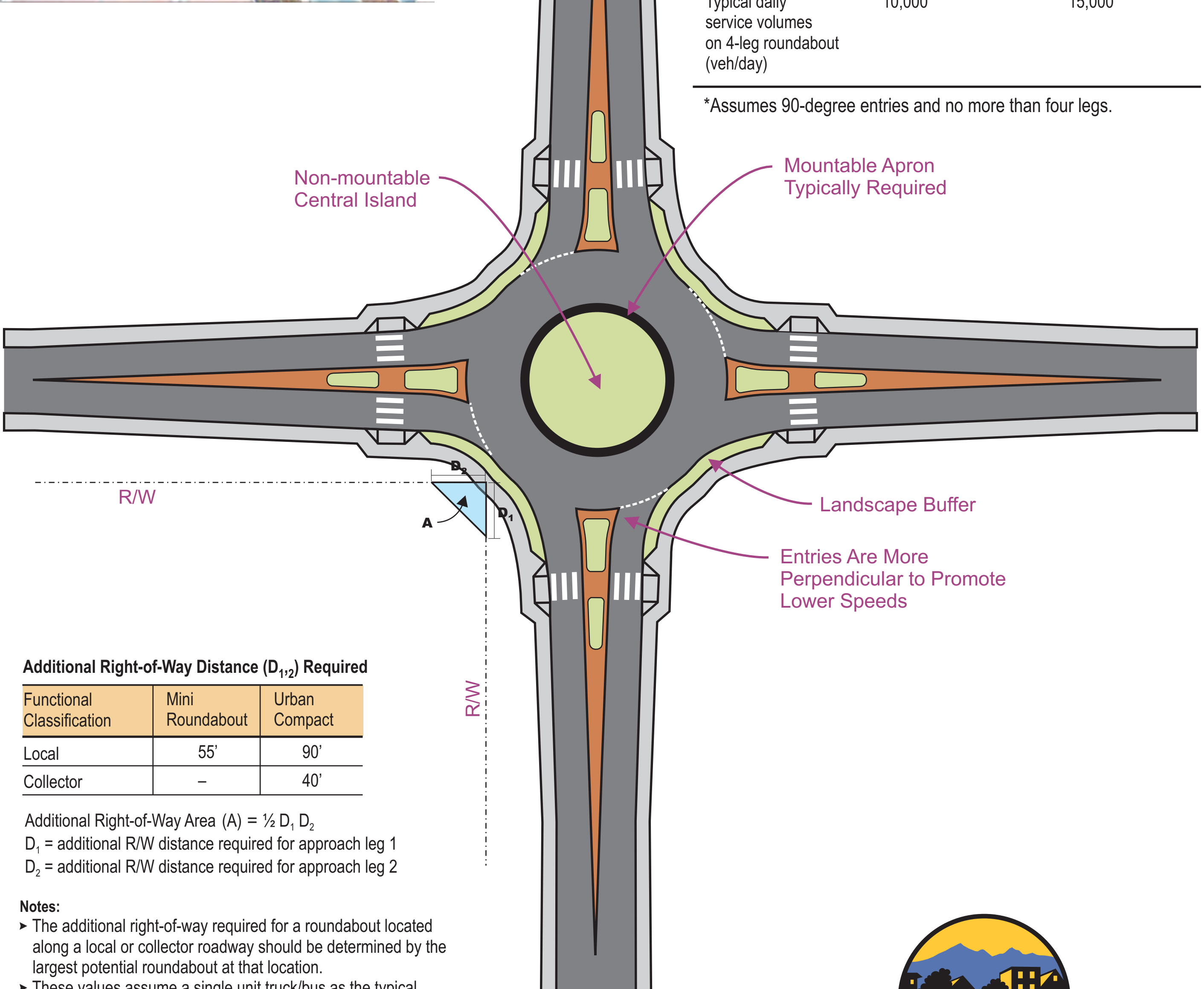
## Mini-Roundabout
## Conceptual Plan View
## Figure 9-7

drawing1b_small.cdr

## Urban Compact Roundabout Example

| Design Element | Mini Roundabout | Urban Compact |
|---|---|---|
| Recommended maximum entry design speed | 25 km/h (15 mph) | 25 km/h (15 mph) |
| Maximum number of entering lanes per approach | 1 | 1 |
| Typical inscribed circle diameter* | 13 to 25m (45 ft to 80 ft) | 25 to 30m (80 ft to 100 ft) |
| Splitter island treatment | Raised if possible, crosswalk cut if raised | Raised with, crosswalk cut |
| Typical daily service volumes on 4-leg roundabout (veh/day) | 10,000 | 15,000 |

*Assumes 90-degree entries and no more than four legs.




**Additional Right-of-Way Distance ($D_{1,2}$) Required**

| Functional Classification | Mini Roundabout | Urban Compact |
|---|---|---|
| Local | 55' | 90' |
| Collector | – | 40' |

Additional Right-of-Way Area (A) = ½ $D_1$ $D_2$

$D_1$ = additional R/W distance required for approach leg 1

$D_2$ = additional R/W distance required for approach leg 2

**Notes:**

- The additional right-of-way required for a roundabout located along a local or collector roadway should be determined by the largest potential roundabout at that location.
- These values assume a single unit truck/bus as the typical design vehicle.
- This table applies to all 4 corners of the roundabout.

**Example:**

If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Local roadway and the largest potential roundabout at that location is an Urban Compact roundabout, then $D_1$= 40' and $D_2$= 90'.

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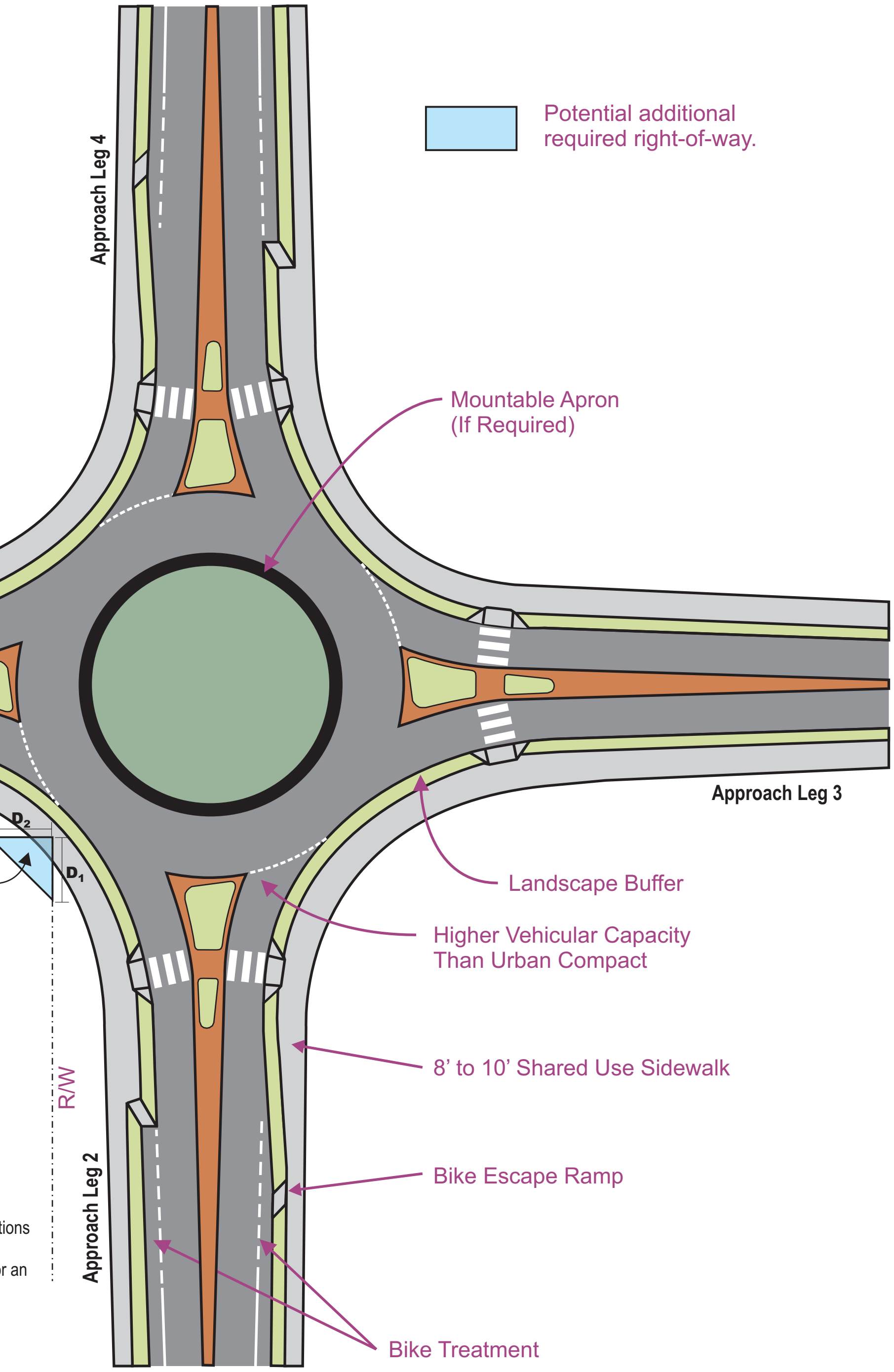
## Urban Compact Roundabout
### Conceptual Plan View
### Figure 9-8

