Chapter 9

GRADE SEPARATIONS & INTERCHANGES
9.1  GENERAL INFORMATION

There are three types of roadway intersections: intersections at-grade, grade separations without ramps, and interchanges. Each type has specific characteristics and applications. Each is appropriate to use in the proper context. Using an inappropriate solution for a specific context can lead to serious safety and operational issues. This chapter discusses both general considerations and specific design features for interchange and grade separation facilities.

Interchanges require major investments and may have significant impact on the natural and built environments. They are the key elements of well functioning access controlled facilities.

The decision to use an interchange as a transportation solution requires careful and complete study, including traffic analysis, geometric design, and environmental impacts. To work properly, an interchange needs to fit into the context of the roadway system, the surrounding area, and be supported by an adequate network of local facilities. Existing interchanges typically have operational and safety issues to consider. Common problem area at interchanges include: close spacing to adjacent interchanges, inadequate speed change areas, inadequate storage for queued traffic, crossroads that have deficient capacity, tight geometry that restricts sight lines or operations, and weaving areas on the mainline.

Close interchange spacing is often a root cause of speed change and weaving issues. Solutions for these types of problems are commonly expensive and difficult to implement. Existing facilities normally can't avoid these problems, unless there is a willingness to remove an interchange (although the grade separation structure may remain). When new interchanges are considered, designers and planners need to adhere to the spacing guidelines in this chapter. Adding frontage roads and grade separations without ramps often helps to maintain or improve the local road network around the interchange.

Particularly during planning efforts, it is important to not default to minimum design values. This often leads to complicated and expensive added features being necessary later on. When working in fully developed areas, this may be unavoidable. - it is often infeasible to provide full standards in design. Designers should always look for opportunities, however, to provide as many incremental improvements as possible within the context of the work. Where greater uncertainty exists, planning for future needs should always allow for as much flexibility as is reasonable.

9.1.1  WARRANTS FOR INTERCHANGES AND GRADE SEPARATIONS

Interchanges are integral features of freeways and are adaptable for solving safety, operational, and traffic congestion problems on other types of facilities provided that adequate access management features are present. They can vary from single ramps connecting between local facilities and arterials to large and complex arrangements connecting two or more highways or
freeways. Grade separations without ramps are also integral features on freeways, and can provide significant system benefits to other facilities.

Since a wide variety of factors come into play at each location, specific warrants for justifying an interchange cannot be conclusively stated. There are several conditions that need to be considered when making a decision whether to use an interchange as a transportation solution. These include:

- Design Designation – Fully Access Controlled Facilities, e.g.
- Reduction of Bottlenecks or Congestion
- Reduction of Crash Frequency and Severity
- Site Topography
- Traffic Volume
- Road User Benefits – Cost of Delays and Congestion, e.g.

Chapter 10 of the AASHTO “Policy on Geometric Design of Highways and Streets – 2011”, page 10-4 to 10-6 has a detailed discussion on things to consider for each interchange warrant. Additional warrants pertaining to grade separations are also located in that section.

### 9.1.2 INTERCHANGE SPACING

Table 9-1 shows the access spacing standards for interchanges for freeway and non-freeway locations. The spacing shown is measured crossroad to crossroad centerline distance. Other access management spacing standards such as the distance between the ramp terminal and the first approach or first full intersection, and the distance between start and end of tapers of adjacent interchanges need to comply with the Oregon Highway Plan (OHP) and Oregon Administrative Rules (OAR) Chapter 734-051 spacing standards or obtain a spacing deviation from the Region Access Management Engineer.

**Table 9-1: Freeway and Non-Freeway Interchange Spacing**

<table>
<thead>
<tr>
<th>Access Management Classification</th>
<th>Area</th>
<th>Interchange Spacing</th>
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<tbody>
<tr>
<td>Freeways</td>
<td>Urban</td>
<td>3 miles</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>6 miles</td>
</tr>
<tr>
<td>Interstate and Non-Interstate</td>
<td>Urban</td>
<td>3 miles</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>6 miles</td>
</tr>
<tr>
<td>Non-Freeways</td>
<td>Urban</td>
<td>1.9 miles</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>3 miles</td>
</tr>
</tbody>
</table>

Expressways, Statewide, Regional, and District Highways
NOTE:

1. A design exception is required if interchange spacing standards are not met for new interchanges. Existing interchanges that do not meet current spacing standards do not require a design exception, but are subject to access spacing deviation requirements (explained in OAR Chapter 734, Division 51).

2. Spacing distance is measured from crossroad to crossroad.

3. Spacing between grade separations is not a design exception, unless plans call for adding ramps in the future. Interchange and ramp spacing criteria apply in those situations.

9.1.3 ACCESS CONTROL AT INTERCHANGES

Complete restriction of access must be obtained in the interchange area consistent with the following:

1. At all rural and suburban/urban fringe area interchanges, access shall be controlled a minimum distance of 1320 feet from the centerline of the ramp. The access control shall be applied equally to both sides of the crossroad. No reservations of access should be allowed within these access controlled areas. No private access should be allowed across from the interchange ramp terminal.

2. All other urban interchange areas should also be access controlled for 1320 feet from the centerline of the ramp. In many existing urban interchange environments however, this distance will be very difficult to achieve due to the built up environment surrounding the interchange. In these situations, the crossroad shall be controlled for a minimum distance of 750 feet. This controlled section applies equally to both sides of the crossroad and shall not include any reservations of access. No private access should be allowed across from the interchange ramp terminal.

Exceptions from the above have been developed through a deviation process associated with interchange access management area planning. OAR Chapter 734-051 provides information and rules involving access management for road connections to state highways. Potential justifications for not obtaining the minimum access control may include but are not limited to:

1. The cost of obtaining the access rights far exceeds the benefits.

2. Existing development patterns make it difficult and costly to provide alternative access routes such as frontage roads, combined access, or completing local roadway networks.

3. Topographical constraints make it impractical to achieve the desired spacings.

Exceptions from the access control standards for new interchanges will generally not be approved. In these situations, the standards should be achievable at a reasonable cost and impact. Only extreme cost or environmental impacts may justify an exception. Substantial inability to meet access criteria may in itself be sufficient reason to dismiss a new interchange alternative.
Additional guidance on controlling access at interchanges can be found in the Oregon Highway Plan and OAR Chapter 734-051.

9.1.4 TRAFFIC STUDIES

Appropriate levels of traffic analysis are necessary for decision making and design on interchanges. This is the case regardless of the type of work (new construction or upgrading/modifying existing facilities). Traffic studies should be requested as early in the development of the design as possible, and the appropriate level of analysis detail determined at that time. Typical requests for analysis include peak hour volumes, turning movements, capacity (Volume/Capacity ratios), storage lengths and levels of service. Analysis for weaving sections, storage lengths, and spacing should also be done as needed. Analysis shall be considered on the basis of a 20-year design life after construction of the project.

9.1.5 DESIGN REVIEWS AND APPROVALS

Prior to the location and design stage, ODOT and FHWA approval must be obtained for the reconstruction, reconfiguration, adding an interchange, or adding new access points to an existing interchange on the Interstate system. The approval procedures are processed through the Roadway Engineering Unit in Technical Services. Justification for new or modified access is based on a number of factors, including roadway system analysis, traffic studies, interchange spacing, cost/benefit ratio, etc. The following documents provide the basis of interchange planning and design process:

1. AASHTO “A Policy on Geometric Design of Highways and Streets - 2011”
2. AASHTO “A Policy on Design Standards-Interstate System - 2005”
3. FHWA Policy Statement on Additional Interchanges to the Interstate System – August 27, 2009 Revision
5. Oregon Administrative Rules (OAR) Chapter 734, Division 51.