Drawing1_small.cdr

drawing2b_small.cdr

## Urban Single-Lane Roundabout Example




**Additional Right-of-Way Distance ($D_{1,2}$) Required**

| Functional Classification | Urban Single-Lane | Urban Double-Lane |
|---|---|---|
| Collector | 75' | 140' |
| Minor Arterial | 60' | 120' |
| Principal Arterial | – | 85' |

Additional Right-of-Way Area (A) = $\frac{1}{2} D_1 D_2$

$D_1$ = additional R/W distance required for approach leg 1

$D_2$ = additional R/W distance required for approach leg 2

**Notes:**

- For Collector and Minor Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should be used in locations where the potential for an urban double-lane roundabout exists.
- For Principal Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should always be used.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

**Example:**
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the potential exists for an urban double-lane roundabout, then $D_1$= 140' and $D_2$= 120'.

| Design Element | Urban Single-Lane | Urban Double-Lane |
|---|---|---|
| Recommended maximum entry design speed | 35 km/h (20 mph) | 40 km/h (25 mph) |
| Maximum number of entering lanes per approach | 1 | 2 |
| Typical inscribed circle diameter* | 30 to 40m (100 ft to 130 ft) | 45 to 55m (150 ft to 180 ft) |
| Splitter island treatment | Raised with crosswalk cut | Raised with, crosswalk cut |
| Typical daily service volumes on 4-leg roundabout (veh/day) | 20,000 | Based on design template used |

**Assumes 90-degree entries and no more than four legs.*

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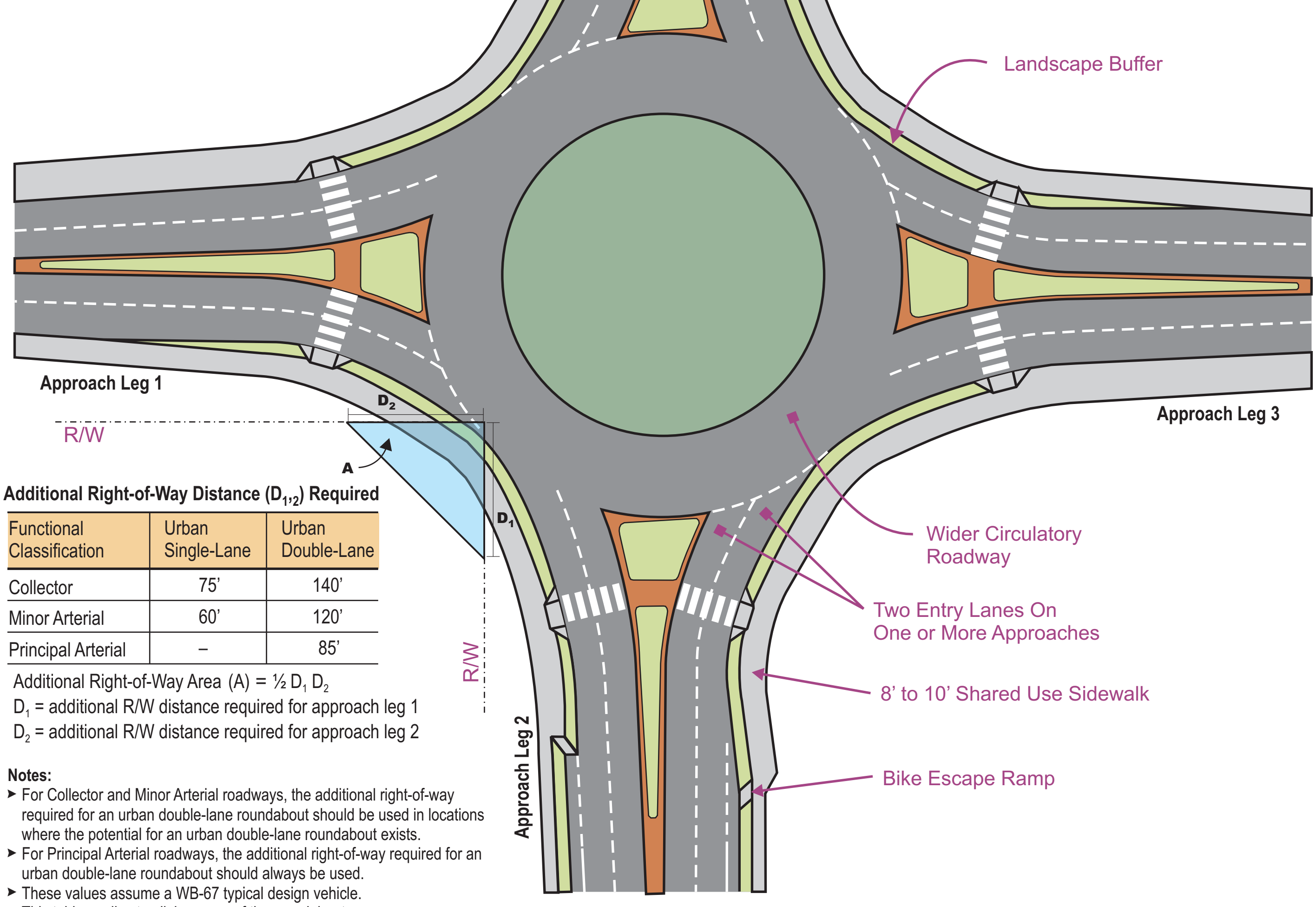
## Urban Single-Lane Roundabout

**Conceptual Plan View**

**Figure 9-9**

drawing2_small.cdr

## Urban Double-Lane Roundabout Example




**Additional Right-of-Way Distance ($D_{1,2}$) Required**

| Functional Classification | Urban Single-Lane | Urban Double-Lane |
|---|---|---|
| Collector | 75' | 140' |
| Minor Arterial | 60' | 120' |
| Principal Arterial | – | 85' |

Additional Right-of-Way Area (A) = ½ $D_1$ $D_2$

$D_1$ = additional R/W distance required for approach leg 1

$D_2$ = additional R/W distance required for approach leg 2

**Notes:**

- For Collector and Minor Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should be used in locations where the potential for an urban double-lane roundabout exists.
- For Principal Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should always be used.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

**Example:**
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| Design Element | Urban Single-Lane | Urban Double-Lane |
|---|---|---|
| Recommended maximum entry design speed | 35 km/h (20 mph) | 40 km/h (25 mph) |
| Maximum number of entering lanes per approach | 1 | 2 |
| Typical inscribed circle diameter* | 30 to 40m (100 ft to 130 ft) | 45 to 55m (150 ft to 180 ft) |
| Splitter island treatment | Raised with crosswalk cut | Raised with, crosswalk cut |
| Typical daily service volumes on 4-leg roundabout (veh/day) | 20,000 | Based on design template used |

**Assumes 90-degree entries and no more than four legs.*

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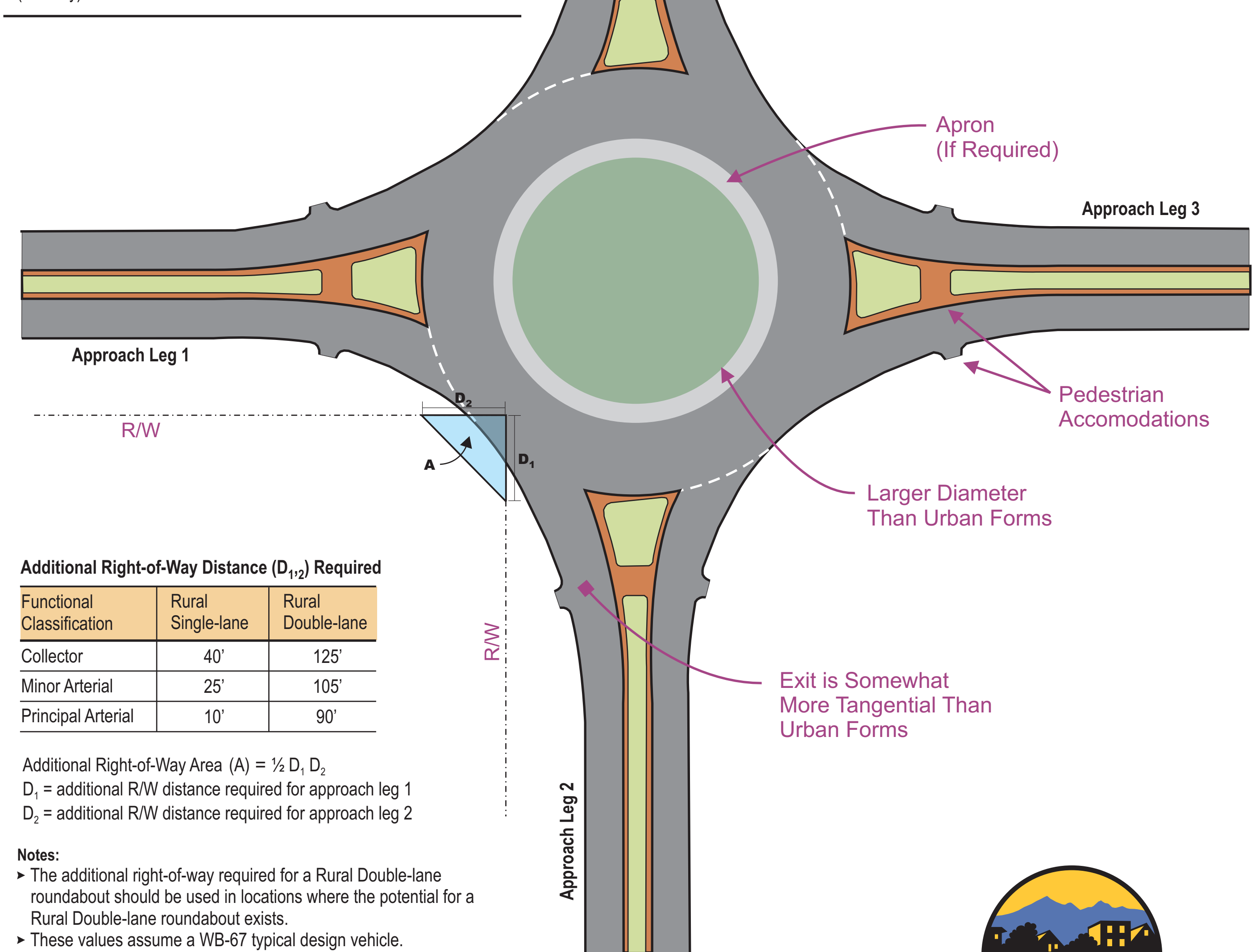
# Urban Double-Lane Roundabout
## Conceptual Plan View
## Figure 9-10

| Design Element | Rural Single-Lane | Rural Double-Lane |
|---|---|---|
| Recommended maximum entry design speed | 40 km/h (25 mph) | 50 km/h (30 mph) |
| Maximum number of entering lanes per approach | 1 | 2 |
| Typical inscribed circle diameter | 35 to 40m (115 ft to 130 ft) | 55 to 60m (180 ft to 200 ft) |
| Splitter island treatment | Raised and extended with crosswalk cut | Raised and extended with crosswalk cut |
| Typical daily service volumes on 4-leg roundabout (veh/day) | 20,000 | Based on design template used |

## Rural Single-Lane Roundabout Example




**Additional Right-of-Way Distance ($D_{1,2}$) Required**

| Functional Classification | Rural Single-lane | Rural Double-lane |
|---|---|---|
| Collector | 40’ | 125’ |
| Minor Arterial | 25’ | 105’ |
| Principal Arterial | 10’ | 90’ |

Additional Right-of-Way Area (A) = ½ $D_1$ $D_2$
$D_1$ = additional R/W distance required for approach leg 1
$D_2$ = additional R/W distance required for approach leg 2

**Notes:**

- The additional right-of-way required for a Rural Double-lane roundabout should be used in locations where the potential for a Rural Double-lane roundabout exists.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

**Example:**
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the largest potential roundabout at that location is an Rural double-lane roundabout, then $D_1$= 125’ and $D_2$= 105’.

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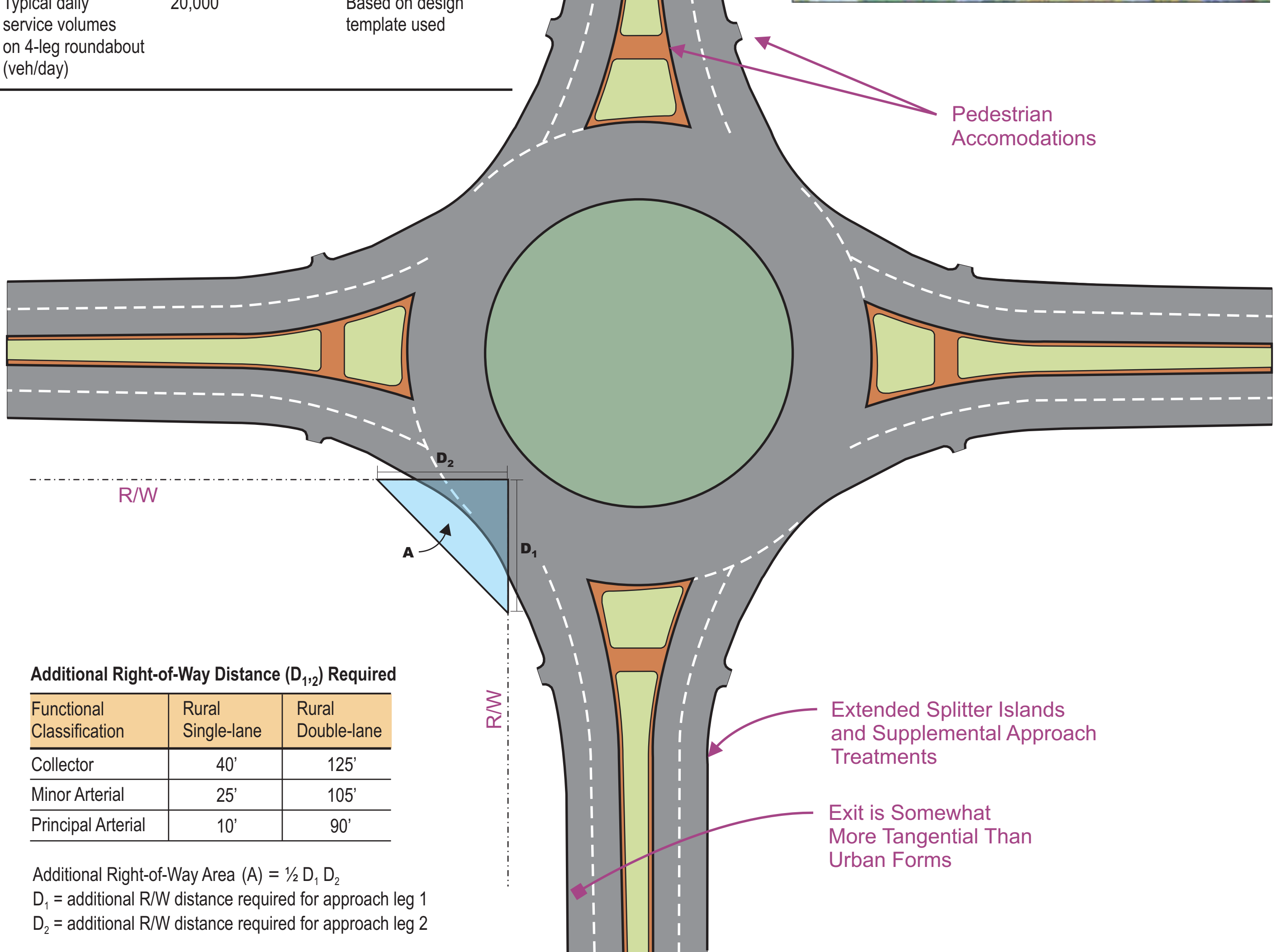
## Rural Single-Lane Roundabout

### Conceptual Plan View
### Figure 9-11

drawing3_small.cdr

| Design Element | Rural Single-Lane | Rural Double-Lane |
|---|---|---|
| Recommended maximum entry design speed | 40 km/h (25 mph) | 50 km/h (30 mph) |
| Maximum number of entering lanes per approach | 1 | 2 |
| Typical inscribed circle diameter | 35 to 40m (115 ft to 130 ft) | 55 to 60m (180 ft to 200 ft) |
| Splitter island treatment | Raised and extended with crosswalk cut | Raised and extended with crosswalk cut |
| Typical daily service volumes on 4-leg roundabout (veh/day) | 20,000 | Based on design template used |

## Rural Double-Lane Roundabout Example




**Additional Right-of-Way Distance ($D_{1,2}$) Required**

| Functional Classification | Rural Single-lane | Rural Double-lane |
|---|---|---|
| Collector | 40’ | 125’ |
| Minor Arterial | 25’ | 105’ |
| Principal Arterial | 10’ | 90’ |

Additional Right-of-Way Area (A) = ½ $D_1$ $D_2$

$D_1$ = additional R/W distance required for approach leg 1

$D_2$ = additional R/W distance required for approach leg 2

**Notes:**

- The additional right-of-way required for a Rural Double-lane roundabout should be used in locations where the potential for a Rural Double-lane roundabout exists.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

**Example:**

If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the largest potential roundabout at that location is an Rural double-lane roundabout, then $D_1$= 125’ and $D_2$= 105’.

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# Rural Double-Lane Roundabout

## Conceptual Plan View

## Figure 9-12

drawing3b_small.cdr

## 9.6 RECOMMENDED ROADWAY TYPICAL SECTIONS

It is important to have established standards that identify the overall character of various roads within a community. These standards should identify the anticipated amount of right-of-way necessary at full build-out. They should also include all of the design elements necessary such as sidewalks, bicycle facilities, landscaping, and space for utilities and snow storage. The standards should reflect the uses for each type of road, and the applicable traffic volumes anticipated.