New or modified interchanges on non-Interstate facilities do not require FHWA approval. These proposals do require coordination between Region Technical Center design staff and Traffic-Roadway Section Interchange Engineers.

9.1.6 STANDARD INTERCHANGE LAYOUT SHEETS

The proposed interchange design shall be documented on the Standard Interchange Layout Sheet by the Roadway Engineering Unit or authorized representative. It serves as the documentation of basic design features for the interchange. When existing interchanges are modified, updated layout sheets are developed to maintain that record.
Study copies of the "Standard Sheet" are submitted to the Roadway Section, Transportation Planning Analysis Unit (or Region Traffic), and the Region Bridge Section for approval. Depending on the level of interchange detail, FHWA approval is obtained at the Division Office for new or revised access on the Interstate System, except for Freeway to Freeway interchanges, which require consultation with FHWA Headquarters staff. Standard Layout Sheets are also developed for non-Interstate facilities – approval for those is internal to ODOT.

The Standard Sheet is normally developed by the Design Acceptance stage of project development, at least in draft form. Guidelines for preparation of Standard Sheets are available at the following link: (http://www.oregon.gov/ODOT/HWY/ENG SERVICES/Pages/interchange_design.aspx)

The approved design will be used for contract plans. If revisions are necessary, they must be made by the Engineer of Record, in consultation with the Roadway Engineering Unit, which will consult with the appropriate Technical Services Sections.
9.2 INTERCHANGE TYPES AND FORMS

Regardless of the type of facility, it is very important that the basic form of the interchanges fits the basic function it is expected to perform. Inappropriate applications can lead to early obsolescence and safety issues.

There are two basic types of interchanges – “System” and “Service”. System interchanges are those that connect two or more freeways. The focus here is on providing free flow and higher speed connections to facilitate mobility. System interchange examples in Oregon include: I-5/I-205 in Tualatin, I-84/I-82 near Hermiston, and I-5/I-105/OR 126 in Eugene-Springfield. Service interchanges connect freeways (or other expressways) to local facilities. Mobility is still an important function of service interchanges. The need to provide appropriate access to the local area, however, generally requires using at-grade intersections with crossroads. The majority of ODOT interchanges are service types.

Figure 9-1 illustrates basic system interchange forms. System interchanges are often complex and need to be customized to local conditions. Because of this, they may not fit exactly to the basic forms shown. ODOT has relatively few system interchanges on its facilities, and the majority of them are in the Portland Metro area.

Figure 9-2 illustrates basic service interchange forms. Figure 9-3 shows compact service forms. ODOT has not used the compact forms extensively, but they are considered proven concepts (when applied in the proper context).

In a few cases, system movements are provided within the confines of a service interchange, such as the I-5/Chemawa Rd/Salem Parkway and Canby/Charbonneau/Wilsonville-Hubbard Highway interchanges. A standard diamond interchange is “superimposed” over a directional Y (See Figure 9-4). For these types, additional care must be taken with respect to spacing between consecutive ramps, lane balance, guide signing, the length of speed change lanes, and providing for driver expectations. Each of these areas are discussed in more detail later in this chapter.

Non-freeway interchange forms are shown in Figure 9-5. These types of solutions are not appropriate for Interstates or other freeways.

Figure 9-6 shows interchange forms for specialized situations. ODOT has used the Trumpet form in a number of locations. It is suitable for connecting two highways as a low level system interchange, and as a service type. The Three-Level diamond is appropriate for connecting two limited access facilities, using a third level to handle turning movements through at-grade intersections, completely separate from thru moves. It too can serve as a low level system type connection. It may be adaptable in non-freeway situations where adequate access control is provided on both facilities.
Partial interchanges (1/2 diamond or “Y”) have sometimes been used in less developed areas to connect local roads or bypassed routes that have no access to other highways. These are limited applications, and usually consist of a pair of interchanges. Examples include: I-84 Exits 313/317 (Encina/Pleasant Valley) in Region 5, and I-5 Exits 76A & 76B (Wolf Creek) in Region 3. Partial interchanges tend to violate driver expectations, and thus can lead to operational problems, especially for unfamiliar users. Drivers using service interchanges expect to be able to exit and enter the highway at the same location. FHWA policy strongly discourages the use of partial interchanges on the Interstate. Less than “full movement” interchanges may be considered on a case-by-case basis for applications requiring special access for managed lanes (e.g. Transit, HOV or HOT lanes) or Park and Ride Lots. The same logic applies to non-Interstate facilities.

Each situation and context has its own characteristics, so it is not possible to say which interchange form is most appropriate for all situations. In general, it is best to avoid using configurations that require heavy left turn demands to go through standard signalized intersections. The exceptions to this are the Single Point and Diverging Diamond forms, where the left turns are handled in a way that works better with through traffic. Also, it is good practice to use the simplest interchange form that will meet expected demands. Driver expectancy is key – drivers should be presented with clear choices and the fewest number of decisions necessary to navigate the interchange (or series of interchanges).

Full cloverleaf interchanges have operational issues that can make their use problematic, even when Collector-Distributor (C-D) roads are used. The key problem is that loop ramps on the same side of the through roadway have significant safety and operational problems. Loop ramps generally have tight curvature (25 – 30 mph). The speed differentials between entering and exiting traffic combined with relatively short weaving/speed change lanes are a serious safety concern. C-D roads (discussed in detail in Section 9.3.6) can provide some limited benefits by removing the weaving and speed change maneuvers from the mainline. Traffic congestion on the C-D facility can reach levels where backups onto freeway mainlines occur – thus rendering the C-D facility obsolete. These issues make it preferable to use other interchange forms. There are cases where loop ramps on the same side of the crossroad work adequately. They are not configured as free-flowing ramps, but rather as “T” intersections in a Folded Diamond configuration.

A preliminary layout of guide signing is a very useful tool when comparing interchange alternatives. The sign plan may help to identify potential confusion points for drivers navigating the facility, and helps to show where design features might cause operational problems. A sign concept should be developed for each alternative considered during early stages of design.
Figure 9-1: Examples of System Interchange Forms
Figure 9-2: Common Service Interchange Forms
Figure 9-3: Examples of Compact Diamond Interchange Forms

EXAMPLE OF COMPACT DIAMOND INTERCHANGE FORMS

SINGLE POINT DIAMOND

SPLIT SINGLE POINT/ SPLIT TIGHT DIAMOND

TIGHT DIAMOND

DIVERGING DIAMOND

RAMP SPACING - 250'-400'
Figure 9-4: Directional Ramps with Diamond Interchange Superimposed
Figure 9-5: Non-Freeway Interchange Forms

NON-FREEWAY INTERCHANGE FORMS

SINGLE QUADRANT ("JUG HANDLE")

GRADE SEPARATED ROUNDBOUT

PARTIALLY GRADE SEPARATED INTERSECTION
Figure 9-6: Examples of Specialized Interchange Forms
9.3 GUIDING PRINCIPLES FOR INTERCHANGES

9.3.1 ROUTE CONTINUITY

The concept of Route Continuity refers to providing a clear directional path along the entire length of a designated route. Through drivers, especially those not familiar with a route should be provided with a continuous through path on which it is not necessary to change lanes to continue on that route. Applying this principle simplifies the driving task because it reduces lane changes and allows for simpler signing. It makes navigating unfamiliar routes easier and reduces the number of tasks drivers need to deal with at any given time. Operationally, fewer lane changes often results in reduced congestion on the main route.