There should be standards for both urban and rural street designs. Standards have been developed for all of the categories of roads that are found within the Bozeman area including local and collector roads, as well as minor and principal arterials. A variety of lane widths have been included in the suggested road standards. Lane widths vary based on the volume and expected type of traffic on each street. Generally, streets which will carry larger numbers of vehicles and vehicles of larger sizes have been given wider travel lanes. Please see **Figures 9-13** thru **9-17.**

Note that landscaped boulevards and sidewalks are required on both sides of all roads. Boulevards are necessary throughout the community to provide space for snow storage and separation of pedestrians and vehicles. The boulevards also provide space for trees and other forms of corridor landscaping, which are considered an essential ingredient to producing a livable community.

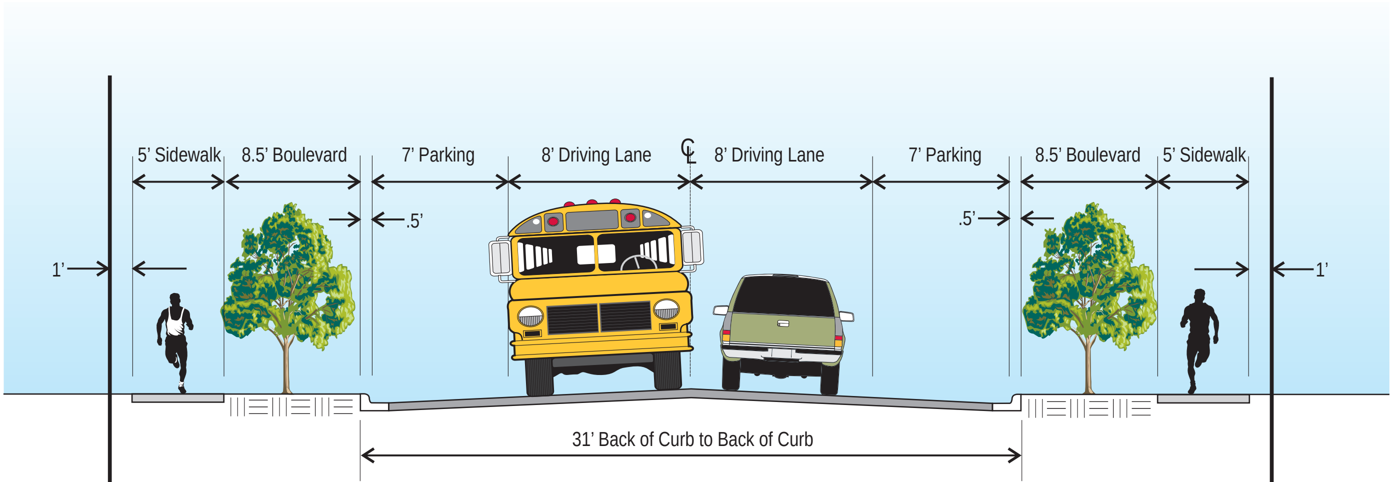
Bicycle facilities are required in all but the local road standards. Bicycle facilities are not necessary on local streets due to the relatively low traffic volumes and low vehicle speeds. In all other cases, five or six-foot-wide bicycle lanes are required on both sides of the street. A ten-foot-wide combined ped/bike trail option is allowed if the necessary right-of-way is available or provided for the primary arterial typical sections. The use of bicycle facilities that are not in the roadway are a safety concern at cross-street intersections, therefore, this option may be proposed only in cases where there are few minor intersections along the corridor.

This plan has taken a multi-modal approach to the provision of transportation services. Therefore, it is important that the pedestrian and bicycle facilities depicted on the street standards illustrated in this chapter be constructed as a basic component of the initial facility rather than being considered as an optional add-on.

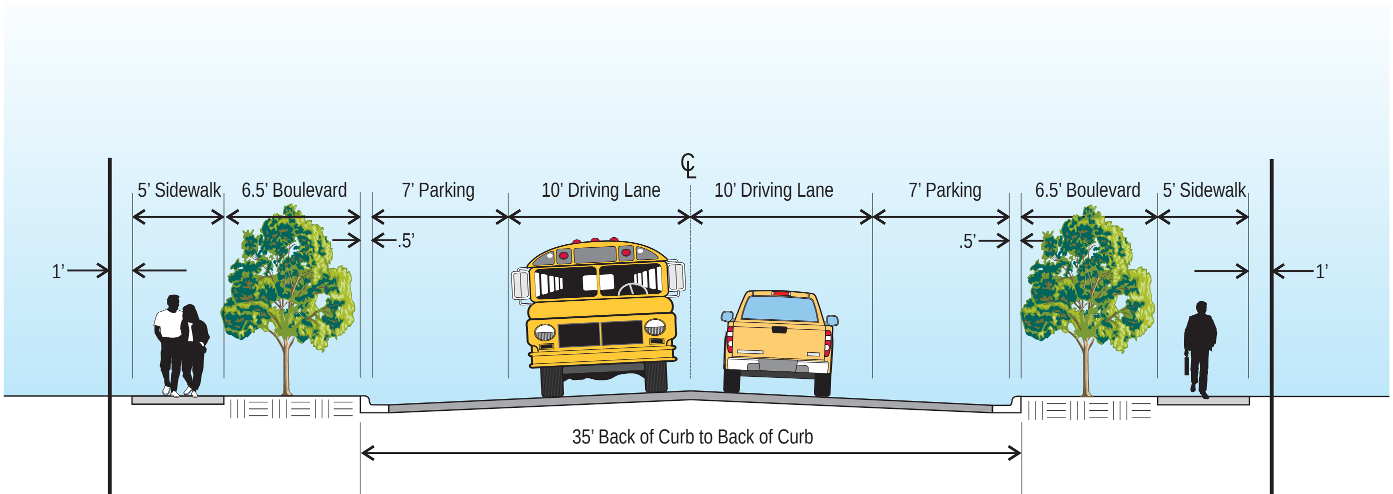
Both flush and raised center medians are included in various road standards. The use of raised versus flush medians will be determined on a case by case basis and depends on the number of driveways. The recommended road standards are presented graphically in **Figures 9-13** thru **9-17**.

The principal focus of this plan is the arterial and collector street network. A wide variety of acceptable local street alternatives exist and may integrate well with the larger scale street depicted in this Plan. For full information on local streets, interested parties are referred to the City of Bozeman and Gallatin County subdivision regulations.

It is appropriate to note that there will always be special circumstances that must be considered as roadway improvements are contemplated. Context sensitive solutions and designs, as initially described in **Chapter 6**, suggests that roadway improvements can be done in harmony with local community objectives and public interest. The potential does exist that deviation to the proposed typical sections may be warranted via reduced lane widths, on-street parking, building placement and orientation and access control features. These should be evaluated on a case by case basis by community leaders.




**2 Lanes**
**Sidewalks/Parking/Boulevard Both Sides**




**2 Lanes**
**Sidewalks/Parking/Boulevard Both Sides** 3

R/W Requirements = 60'

*Not To Scale*

## NOTES:

1 Narrower or wider local street configurations may be acceptable depending on the character of the neighborhood. Please examine the City of Bozeman's Subdivision and Zoning Regulations for details.

2 Local streets are not on the official "Urban Aid System" and therefore jurisdiction for the geometric layout falls exclusively under the City of Bozeman regulations.

3 Use this street section as local road *if* adjacent to park.

4 Sidewalks adjacent to parks on local streets are required to be 6-feet in width. This additional foot of width should be taken out of the boulevard section.

**Minimum Features:**
- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Not Required
- Boulevards - Both Sides
- Parking - Both Sides
  (Where Parking is Provided)