Route continuity applies to entire systems of roadways, but the interchange (or series of interchanges) design features are used to provide for it. A practical aspect of route continuity is that interchange configurations and designs should not always favor heavier movements but rather the through route. Heavier movements can be accommodated with more generous geometry and reasonably direct connections and auxiliary lanes. The net result may be that an interchange that provides good route continuity requires more grade separating structures. The effects of poor route continuity are more pronounced when a route goes through an urban area or on a bypass, but they still apply in other contexts.

9.3.2 BASIC NUMBER OF LANES

A basic lane is simply a through travel lane that continues for a specified distance along a highway route. For example, an Interstate route has a minimum of four basic lanes (two in each direction) over its entire length. The basic number of lanes is maintained over a significant length of the route based on the capacity needs of that section. Localized variations in traffic volume, such as weaving areas between interchanges, do not change the basic number of lanes. These variations are handled by introducing auxiliary lanes (See Section 9.3.5 for discussion). It is very important in systems planning to identify the appropriate number of basic lanes and their logical termini. AASHTO’s “A Policy on Geometric Design of Highways and Streets -2011”, page 10-72 & 10-73, discusses the concept of Basic Number of Lanes It is closely associated with the ideas of Route Continuity and Lane Balance (which is discussed in Section 9.3.3).

When basic through lanes are suddenly added or dropped on a facility in an unexpected manner, it leads to confusion for users. Adding a basic lane is usually not problematic – it typically happens at major entrance ramps. Lane drops should be clearly visible to approaching users, preferably on flat horizontal alignment and grade. They should occur at places that make sense to drivers, and are as free as possible from other features that place
demands on drivers’ attention. Reductions in the basic number of lanes should only be done when overall traffic demand on the route drops significantly. Examples include the outer edge of a major metro area, a major system interchange, or a series of exits that remove sufficient demand so that the basic lane is no longer necessary. Figure 9-7 shows, in order of preference, typical configurations for dropping a basic lane.
BASIC LANE DROP HIERARCHY

PREFERENCE 1

* Taper

PREFERENCE 2

2000 ft to 3000 ft
300 ft
NORMAL ACCEL.

PREFERENCE 3

* Taper

500 ft to 1000 ft

PREFERENCE 4

* Taper

NOTE:
First preference is to drop the lane at a two lane exit, within the interchange.
Second is to drop the 2000 to 3000 ft beyond interchange allowing for adequate signing.
Third is to drop the lane at a single lane exit with an adequate recovery lane.
Fourth is to drop the lane at a single lane exit without a striped recovery lane (as in a lane drop for auxiliary lanes).
* - Use Speed Ratio Taper (between 70:1 & 50:1)
Pavement Marking shown is for illustrative purposes. Refer to ODOT Traffic Line Manual for appropriate markings.

Based upon information from AASHTO 2011, pg. 10-76 to 10-80

Figure 9-7: Freeway Lane Drops
9.3.3 LANE BALANCE

To realize efficient traffic operation through an interchange, there should be a balance in the number of traffic lanes on the highway and ramps. Design traffic volumes and capacity analysis determine the number of lanes to be used on the highway and on the ramps, but the number of lanes for some sections should be increased to ease operation from one roadway to another. Lane balance should be checked after the minimum number is determined for each roadway on the basis of the following principles:

1. The number of lanes beyond the merging of two traffic streams should not be less than the sum of all traffic lanes on the merging roadways minus one.

2. For entrance ramps bringing two lanes of traffic onto a highway, the road beyond the ramp entrance should be at least one lane wider than the road approaching the entrance. The parallel design for two lane entrance ramps shall be used. Any exception from this standard shall be approved by the State Traffic-Roadway Engineer. (See AASHTO’s “A Policy on Geometric Design of Highways and Streets - 2011 “, pages: 10-73 to 10-75 for additional information).

As a preliminary guide, the minimum distance between a freeway entrance and exit ramp at separate interchanges is one mile for urban freeways and two miles for rural freeway (see OAR Chapter 734-051 guidelines). The minimum distance between successive freeway entrance and exit ramp terminals is 1000 feet. The minimum distance for a single exit followed by a secondary exit or split is 800 feet. Exceptions from the standard spacing must be obtained from the State Traffic-Roadway Engineer. All exception requests should be reviewed by the Transportation Planning Analysis Unit, Region Traffic staff, or others designated to do the work to ensure the freeway and ramps will function acceptably.

Where the distance between an entrance terminal and an exit terminal is 2500 feet or less, the interim space generally becomes a weaving section and must be analyzed for required length and design by the Transportation Planning Analysis Unit, Regional Traffic staff, or others designated to do the appropriate analysis. Where the distance is 1500 feet or less, an auxiliary lane may help to smooth traffic flow and should be considered.

Collector-Distributor roads may be used to reduce traffic friction from multiple entrance and exit connections on the same side of the freeway, thereby permitting higher speeds on the through traffic lanes.

9.3.4 WEAVING SECTIONS

Weaving sections occur when entrance ramps are closely followed by exit ramps, and/or an auxiliary lane is utilized. Such areas present special design problems due to the concentrated lane changing maneuvers of merging and diverging traffic. The development of the design involves the following factors: desired mobility standard; length; number of lanes; traffic volumes; weaving and non-weaving vehicles; and average speed. Auxiliary lane lengths
generally will be below access management spacing standards and may require a deviation. Design guidance may be obtained from "Design Controls and Criteria, Chapter 2 of AASHTO’s “A Policy on Geometric Design of Highways and Streets – 2011" and from "Freeway Weaving” TRB #209, Highway Capacity Manual, Chapter 24.

The Transportation Planning Analysis Unit or Region Traffic staff shall be consulted for data and direction on the design of each weaving section and the location of consecutive entrance and exit ramps.

Figure 9-8 shows the terminal points for measuring the length of a weaving section.

9.3.5 AUXILIARY LANES

Auxiliary lanes are introduced adjacent to through lanes for limited distances for specific operational or capacity reasons. They are used to provide lane balance, facilitate weaving maneuvers, and help smooth out flow in through lanes. A typical application is to provide an added lane on the mainline between closely spaced interchanges.

Auxiliary lanes have the same width as through lanes. Shoulders adjacent to auxiliary lanes should be the same width as the remainder of the corridor (typically 10 feet or more), with a minimum width of eight feet (plus 2 feet if longitudinal barrier is present). Auxiliary lane drops at exits shall be configured according to the details in Figure 9-12.

9.3.6 COLLECTOR-DISTRIBUTOR (C-D) ROADS

C-D roads are introduced to freeway systems to eliminate weaving directly on mainline through lanes. They are physically separated from the through roadway and connect to it by way of slip ramps. They may be provided within a single interchange, between two adjacent interchanges, or even continuously between several interchanges of a freeway segment. Ramp connections occur on the C-D road, which then conveys traffic to the mainline lanes.

C-D roads are one-way facilities similar to frontage roads except that access to abutting property is not permitted. The design speed of the C-D can be less than the through roadway, although it’s preferred to keep that differential to no more than 10 mph. They may have single lane or more commonly, multi-lane configurations. Typical cross sections for C-D roads should, as a minimum, match the ODOT standard ramp dimensions as shown in Figure 9-22. The outer separation between edges of travelled way should be a minimum of 20 feet with an appropriate barrier separating the two roadways. Slip ramp connections to or from the through lanes are configured the same as any other exit or entrance ramp.
9.3.7 GRADE SEPARATION STRUCTURE CONSIDERATIONS

In all cases, interchange structures need to provide vertical clearance in accordance with Chapter 4 guidelines. They also need to provide for adequate sight lines. Particularly at depressed interchanges, structure elements often impair sight lines for traffic stopped at ramps. The appropriate sight lines to consider for design are usually based on Stopping Sight Distance, (SSD) or Intersection Sight Distance (ISD). The roadway context (urban or rural, higher or lower speed), type of intersection traffic control and geometry at the ramp intersections all need to be considered. Skewed ramp intersections and abrupt vertical curves can make it difficult to achieve sight distance goals. Shoulder widening or flaring the corners of structures may be needed to achieve SSD, so early coordination with structural designers is important. Use the “C” Table on Figure 9-17 as a guide for minimum requirements.

Although it is often appropriate to provide Intersection Sight Distance (ISD) at the intersections, this is sometimes difficult to achieve on existing facilities. When the ramp intersection is stop controlled, using ISD is the most appropriate treatment. Designers should refer to “A Policy on Geometric Design of Highways and Streets – 2011” - Sections 3.2 and 9.5 for guidance on selecting the most appropriate sight distance case to use. Designers should also consider using ISD at signal or roundabout controlled intersections. SSD for the design speed of the crossroad is the minimum to be provided in all cases – again in accordance with Figure 9-17.

Structure layout needs to consider future needs for both the through road and the crossroad. This normally means two things. First, the clear opening underneath the structure needs to accommodate the “ultimate” typical section envisioned for the facility (future lane additions, e.g.). Secondly, grades on the structure should also allow for future widening without restricting vertical clearance. It is also important to check sight lines on long flyover and viaduct structures. The combination of horizontal and vertical curvature and superelevation transitions can sometimes result in sight line limitations. Bridge rails can also limit sight lines. Geometric designers need to coordinate with structure designers to arrive at appropriate solutions, since it’s normally impractical to widen these structures to allow for added sight distance.

Refer to AASHTO’s “A Policy on Geometric Design of Highways and Streets – 2011” - Chapter 10 for detailed discussion on grade separation design.
### RECOMMENDED MINIMUM RAMP TERMINAL SPACING (ft.)

(BASED UPON OPERATIONAL EXPERIENCE AND NEED FOR FLEXIBILITY)

<table>
<thead>
<tr>
<th>ENTRANCE TO ENTRANCE EXIT TO EXIT</th>
<th>EXIT TO ENTRANCE</th>
<th>TURNING ROADWAYS</th>
<th>ENTRANCE TO EXIT (WEAVING)</th>
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<tr>
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<td><a href="image">Diagram</a></td>
<td><a href="image">Diagram</a></td>
<td><a href="image">Diagram</a></td>
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<thead>
<tr>
<th>GUIDELINES</th>
<th>FULL FREeway</th>
<th>C-D ROAD OR FWy. DIST.</th>
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<td>1200</td>
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<tr>
<td>ADEQUATE</td>
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<td>1000</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>1000</td>
<td>800</td>
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<th>GUIDELINES</th>
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<tbody>
<tr>
<td>GUIDELINES</td>
<td>SYSTEM INTCHG.</td>
<td>SERVICE INTCHG.</td>
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<td>1000</td>
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<td>2000</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>2000</td>
<td>1500</td>
</tr>
</tbody>
</table>

*RECOMMENDED: SHOULD BE CHECKED IN ACCORDANCE WITH PROCEDURE OUTLINED IN THE HIGHWAY CAPACITY MANUAL, 2001. (LARGER OF THE VALUES TO BE USED)*


FOR MINIMUM RAMP TERMINAL SPACING, SEE AASHTO, 2011, FIGURE 10-68, PAGE 10-106.

### TERMINAL POINTS FOR MEASURING LENGTH OF WEAVING SECTION

![Diagram](image)

**Projected Edge of Travelled Way (May Be in Curvature)**

**Weaving Length**

**Median**

**Exit Terminal**

**RAMP TERMINAL SPACING**

**HIGHWAY DESIGN MANUAL**

**Figure 9-8: Minimum Ramp Terminal Spacing**
9.4 COMMON ELEMENTS FOR INTERCHANGE DESIGN AND PLANNING

Several features and issues are common to all types of interchanges. These items are important to consider in all contexts. New or Existing facilities, Freeway or Non-Freeway, Urban, Rural or Transitional Areas - these features must be evaluated for all projects.

Common elements include:

- Clear Sight Lines (vertical & horizontal)
- Interchange Form – appropriate for traffic types and patterns
- Appropriate Horizontal/Vertical Geometry
- Adequate Speed Change Lanes
- Driver Expectancy/Positive Guidance – adequate perception/reaction distances for typical maneuvers – all exits/entrances to the right of through traffic
- Design Vehicle Offtracking
- Adequate Storage for Vehicle Queues
- Adequate Accommodation for Signing
- Long Range Planning Vision for the Interchange – including the crossroad facility

“Ideal” designs are typically not possible, especially in retrofit situations and in fully developed areas. In retrofit situations evaluating deficiencies and making tradeoffs is necessary. Designers must still consider the key features and how to make safety and operational improvements whenever possible. Tools such as the Highway Safety Manual and experienced senior staff are available to help in making these evaluations.
9.5 INTERCHANGE GEOMETRIC DESIGN

9.5.1 CROSSROAD DESIGN

The urban, rural, and intersection design chapters, Chapters 6, 7 and 8, discuss typical section elements for roadways. Refer to these chapters for the crossroad design. Crossroad design, including nearby intersections, is a significant part of the overall interchange, regardless of whose jurisdiction the road falls under. Deficient crossroads often create safety and operational concerns, such as vehicle queues extending back to freeway thru lanes on exit ramps. New interchange layouts need to provide good profiles, intersection design, and appropriate access management. Retrofit designs, especially in developed areas, need to carefully consider identified design and operational issues and make appropriate accommodation. Essential information for crossroad design includes: Traffic volumes and queue lengths, crash history and analysis, and clearly defined project goals.

9.5.2 RAMP DESIGN

Well planned and designed ramps are essential to the proper functioning of interchanges, which in turn are a key feature of well planned and designed access controlled highways. The principal thing to keep in mind when designing ramps is the concept of functional transitions. Ramps are the transition roadway between high speed, free flowing traffic and the local road system, and need to accommodate the various things drivers are dealing with at that point. Designs that require drivers to deal with too much information or maneuvering in a short time span will often have operational and safety problems.

Ramps consist of three discrete elements:

1. The Speed Change Area (including the gores).
2. The Main Transition Area (sometimes called the “Main Curve”, although it may be on tangent alignment).
3. The Terminal Area – which is in some ways an extension of the intersection with the crossroad.

Each discrete piece of the ramp has design features intended to accommodate typical things drivers are dealing with in that area. In cases where ramps connect two freeways in a System, the Terminal Area is typically a second Speed Change Area. When the HDM makes reference to Design Speed on ramps, it is referring to the Main Transition Area. Figure 9-9 illustrates the discrete elements of a typical ramp.
Figure 9-9: Discrete Areas of A Typical Ramp
Figure 9-10 illustrates examples of different types of ramps. Some types are only appropriate for non-freeway applications. Assuming adequate access control is in place, the other types can be adapted for non-freeway use as well.