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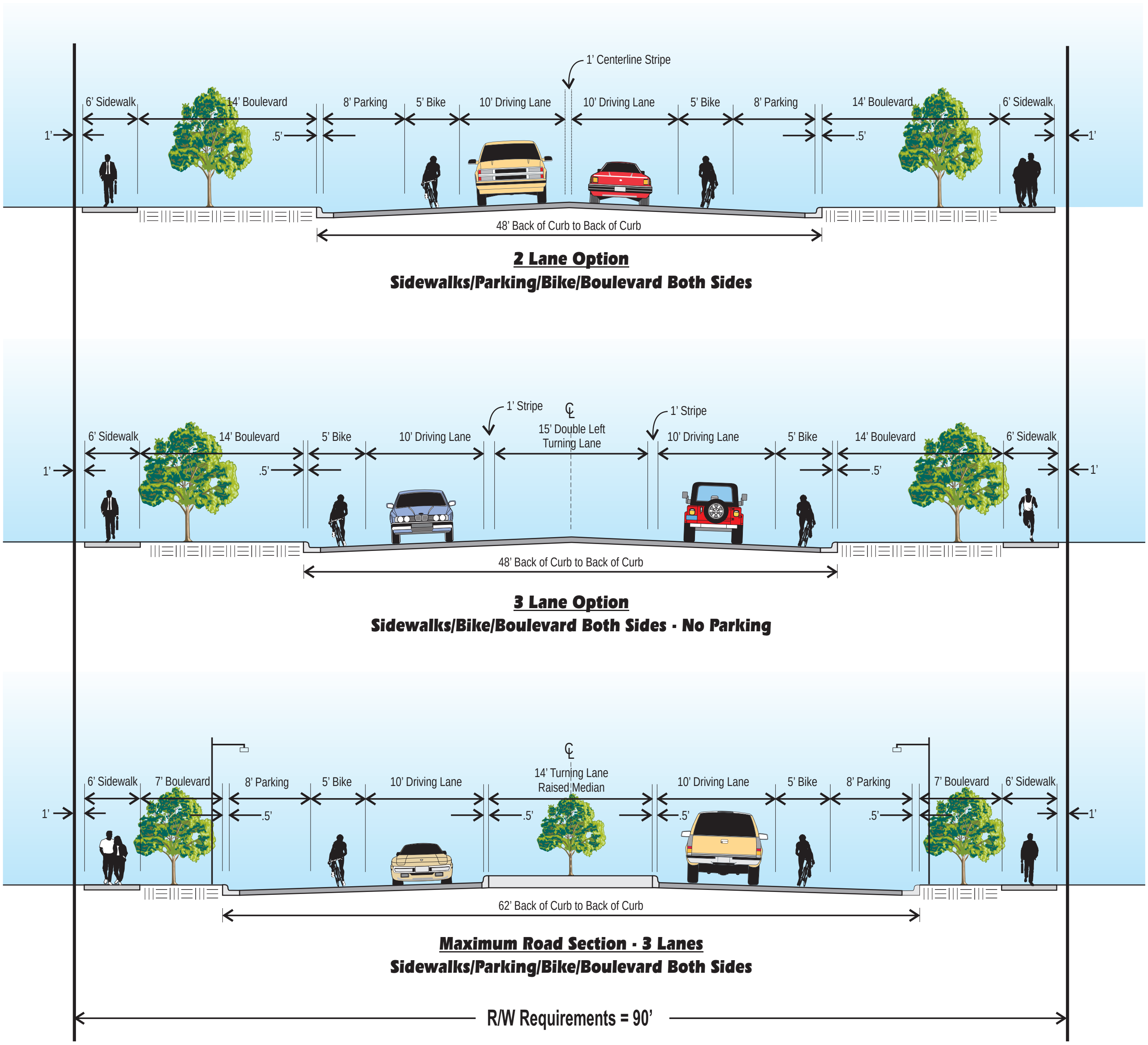
**Suggested Local Street Standards**
**Figure 9-13**




*Not To Scale*

## NOTES:

- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.
- MDT routes will need to meet MDT Urban Design Standards which may not be represented in this graphic.

**Minimum Features:**

- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Both Sides
- Boulevards - Both Sides
- Parking - Both Sides (Where Parking is Provided)

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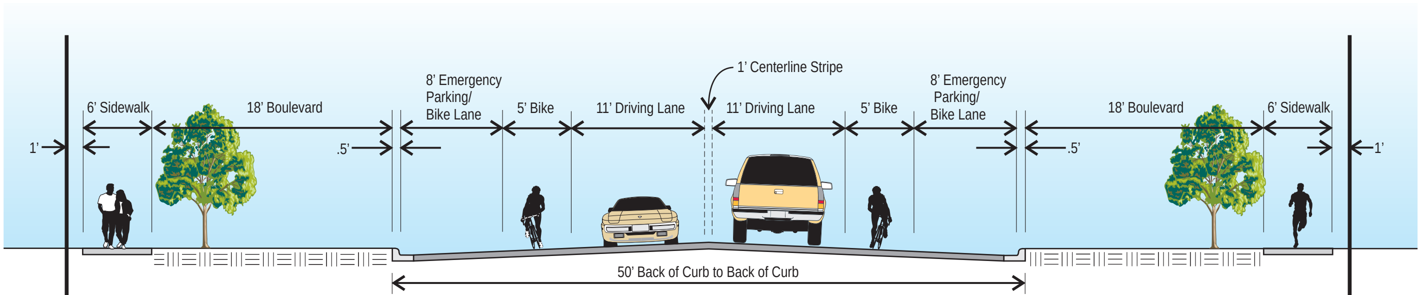
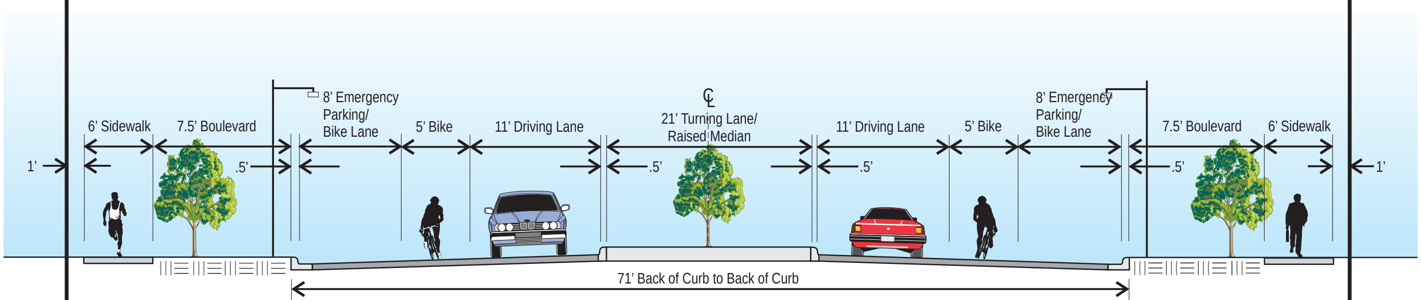
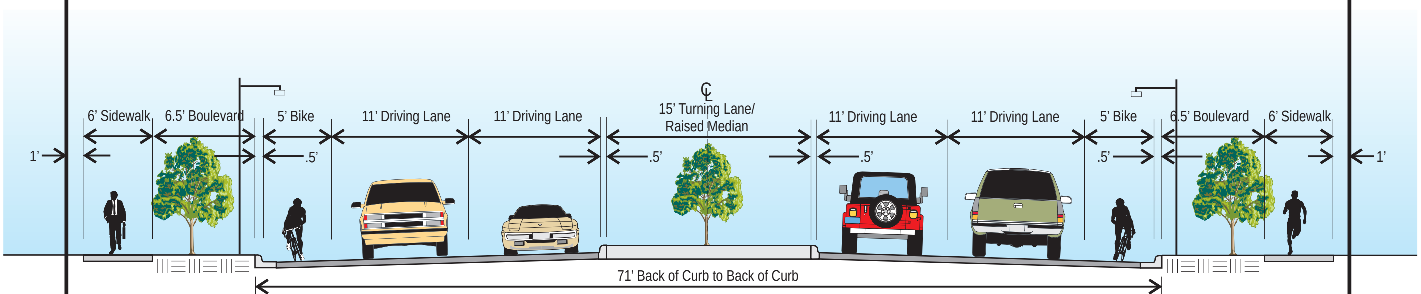
# Recommended Collector Street Standards
# Figure 9-14




**2 Lane Option**
**Sidewalks/Parking/Bike/Boulevard Both Sides/No Parking**




**3 Lanes Option**
**Sidewalks/Parking/Bike/Boulevard Both Sides/No Parking**
**(Double Fronting Lots)**




**Maximum Roadway Section - 5 Lanes**
**Sidewalks/Bike/Boulevard Both Sides - No Parking**

**R/W Requirements = 100'**

*Not To Scale*

**NOTES:**

- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.
- MDT routes will need to meet MDT Urban Design Standards which may not be represented in this graphic.

**Minimum Features:**
- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Both Sides
- Boulevards - Both Sides
- Emergency Parking/ Bike Lane - Both Sides

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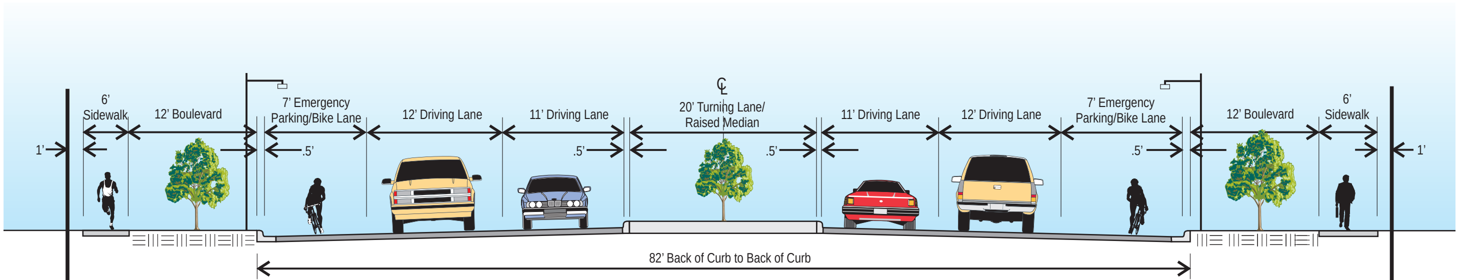
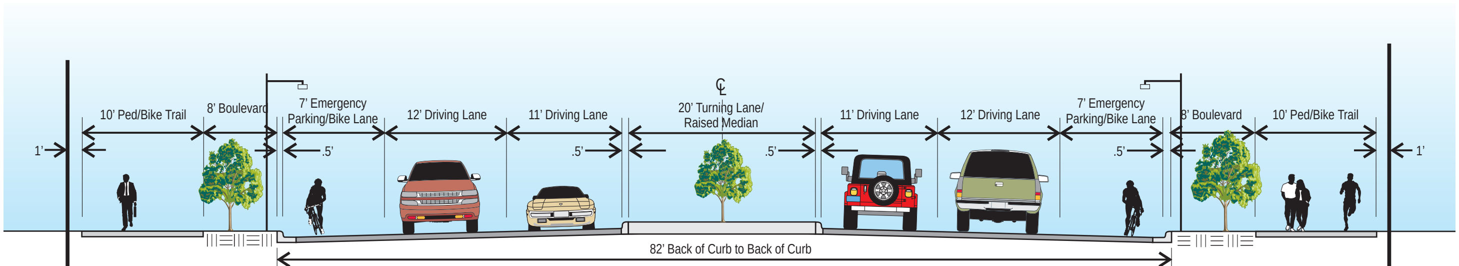
## Recommended Minor Arterial Street Standards
## Figure 9-15