Ramp designs need to provide flexibility for the future. This doesn’t mean over-designing, just making sure that there is flexibility to deal with changing needs. Providing additional deceleration length and at least 100' of tangent on the horizontal alignment between the main curve and the terminal curve will often help in this regard. Designing to bare minimums often leads to operational and safety issues. Another consideration is an interchange where future lanes may be added to the right. Ramp gores in these situations should be developed to fit the future condition so that the ramp itself would not have to be rebuilt. The interim condition will provide added speed change length.

Typical problem areas on ramps include: inadequate speed change length, insufficient storage for vehicles stopped on the ramp, inadequate or unsuitable intersections at the cross-road, obstructed sight lines, and deficient geometry. Each of these elements needs to be checked to make sure they will be adequate and appropriate for expected operations.

Geometry on existing ramps often can’t be significantly altered, but the basic functions of each portion need to be accommodated to the extent possible. Assuming that there are no significant geometric issues, as a minimum the speed change area shall be long enough for traffic to stop before reaching the end of vehicle queues in the terminal area. This means providing for deceleration to a complete stop from mainline operating speed. Vehicle queues on ramps are typically (but not always) at their greatest length during the mainline peak hour traffic, when thru speeds may be less than off-peak hours. During off-peak, queues may be much shorter, but deceleration needs are usually increased. Each location needs to be evaluated to determine the most appropriate condition to use for design. Designers need to evaluate other interchange features (such as sight lines) to make sure they aren’t compromised by using minimal solutions on ramps.

Ramp terminal intersection design and controls have a significant impact on the safety and efficiency of the entire interchange. If the ramp intersections are not able to manage the traffic demands at an appropriate level, it can quickly lead to queues building up on exit ramps and the crossroad. This can occur because of deficient geometric design or intersection controls that are inappropriate for the context. Geometric issues are normally easy to identify but sometimes difficult to correct, especially in more fully developed areas. Evaluation of the intersection controls should be done in a timely enough manners to be incorporated into project scoping efforts.
Figure 9-10: Ramp Types

- **Diamond / Diagonal**
- **Loop & Semidirect**
- **Outer Connection**
- **Flyover/Directional**
- **Braided Ramp**
- **Single Quadrant ("Jug Handle")**
  - Only used for non-freeway applications
9.5.3  DESIGN SPEED

Ramp design speed normally varies from 50% (minimum) to 85% (desirable) of the freeway speed, with the exception of loop ramps, which are usually designed to 25 or 30 mph. Design speed applies to the ramp proper and not to the terminals and speed change areas, which are relative to the speed of the highway involved. The design speed influences the horizontal and vertical curvature of the ramp, and the length of speed change lanes. Table 9-2 below can be used to determine the appropriate ramp design speed. Ramp capacity is also influenced by the design speed. (See Table 9-3).

Table 9-2: Ramp Design Speed

<table>
<thead>
<tr>
<th>Ramp Design Speed (mph)</th>
<th>Highway Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Desirable</td>
<td>45</td>
</tr>
<tr>
<td>Minimum</td>
<td>25</td>
</tr>
</tbody>
</table>

NOTE:

- Loop Ramp Design Speed shall not be less than 25 mph.
- * Loop ramps typically have a Design Speed less than 35 mph, but adequate speed change lanes always must be provided. See Figure 9-11 and Figure 9-12 for details.

Table 9-3: Single Lane Ramp Capacity

<table>
<thead>
<tr>
<th>LOS</th>
<th>Ramp Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 - 30</td>
</tr>
<tr>
<td>A</td>
<td>*</td>
</tr>
<tr>
<td>B</td>
<td>*</td>
</tr>
<tr>
<td>C</td>
<td>*</td>
</tr>
<tr>
<td>D</td>
<td>1200</td>
</tr>
<tr>
<td>E</td>
<td>1450</td>
</tr>
<tr>
<td>F</td>
<td>Variable</td>
</tr>
</tbody>
</table>

* Level of service not obtainable due to restricted design speed.
NOTE: For two lane ramps, multiply the values in the table by:

- 1.8 for 21 - 30 mph
- 1.9 for 31 - 40 mph
- 2.0 for 41 mph or over

9.5.4 SPEED CHANGE LANES

ODOT uses tapered type exit and parallel type entrance configurations. Tapered exits fit the direct path most drivers use during the exit maneuver, and give them a clear indication of the point where the exit departs from the through roadway. Parallel entrance ramps provide an added lane of sufficient length to aid in gap acceptance and merging. The actual merging maneuver is similar to changing lanes to the left. The gore area is the configured the same for all entrances. The length of the parallel portion varies to account for speed changing and the effects of longitudinal grades. Figure 9-11 & Figure 9-12 show the ODOT standard for ramp acceleration and deceleration lanes, and dimensions for gore areas. Information on making adjustments for grades is also shown on those two figures. Figure 9-13 shows the details for consecutive entrances at the same interchange (typical in partial cloverleaf interchanges). Figure 9-14 shows details for two lane parallel entrances.

The deceleration and acceleration characteristics of trucks are quite different from the normal passenger vehicle. When there is significant truck traffic (over 20 trucks with 4 or more axles per hour), the minimum deceleration design lengths for trucks should be consistent with Figure 9-12. Due to the longer acceleration requirements, it is normally not practical for acceleration lanes to be designed for significant numbers of large trucks. Instead, all types of vehicles should be considered in the design of interchange ramps. When significant truck traffic is present, as much parallel acceleration length as is reasonable should be added to the minimum values listed in Figure 9-11.

Standard gore area details are shown on Figure 9-11 and Figure 9-12, including minimum acceleration and deceleration lengths. Since gore areas (especially exit gores) are important decision points for drivers, their layout and dimensions can directly affect safety. Gores should present drivers with a clear and easily understood view of how to transition from the mainline to the ramp (or vice-versa). Non standard elements are not necessarily unsafe; many existing ramps have non-standard features and are not experiencing significant safety issues. Each situation needs to be evaluated for its potential effects on safety and operations and documented in a Design Exception.

Tradeoffs requiring non-standard features in gore design are unavoidable in some situations, even on new ramps. Examples of this include: exits on elevated structures, bridge columns in the gore, or tightly constrained urban facilities. In these types of situations, the key elements for helping drivers make safe transitions are the deceleration (or acceleration) distance, adequate room in the gore for impact attenuators (or traffic separators), and pavement cross slopes in the gore area. Non-standard features cannot compromise these elements. Refer to AASHTO “A Policy on Geometric Design of Highways and Streets” – Chapter 10 for more information on gore design.
ENTRANCE RAMP DETAILS

Figure 9-11: Entrance Ramp Details
Figure 9-12: Exit Ramp Details
Figure 9-13: Consecutive Entrance Ramps

**NOTES:**

1. HDM figure 9-22 shows this point to be a P.T. but due to lengthening caused by loop acceleration lane, this point will likely be a P.Q.T. This point is still considered the beginning of the acceleration lane.

2. See HDM Figure 9-22 for acceleration length.
TWO-LANE PARALLEL ENTRANCE RAMP DETAIL

285 ft

SEE TABLE "A"

300 ft

2000 TO 3000 feet

300 ft

TABLE "A"

<table>
<thead>
<tr>
<th>Design Speed of Turning Curve</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50 +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Curve Radius in feet</td>
<td>160</td>
<td>230</td>
<td>320</td>
<td>430</td>
<td>555</td>
<td>695</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Speed of Highway mph</th>
<th>TOTAL LENGTH OF ACCELERATION LANE (WITHOUT TAPER) Length in feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>540 540 540 540 540 540 540</td>
</tr>
<tr>
<td>50</td>
<td>550 540 540 540 540 540 540</td>
</tr>
<tr>
<td>60</td>
<td>780 670 560 540 540 540 540</td>
</tr>
<tr>
<td>70</td>
<td>1020 910 800 550 540 540 540</td>
</tr>
<tr>
<td>80</td>
<td>1220 1120 1000 770 690 540 540</td>
</tr>
</tbody>
</table>

* Where possible minimum length for design should be **750 ft**, this allows additional decision time for picking gaps.

NOTE: This is the standard two lane ramp configuration.

Figure 9-14: Two-Lane Parallel Entrance Ramp
9.5.5 HORIZONTAL ALIGNMENT

The main curve (the curve immediately following the exit taper or preceding the entrance taper) should conform to the desirable ramp design speed, with maximum degrees of curvature shown in Table 9-4. Variations of this will require adjustments to the exit taper or acceleration lane length. Ramps alignments use standard spiral lengths that are different from those used for open road design. See Figure 9-11 and Figure 9-12 for ramp spiral data. Ramp Terminal Curve spirals also have unique values, shown in Figure 9-19.

Table 9-4: Maximum Degree of Curvature and Sight Distance on Ramps

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Design Speed of Ramp (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Maximum Design Degree of Curvature</td>
<td>36°</td>
</tr>
<tr>
<td>Stopping Sight Distance (feet)</td>
<td>155</td>
</tr>
</tbody>
</table>

The layout of the interchange is influenced by the skew and horizontal alignment of the crossroad. The skew of the crossroad to the highway should be as close to 90 degrees as possible. The use of horizontal curves on either highway through the interchange should be avoided. However, there are numerous existing interchanges on ODOT highways that include horizontal curves. It is often not practical or necessary to remove these features, unless significant safety issues have been documented that relate directly to the curved alignment. Even in those cases, there are often alternatives for solving problems that don’t require major roadway realignments.

When one way, one-lane ramps exceed 1500 feet in length, consider adding a second lane to relieve congestion caused by slow moving or stalled vehicles. Steep grades and/or a high percentage of trucks may require an added lane on shorter ramps.

Typical horizontal exit and entrance details for the connection to the main highway can be found in Figure 9-11 and Figure 9-12. Ramp terminals are desirably perpendicular to the crossroad as shown on Figure 9-18. Various acceptable configurations for terminal area horizontal geometry are shown on Figure 9-19. Ramp terminal alignments that have spirals at one end only (the entering end on exit ramps and the trailing end on entrance ramps) do not require design exceptions. The first two Options are the most desirable, with Option 2 being common practice. Using Option 3 or Option 4 on Figure 9-19 is generally discouraged when developing new ramp alignments – contact the Roadway Engineering Unit for guidance.

Designers need to keep in mind that roadside barriers and bridge ends can create sight distance restrictions for the ramp intersections. The appropriate sight distance (Stopping or Intersection) application needs to be determined, each location needs to be evaluated to clearly identify and
prioritize problems and the potential solutions. Appendix J includes numerous design aids for fitting alignments. The Roadway Engineering Unit can provide guidance on the use of these design aids also.

Special treatments are used in cases where ramps connect to the mainline on curves. Figure 9-15 and Figure 9-16 provide guidance on developing curved ramp horizontal alignments. The intent of these configurations is to approximate the conditions where ramps merge or diverge on tangent alignments. Additional information is also located in Appendix J of this manual, where numerous specific cases and recommended configurations are shown. In many of these cases it is necessary to use spiral segments to deal with compound horizontal curves. Details on spiral segments are also presented in Appendix J.

Minimal horizontal alignment, especially on ramps, often has a negative impact on vertical alignment as well. Designers need to pay careful attention to the combined effects of horizontal and vertical geometry. In fully developed areas it is often infeasible to change the crossroad profile, but ramps may have more flexibility. A general discussion on horizontal alignments for roadways can be found in Section 3.3.1.
Figure 9-15: Entrance Ramps on Curves

**NOTES:**

1. Use same degree of curvature as mainline curve, the idea being to emulate a tangent condition for entire configuration.

2. Dimensions in gore areas on curved alignments should closely approximate those of tangent alignments. See Figure 9-11 for details.

**ENTRANCE RAMP ON OUTSIDE OF CURVE**

Additional Details for a variety of curved ramp situations are located in Appendix J of the HDM.

**ENTRANCE RAMP ON INSIDE OF CURVE**

NOTES:

1. Use the same degree of curvature as mainline curve. The theory being to emulate a tangent condition for the entire configuration.

2. Use spiral segment to join ramp curve to acceleration lane curve. The "A" value for entrance curve and acceleration curve preferably the greater. Entrance Angle is 2.5 degrees to the local tangent. Spiral segments are required to be used with successive curves in the same direction, as per HDM.

2012 ODOT Highway Design Manual
Grade Separations & Interchanges

§ 9.5 - Interchange Geometric Design

9-34
DETAIL OF EXIT RAMP ON CURVE

IDENTICAL CURVATURE

NOTES:

The theory behind this is to emulate a tangent condition for the entire configuration.

1. This angle is to be 4°15' to local tangent.
2. 'Tg' should emulate distance from takeoff to gore on tangent section (approximately 405 ft)

EXIT RAMP ON OUTSIDE OF CURVE

NOTES:

1. This angle is to be 4°15' to local tangent.
2. 'Ta' distance will be the 'T' distance from table for exit curve plus the difference between the length of spiral specified for the exit curve and the length of the spiral segment.

EXAMPLE:

Given: T = 320 ft, Ta = 410 ft, 1/2 Sp. = 120 ft
grade = 4%, factor = 1.2
320 ft (T) + 120 ft (1/2 Sp.)
= 440 ft x 1.2 = 528 ft (round to 530)
"Ta" = 530 ft - 440 ft = 410 ft = 500 ft

3. "L" deceleration lane length is the "T" distance from the table for exit curve plus 1/2 length of spiral normally used. To adjust "Ta" for grade correction using above data see example.

Additional Details for a variety of curved ramp situations are located in Appendix J of the HDM.

EXIT RAMP ON INSIDE OF CURVE

Figure 9-16: Exit Ramps on Curves
9.5.6 VERTICAL ALIGNMENT

Ramp grades should be as flat as possible. (See Table 9-5 following) Steep grades at the terminal area may significant operational effects, especially for large vehicles. Where ramp traffic has a significant percentage of heavy trucks or buses, 3 or 4% gradients are strongly preferred. A gradient of 2% for "landings" at ramp terminals shall be provided when possible. In Figure 4-10 of this manual illustrates the effect of grades on truck speeds. Speed of trucks on grades is directly related to the weight/horsepower ratio. (See AASHTO “A Policy on Geometric Design of Highways and Streets – 2011” page 3-113 to 3-117.) Vertical alignments and clearances for the crossroad and ramps should be designed in accordance with Chapter 4 guidelines, specifically Section 4.5. Ramp profile grades are normally located coincident with the horizontal alignment.

### Table 9-5: Maximum Grades For Ramps

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Ascending Grades %</th>
<th>Descending Grades %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Desirable</td>
<td>Maximum</td>
</tr>
<tr>
<td>25-30</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>35-40</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>45-50</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Except in special cases, descending grades on exit ramps should be the same as the ascending grades. Depressed interchanges are the most common situation where this would apply. Exits on downgrades require added deceleration length, and steeper grades increase this requirement. Steeper grades also make it more difficult to provide an appropriate vertical curve in the gore area, thus the recommendation for keeping the descending exit grades similar to the ascending. An example of a special case would be an outer connection on a partial cloverleaf or system interchange, These ramps do not have to account for stopped vehicles in a queue (although they still need to provide SSD), so there is greater flexibility in the profile design.