**Maximum Roadway Section - 5 lanes**
**Sidewalks/Bike/Boulevard Both Sides - No Parking**

R/W Requirements = 120'

*Not To Scale*




**Maximum Roadway Section - 5 lanes**
**Sidewalks/Bike/Boulevard Both Sides - No Parking**

R/W Requirements = 120'

*Not To Scale*

**Minimum Features:**
- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Both Sides
- Boulevards - Both Sides
- Emergency Parking/Bike Lanes - Both Sides

## NOTES:
- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.
- MDT routes will need to meet MDT Urban Design Standards which may not be represented in this graphic.

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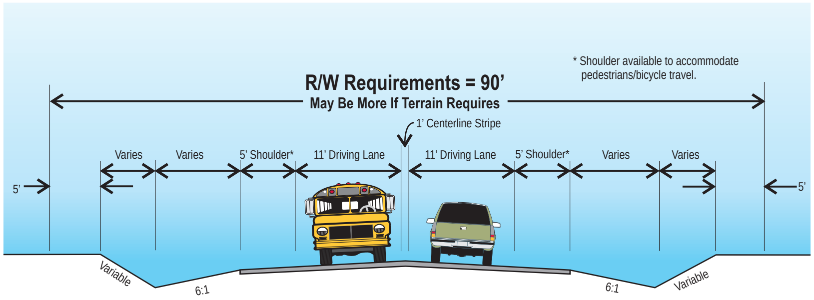
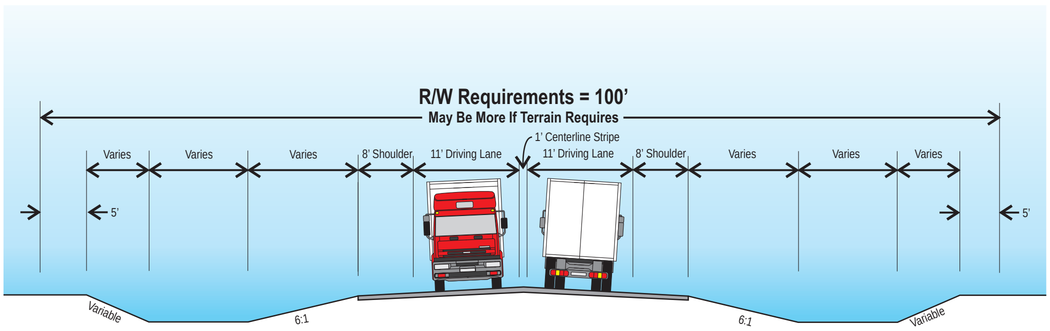
# Recommended Principal Arterial Street Standards
# Figure 9-16

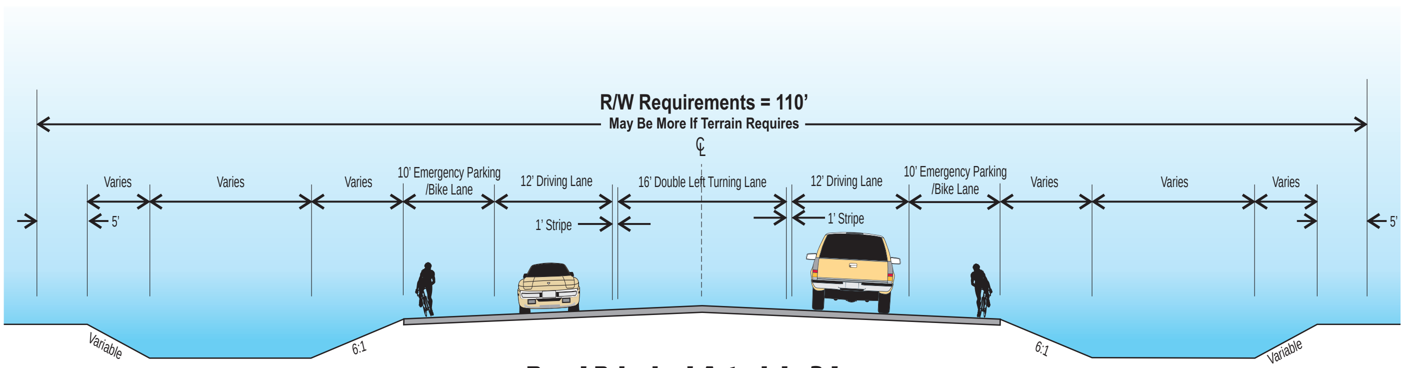
NOTE: Recommended Rural Street Standards are future visions for the County's rural roadway system. They do not match the currently utilized roadway geometrics as per the Gallatin County Subdivision Regulations.




**Rural Collector - 2 Lanes**




**Rural Minor Arterial - 2 Lanes**




**Rural Principal Arterial - 3 Lanes**

| Minimum Paving & Street Width Standards * | | |
|---|---|---|
| ADT | Finished Gravel Width | Minimum Paving Width |
| Non-Mountainous Terrain | | |
| 8 | 24' | 22' |
| 16 | 24' | 22' |
| 24 | 24' | 22' |
| 32-99 | 26' | 24' |
| 100+ | 26' | 24' |
| Major Collectors & Arterials | 30' | 28' |
| Mountainous Terrain | | |
| 8-40 | 24' | 22' |
| 41-99 | 26' | 24' |
| 100+ | 24' | 24' |
| Major Collectors & Arterials | 30' | 28' |

* As per Gallatin County Subdivision Regulations

*Not To Scale*

## NOTES:

- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.

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## Recommended Rural Street Standards
## Figure 9-17

## 9.7 PEDESTRIAN AND BICYCLE DESIGN GUIDELINES

The design of pedestrian and bicycle infrastructure is governed by many local, state, and federal standard documents. In the Bozeman area, these documents include the Montana Public Works Standard Specifications, the Bozeman Modifications to the Montana Public Works Standard Specifications, the Manual of Uniform Traffic Control Devices, the AASHTO Guide for the Development of Bicycle and Pedestrian Facilities, the City of Bozeman Design Standards and Specification Policy, and the Americans with Disabilities Act Access Board (ADAAG) Guidelines. This section provides additional guidance that could benefit the Bozeman area with some found in the above standards, and some experimental.

### 9.7.1 Pedestrian Facilities

The design of the pedestrian environment will directly affect the degree to which people enjoy the walking experience. If designed appropriately, the walking environment will not only serve the people who currently walk, but also be inviting for those who may consider walking in the future. Therefore, when considering the appropriate design of a certain location, designers should not just consider existing pedestrian use, but how the design will influence and increase walking in the future. Additionally, designers must consider the various levels of walking abilities and local, state, and federal accessibility requirements. Although these types of requirements were specifically developed for people with walking challenges, their use will result in pedestrian facilities that benefit all people.

#### Crosswalks

Crosswalks are a critical element of the pedestrian network. It is of little use to have a complete sidewalk system if pedestrians cannot safely and conveniently cross intersecting streets. Safe crosswalks support other transportation modes as well. Transit riders, motorists, and bicyclists all may need to cross the street as pedestrians at some point in their trip.