Ramp profiles in gore area need to be developed to match the mainline profile adequately, in order to minimize cross slope variations in that area. It is preferable to develop grades in gore areas based on the mainline profile up to the point where gore paving ends (refer to Figure 9-11 and Figure 9-12 for details). The ramp profile can become independent at that point. In constrained situations it may be necessary to vary from this practice. Significant cross slope breaks can create problems for vehicles traversing the gore area, especially at exits, so the profile always needs to match mainline to the extent possible in each situation.

Ramp grades have significant operational impacts, but it’s equally important to provide adequate sight distance along the entire length of the ramp. When the crossroad is over the main facility, the ascending exits and descending entrances generally have fewer problems,
provided they have sufficient length and good horizontal alignment. Sight line limitations are often found on depressed interchanges (crossroad under), both on ramps at the gore area and at the intersection with the crossroad. Sight distances at exit and entrance gore areas require careful evaluation, as these are higher speed conflict areas. The vertical alignment at the terminal end of a ramp can have adverse impacts on sight lines. A profile that includes a relatively steep grade at the terminal end affects not only sight lines, but startup and stopping operations, which in turn affects the sight distance needed for safe operation.

Partial cloverleaf ramp arrangements may create sight line restrictions as well, in the area where the outer ramp wraps around the loop. The combined effects of horizontal and vertical alignment need to be carefully evaluated in all cases.

In situations where it is impractical to make significant changes to the profile, sight lines should take priority over specific gradient controls. As a minimum, exit ramp profiles shall provide appropriate stopping sight distance to expected vehicle queues. Exit profiles, especially at depressed interchanges, need to maximize sight distance in the gore area.

9.5.7 SUPERELEVATION

Superelevation on ramps shall follow the same guidelines as those on the main roadway with consideration given for speed and local conditions (see Section 3.3.1). Ramps have standard spiral lengths that differ from open road conditions. The terminal curve will use minimal superelevation as appropriate for the intersection (typically one-half the full super rate). See Figure 9-11 & Figure 9-12 for ramp supers and Figure 9-19 for terminal curve spiral and super information.

Cross-slope breaks in gore areas are normally acceptable if limited to an algebraic difference of 4% or less. Multiple breaks in the cross-slope are awkward to construct and should be avoided if possible. A cross-slope break of up to 5% is preferable to having multiple breaks. Superelevation is often transitioning in these areas, so each gore location needs to be checked for adequate matching of grades and cross-slopes.

9.5.8 RAMP TERMINAL CURVES

Terminal curves (where a ramp terminates at a crossroad) are generally sharper than the main curve, varying with the conditions. Ramp Terminal areas are typically designed to between 50% (minimum) and 85% of the main ramp curve speed.

Due to the crossroad grade often being adverse to a normal superelevation for terminal curves and the fact that traffic is slowing to stop at the crossroad, ramp terminal curves seldom are fully superelevated and may not be superelevated at all. Therefore, the need for spirals, particularly standard length spirals, is diminished and sometimes eliminated on terminal curves. While spirals may not be required for superelevation transition, their use is always beneficial for leading traffic smoothly into the terminal curve. The ramp terminal curve
superelevation rate is typically one-half the full superelevation rate for that curve. Refer to Figure 9-18 & Figure 9-19 for geometry details on Terminal Curves.

9.5.8.1 RAMP TERMINAL INTERSECTIONS

The separation or "spread" between ramp terminal intersections on the crossroad should be adequate to allow for standard median channelization if left turns are required. Figure 9-17 gives minimum spread distances for a basic diamond interchange at various design speeds. Particular attention should be paid to adequate vertical and horizontal sight distance at the ramp terminals. Design elements such as barrier, protective screening, superelevation rates, and landscaping can have an impact on the sight distance of ramp terminals.

Exit ramp and entrance ramp terminals on the crossroad should be offset to encourage drivers to use the entrance ramp and to discourage wrong way moves. See Figure 9-18 for details on exit and entrance ramp terminal intersection design. AASHTO “A Policy on Geometric Design of Highways and Streets-2011”- Chapter 10, pages 10-82 to 10-87, discusses issues and possible mitigations to help discourage wrong-way entry. Wrong-way potential can be minimized by using conventional, easily recognized intersection and interchange layout, clear pavement markings, and proper signing.

Ramp terminals on many existing facilities do not meet the “X-X Minimum” distance shown in Figure 9-17. Achieving this target distance is often not feasible, particularly in fully developed areas. Designers need to work with traffic analysis staff to determine the range of options for dealing with anticipated left turn demand on the crossroad. It may be necessary to widen a structure to provide additional turn lanes for storage (along with widening of ramps to receive the added lane). In some cases it may be necessary to reconfigure the interchange to a more compact form, such as a Tight Diamond or Single Point.

On the other hand, where interchanges are in remote locations with very little traffic demand, the need for accommodating turn lanes is practically non-existent. In those cases, the chief control is sight lines (as shown in Figure 9-17, Table C). The type of traffic control at the intersection guides in the selection of the most appropriate case to use – Stopping Sight Distance for the crossroad design speed being the minimum. Designers should consider whether it is appropriate to provide Intersection Sight Distance, although in many situations this may prove impractical. Each individual situation must be evaluated to determine which is the appropriate sight distance that will control for design.

In cases where the crossroad is on a horizontal curve, added caution is necessary. Superelevated crossroads introduce awkward breaks in the cross-slope that have serious operational and safety implications, especially when there are significant numbers of trucks present. Horizontal curves can also make it more difficult to provide appropriate sight lines. Crossroad alignments should therefore be as close to tangent alignment as possible.

Refer to Chapter 8 of this manual and AASHTO “A Policy on Geometric Design of Highways and Streets” Chapter 9 for detailed discussion on intersection design and Intersection Sight Distance.
### DIAMOND INTERCHANGE - TERMINAL RAMP SPREAD

**CHANNELIZATION DIMENSIONS**

<table>
<thead>
<tr>
<th>MPH</th>
<th>R (ft)</th>
<th>T (ft)</th>
<th>S (ft)</th>
<th>L min. (ft)</th>
<th>X-X MIN. (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>195</td>
<td>100</td>
<td>150</td>
<td>100</td>
<td>600</td>
</tr>
<tr>
<td>30</td>
<td>195</td>
<td>100</td>
<td>150</td>
<td>100</td>
<td>600</td>
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<td>70</td>
<td>680</td>
<td>190</td>
<td>600</td>
<td>150</td>
<td>1470</td>
</tr>
</tbody>
</table>

**GLOSSARY OF TERMS**

- **MHP**: Design speed of crossing roadway.
- **R**: Radius of reversing curve.
- **T**: Length of reversing curve.
- **S**: Stopping sight distance for a speed 10 mph less than the Design Speed.
- **L**: Length of storage determined by storage analysis - Minimum shown.
- **W**: 100' for 3-lane @ 90° in tangent section, 50' for 5-lane @ 90° in tangent section. W determined by where turning vehicle's off-track crosses edge of left-turn lane (See figure right). This is where stop bar should be placed.
- **X-X**: Minimum distance between the left edges of travel of the ramp terminals (see diagram left). X-X = 2(W+L+S)-T; where S ≥ T. Else X-X = 2(W+L)+T.
- **C**: Combined horizontal and vertical sight distance clearance from the structure. Typically 200 feet or more.
- **RT**: Ramp terminal radii should accommodate a WB-67 Intermediate Design Vehicle (IDV).
- **ET**: Edge of Travel

### 'C' TABLE

<table>
<thead>
<tr>
<th>Clearance from Structure (ft) to % of Ramp Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Width (ft) on Structure</td>
</tr>
</tbody>
</table>

### 'C' TABLE NOTES

1) 'C' Table values are based on the appropriate vertical curve and Stopping Sight Distance values for the design speed in a tangent section. These represent minimum clearance needs. Intersection Sight Distance (ISD) is the desirable condition, but is often difficult to achieve in existing conditions (unless the structure can be modified). See AASHTO 54 Policy on Geometric Design of Highways and Streets-2017, Chapter 9 for detailed discussion on ISD.
2) Clearance calculations do not include sidewalks; as there may or may not be barrier separation from the roadway. Barriers must be used when the cross-road design speed is 45 mph or greater.
3) Many low volume rural interchanges do not have a left turn lane on the roadway. In this case the sight distance requirements and allowance for truck (WB-67) off-tracking are the controlling features. The spread between ramps should always consider possible future turn lane needs.