*Frequency*

In general, whatever their mode, people will not travel out of direction unless it is necessary. This behavior is observed in pedestrians, who will cross the street wherever they feel it is convenient. The distance between comfortable opportunities to cross a street should be related to the frequency of uses along the street that generate crossings (shops, high pedestrian use areas, etc.). In areas with many such generators, like high pedestrian use areas, opportunities to cross should be very frequent. In areas where generators are less frequent, good crossing opportunities may also be provided with less frequency.

| Where | Generally not further apart than | Generally not closer together than |
|---|---|---|
| High Pedestrian Use Areas | 200 – 300 feet (60-90 m) Where blocks are longer than 400 feet (120 m) | 150 feet (45 m) |
| Local Street Walkways and Low Pedestrian Use Areas | Varies, based on adjacent uses. Do not prohibit crossing for more than 400 feet (120 m) | 150 feet (45 m) |

*Crosswalk Pavement Markings*

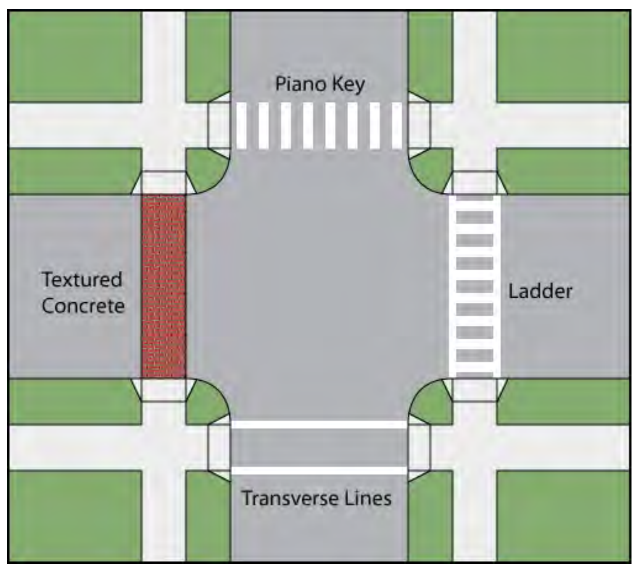
Marked crosswalks indicate to pedestrians the appropriate route across traffic, facilitate crossing by the visually impaired, and remind turning drivers of potential conflicts with pedestrians. Crosswalk pavement markings should generally be located to align with the through pedestrian zone of the sidewalk corridor.

Marked crosswalks should be used:

- At **signalized intersections**, all crosswalks should be marked.
- At **unsignalized intersections**, crosswalks should be marked when they
  - help orient pedestrians in finding their way across a complex intersection, or
  - help show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts, or
  - help position pedestrians where they can best be seen by oncoming traffic.

There are three common types of crosswalk striping currently used in the United States including the Piano Key, the Ladder, and the standard Transverse crosswalk. Of these, the Piano Key and the Transverse Lines crossings are typically used in Montana. Other types of textured or colored concrete surfacing may be used in appropriate locations where it helps establish a sense of place such as shopping centers and downtown Bozeman.

Ladder or piano key crosswalk markings are considered 'high-visibility' markings and are recommended for most crosswalks in the Bozeman area where heavy pedestrian traffic exists, including school crossings, across arterial streets at pedestrian-only signals, at mid-block crosswalks, and where the crosswalk crosses a street not controlled by signals or stop signs. A piano key pavement marking consists of 2-ft (610 mm) wide bars spaced 2-ft apart and should be located such that the wheels of vehicles pass between the white stripes. A ladder pavement marking consists of 2-ft (610 mm) wide bars spaced 2-ft apart and located between 1-ft wide parallel stripes that are 10-ft apart.




## Curb Extensions

Curb extensions (sometimes called curb bulbs or bulb-outs) have many benefits for pedestrians. They shorten the crossing distance, provide additional space at the corner (simplifying the placement of elements like curb ramps), and allow pedestrians to see and be seen before entering the crosswalk. Curb extensions can also provide an area for accessible transit stops and other pedestrian amenities and street furnishings.

Curb extensions may be useful for local or collector roadways and may be used at any corner location, or at any mid-block location where there is a marked crosswalk, provided there is a parking lane into which the curb may be extended. Curb extensions are not generally used where there is no parking lane because of the potential hazard to bicycle travel. Under no circumstances should a curb extension block a bike lane if one exists.

In high pedestrian use areas such as downtown Bozeman, curb extensions are a preferred element for corner reconstruction except where there are extenuating design considerations such as the turning radius of the design vehicle, or transit and on-street parking factors.

Curb extensions can be compatible with snow removal operations provided that they are visibly marked for crews. Where drainage is an issue, curb extensions can be designed with storm drain inlets, or pass through channels for water.

## Refuge Islands

Refuge islands allow pedestrians to cross one segment of the street to a relatively safe location out of the travel lanes, and then continue across the next segment in a separate gap. At unsignalized crosswalks on a two-way street, a median refuge island allows the crossing pedestrian to tackle each direction of traffic separately. This can significantly reduce the time a pedestrian must wait for an adequate gap in the traffic stream.

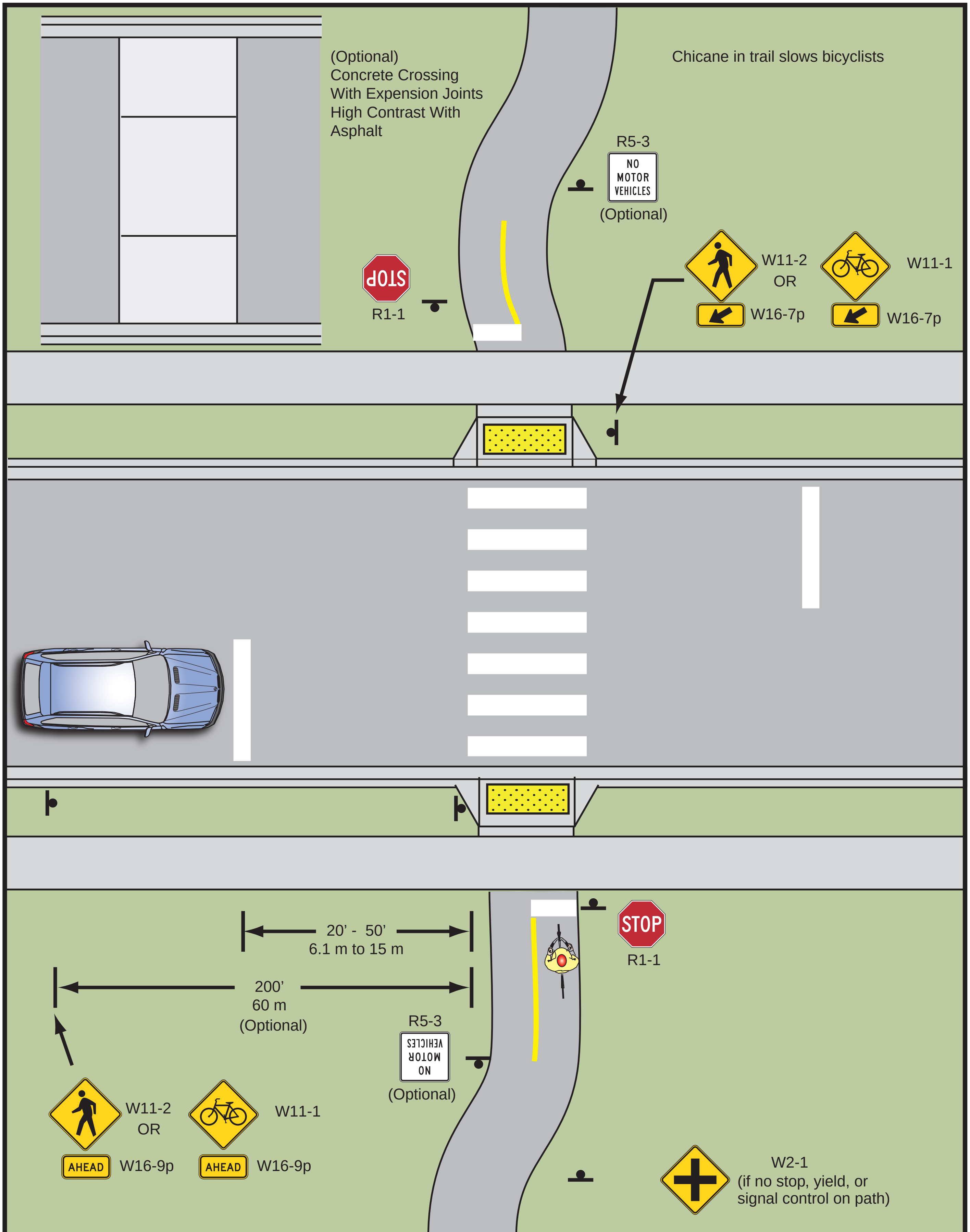
## Mid-Block Crossings

Mid-block crossings are installed where there is a significant demand for crossing and no nearby existing crosswalks. Within the Study Area there are numerous stream corridors traveling mainly south to north. These corridors have been well utilized by developers and support numerous trail systems, which nearly always require mid-block crossings to be continuous. Currently, the treatments employed for the existing crossings vary street to street with varying levels of accommodation and visibility. This section will dictate design of future mid-block crossings in the Bozeman area for consistency. In general, because these crossings are not at existing intersections they should be designed for a high level of visibility through appropriate signage, lighting, and high-contrast pavement markings and treatments.

### *Local Streets*

Local roadways are the most common location for midblock crossings currently found in the Bozeman area. Mid-block crossings should use high visibility crosswalk markings either as a concrete pad contrasting with the asphalt or as a ladder or piano key crossing using thermoplastic markings for durability. Six-inch vehicle stop lines should be placed 20 feet in advance of the crossing with MUTCD W11-2 signage at the crossing. Higher volume local streets may need a second warning sign in advance of the crossing. On-street parking should be prohibited within 40 feet of the crossing, and if being constructed as part of a new roadway, curb extensions should be considered where parking is allowed to shorten the crossing distance.

Mid-block crossings of collector and arterial streets are strongly discouraged, but may be considered in unique situations where adequate warning and protection are provided.




***Mid-Block Trail Crossing - Local Streets***
***Figure 9-18***

alta PLANNING + DESIGN

### 9.7.2 Bicycle Facilities

Similar to pedestrian facilities, the overall safety and usability of the bicycle network lies in the details of design. The following guidelines provide useful design considerations that fill in the gaps from the standard manuals such as the MUTCD and the AASHTO Guide for the Development of Bicycle Facilities.

**Shared-Use Paths / Bike Paths**

Facilitates two-way off-street bicycle and pedestrian traffic, which also may be used by skaters, wheelchair users, joggers and other non-motorized users. These facilities are frequently found in parks, and in greenbelts, or along rivers, railroads, or utility corridors where there are few conflicts with motorized vehicles. Shared use facilities can also include amenities such as lighting, signage, and fencing (where appropriate). In Montana, design of Shared use facilities should follow guidance in the AASHTO Guide for the Development of Bicycle Facilities. For non-paved shared-use facilities, see trail standards in the Bozeman Parks, Recreation, Open Space and Trails Plan (PROST) or the Gallatin Valley Trails Plan.

*General Design Practices:*

Shared-use paths can provide a good facility, particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. Shared-use paths should generally provide directional travel opportunities not provided by existing roadways. Some of the elements that enhance off-street path design include:

- Implementing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use;
- Placing adequate signage for cyclists including stop signs at trail crossings and directional signs to direct users to and from the path;
- Building to a standard high enough to allow heavy maintenance equipment to use the path without causing it to deteriorate;
- Limiting the number of at-grade crossings with streets or driveways;
- Terminating the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street. Poorly designed paths can put pedestrians and cyclists in a position where motor vehicle drivers do not expect them when the path joins the street system.

Both the Federal Highway Administration and the AASHTO Guide for the Development of Bicycle Facilities generally recommend against the development of shared-use paths directly adjacent to roadways. Also, known as "sidepaths" these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in bicyclists going against traffic when either entering or exiting the path. This can also result in an unsafe situation where motorists entering or crossing the roadway at intersections and driveways do not notice bicyclists coming from their right, as they are not expecting traffic coming from that direction. Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may frequently block path crossings. Even bicyclists coming from the left may also go unnoticed, especially when sight distances are poor. Because of these operational challenges, sidepaths should be provided on both sides of the roadway to reduce the numbers of bicyclists travelling against vehicle traffic.

Shared-use paths may be considered along roadways under the following conditions:

- The path will generally be separated from all motor vehicle traffic.
- Bicycle and pedestrian use is anticipated to be high.
- In order to provide continue an existing path through a roadway corridor.
- The path can be terminated at each end onto streets with good bicycle and pedestrian facilities, or onto another safe, well-designed path.
- There is adequate access to local cross-streets and other facilities along the route.
- Any needed grade separation structures do not add substantial out-of-direction travel.
- The total cost of providing the proposed path is proportionate to the need.
- The paths are provided on both sides of the roadway.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, many stop riding on paths placed adjacent to roadways. Bicyclists may also tend to prefer the roadway a pedestrian traffic on the Multi-use path increases due to its location next to an urban roadway. When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bicycle lane width on the roadway, as the on-street bicycle facility will generally be superior to the "sidepath" for experienced cyclists and those who are cycling for transportation purposes. In fact, bicycle lanes should be provided as an alternate (more transportation-oriented) facility whenever possible.

*At Grade Crossings*

When a grade-separated crossing cannot be provided, the optimum at-grade crossing has either light traffic or a traffic signal that trail users can activate. If a signal is provided, signal loop detectors may be placed in the shared-use path pavement to detect bicycles. This feature can be combined with or replaced by a pedestrian-actuated button provided (placed such that cyclists can press it without dismounting.) At unsignalized crossings, a trail sized stop sign (R1-1) or yield sign (R1-2) should be placed about 5 feet before the intersection with an accompanying stop line. Direction flow should be treated either with physical separation or a centerline approaching the intersection for the last 100 feet. Additional design considerations can slow bicyclists as they approach the crossing include chicanes, bollards, and pavement markings.

If the street is above four or more lanes or two/three lanes without adequate gaps, a median refuge should be considered in the middle of the street crossed. The refuge should be 8 feet at a minimum, 10 feet is desired. Another potential design option for street crossings is to slow motor vehicle traffic approaching the crossing through such techniques as speed bumps in advance of the crossing, or a painted or textured crosswalk.

*Grade Separated Crossings*

When the decision to construct an off-street multi-use path has been made, grade separation should be considered for all crossings of major thoroughfares. At-grade crossings introduce conflict points. The greatest conflicts occur where paths cross roadway driveways or entrance and exit ramps. Motor vehicle drivers using these ramps are seeking opportunities to merge with other motor vehicles; they are not expecting bicyclists and pedestrians to appear at these locations. However, grade-separated crossings should minimize the burden for the user, and not, for example, require a steep uphill and/or winding climb.

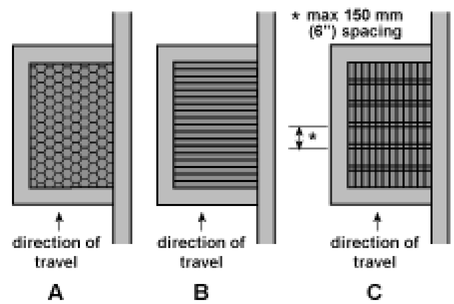
In the Bozeman Area, the preferred type of grade-separated crossing is an undercrossing due to weather and visual considerations. Several currently exist in the area in Four Corners and Gallatin Gateway. Undercrossings should be lighted if in high use areas or if longer than 75 feet in length. Groundwater infiltration may be a significant issue and should be considered early in the decision making process when any undercrossing is considered.

## Bike Lanes

Bike lanes are defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bicycle lanes are generally found on major arterial and collector roadways and are 4-6 feet wide. Bike lanes should be constructed in accordance with the recommended roadway typical sections in this chapter and should be designed following AASHTO guidelines.

*Additional Considerations*

Drainage grates located within bike lanes can often be hazardous to bicyclists. Drainage grates with large slits can catch bicycle tires and cause a crash. Poorly placed drainage grates may also be hazardous, and can cause bicyclists to veer into the auto travel lane to avoid them. Sometimes, resurfacing projects result in a vertical lip surrounding a drainage grate. Such abrupt changes can jar a cyclist and cause a crash. Resurfacing projects should taper the pavement to the drainage grate or other relevant utility access point.

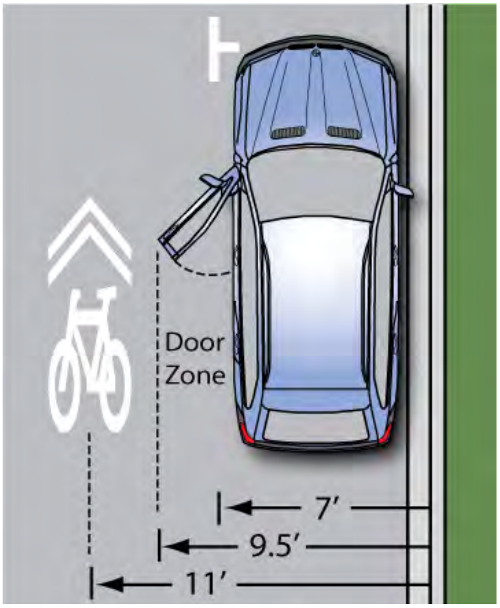



Bicycle-Friendly Drainage Grates

*Bicycle Friendly Rumble Strips*

Rumble Strips can hamper bicycling by presenting obstacles through trapped debris on the far right of the road shoulder and the rumble strip to the left. Consequently, special care needs to be exercised for bicyclists when this treatment for motorist safety is planned and built, with a robust maintenance schedule put into place. The rumble strip design and placement are also important; placing the rumble strip as close to the fog line as possible leave the maximum shoulder area available for cyclists. Certain rumble strip designs are safer for bicyclists to cross, and still provide the desired warning effect for motorists.

The Federal Highway Administration performed a study on the design of rumble strips in 2000 reviewing different techniques of installation and studies performed by ten state DOTs from the point of view of motorists and bicyclists. Based on the information provided in the FHWA study, the recommended design for a rumble strip should be of a milled design rather than rolled that is 1 foot (300mm) wide with 5/16 ± 1/16 in (8 ± 1.5 mm) in depth. Rumble strips are recommended to be installed only on roadways with shoulders in excess of 5 feet (1.5 m). A shallow depth of the milled portions of the rumble strips are preferred by bicyclists. Since the roadway shoulder can become cluttered with debris it is recommended to include a skip (or gap) in the rumble strip to allow bicyclists to cross from the shoulder to the travel lane when encountering debris. This skip pattern is recommended to be 12 feet (3.7 m) in length with intervals of 40 or 60 feet (12.2 or 18.3 m) between skips.




Recommended SLM placement.

**Shared Lane Markings (SLMs)**

Recently, Shared Lane Marking stencils (also called "Sharrows") have been introduced for use in the United States as an additional treatment for shared roadway facilities. The stencil can serve a number of purposes, such as making motorists aware of bicycles potentially in their lane, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to ride further from parked cars to reduce the risk of "dooring" collisions. Shared Lane Markings are expected to be included in the 2009 MUTCD and would be valuable additions to the proposed bicycle boulevards in **Chapter 5**.