---

Figure 9-17: Interchange Ramp Spread
Figure 9-18: Detail at Ramp and Crossroad Intersection

- Ramp skew angle may vary between 60° and 120°, 90° being preferred in most cases. Larger skew angles result in excessive pavement width.
- These tapers correspond to the design speed, where Design Speed = Taper Example: Design Speed = 50 mph 50 mph = 50 : 1 Taper (55:1 Maximum)
- This offset usually varies between 10 and 35 feet, but may be less or greater depending on individual circumstances. The offset is used to discourage a wrong way left turn. (See 2011 AASHTO pages 10-53 to 10-87 and Figures 10-56 & 10-57)

*NOTE: Normally, two-centered curves are used in the place of a single radius. Layout details for two centered curves are in Appendix J of this manual (Design Helps).
ACCEPTABLE TERMINAL CURVE DESIGNS
in descending order of preference

TERMINAL CURVE SPIRAL DATA (ONE LANE)

<table>
<thead>
<tr>
<th>Curve</th>
<th>Sp. length</th>
<th>α %</th>
<th>α</th>
<th>S°</th>
<th>p</th>
<th>q</th>
<th>x</th>
<th>y</th>
</tr>
</thead>
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Spiral lengths are based on using ½ of standard superelevation.
Use on terminal curves only.

**TERMINAL CURVE NOTES**

1. This angle may vary between 60° and 120°; where 60° is desirable in most cases.
2. To minimize intersection opening ramp curve should end near tangency of the variable crossing radius.
3. A two-centered curve design should be used to optimize intersection area and accommodate truck off-tracking.

* TWO-CENTERED CURVE DETAIL

Two-centered curves should be used in place of a single radius.
See Appendix J for additional details.

Figure 9-19: Ramp Terminal Curve Design
Freeway ramp terminals, and intersections pre-approved interstate trucks as shown on Route Map 7 (Route Map 7 can be found at http://www.odot.state.or.us/forms/motcarr/od/8104.pdf) at major truck use locations, shall accommodate the current Interstate Design Vehicle (WB-67). Other intersections that have known large truck usage should also be designed to accommodate the current Interstate Design Vehicle. Computer and CADD generated wheel paths of the design vehicle should be used to determine adequate clearances. This is particularly important when determining stop lines for left turn bays and when designing double left turns and two lane loop ramps.

Interstate Design Vehicle swept path requirements can also be found on Figure 9-20. Typically, two centered curves are used at ramp terminals due to the benefits of matching the turning characteristics of large vehicles. Two centered curves assist in reducing the crossing distance at ramp terminals while accommodating the turning requirements of the design vehicle. Appendix J has detailed helps on developing two-centered curves.

Ramp intersection design simultaneously needs to provide for design vehicle movements, pedestrian crossings, good lines of sight, and appropriate traffic control devices. As mentioned above, care needs to be taken to minimize wrong-way movement potential. Minimizing the skew angle will normally help in dealing with these issues. Ramp intersection design also needs to make appropriate accommodation for bicycles, pedestrians, and transit use (when applicable). HDM Chapter 13 and Appendix L have detailed discussion on bike and ped issues and treatments. Refer to Chapter 12 for discussion of Public Transportation design. Each individual situation needs to be evaluated to determine the most appropriate solutions to apply. Coordination between all disciplines involved, preferably early in design, is important for getting good results. All of these considerations need to be balanced with the need to keep the intersection to a manageable size, and to accommodate the expected demand at an acceptable level.
Figure 9-20: Maximum I.D.V. Swept Path

9.5.9 RAMP METERS

In highly congested areas, typically urban, the use of ramp meters may be beneficial to freeway traffic operations. Ramp meters reduce merge area turbulence and regulate total freeway flow through downstream bottlenecks. The Traffic-Roadway Section should be contacted when ramp meters are being considered in the project development process. In addition, there are geometric and safety issues with the design of the ramps and placement of the ramp meter signals that should be considered in the design.

Ramp meters can be installed on single lane or two lane entrance ramps. Ramp meters should not be installed on ramps connecting freeways to freeways, as those types of ramps are designed to operate as free flow ramps. Where ramp meters are installed on a single lane entrance ramp, the ramp design shall be consistent with the appropriate design for 4R/New Construction for Freeway or Non-Freeway Ramps found in Figure 9-11 and Figure 9-15. Metered ramp acceleration lanes shall, as a minimum, meet the values in Table “A” of Figure 9-11. This may require lengthening existing acceleration lanes that don’t meet current criteria.

In a 3R project, installation of a two lane ramp meter on a single lane ramp should be built to 4R/New Construction standards (the ramp should be widened to full two lane ramp standards). In constrained areas, an evaluation should be made to determine if the existing one lane ramp should be widened to two full standard lanes or if the existing one lane ramp width can be retrofitted for installation of two ramp meters. Single lane ramps retrofitted for two lane ramp meters require a design exception. The ramp meter signals should be located just prior to the paved edge of the ramp gore area. Figure 9-21 details the proper location and typical section for a two lane tapered to one lane parallel entrance ramp meter.

It is important to locate the ramp meter signals outside of the freeway clear zone. It is equally important that queued vehicles not be stopped within that same clear zone. Following the guidance in Figure 9-21 should yield a design that meets that requirement. Flat entrance curves may have some design issues, since the more gradual convergence of the roadways has a longer paved gore area. Each location where a ramp meter is considered needs to be checked to verify the clear zone issue. For further information contact the Roadway Engineering Unit or Region 1 Preliminary Design.
Figure 9-21: Two-Lane Ramp Meter with Taper to One-lane Entrance Ramp
9.6 RAMP TYPICAL SECTIONS

The number of lanes at the actual exit or entry point determines how a ramp is categorized. Single lane ramps that taper to multiple lanes after exiting are still considered one lane – standard shoulders for one-lane ramps are appropriate. Some entrance ramps include added lanes and then taper to a single lane prior to actual freeway entry – again these are considered single lane ramps. Figure 9-22 shows standard dimensions for freeway ramps.

Standard single-lane freeway ramps are 26 feet wide. The 26’ width provides for continued operation if a stalled heavy vehicle or maintenance activity requires using some of the width, although a large truck offtracking in relatively sharp ramp curves can make this more difficult. When roadside barriers are introduced, the right shoulder is widened by 2 feet. The left shoulder is normally not widened when barriers are used.

If an additional lane is being added to the ramp, it will normally only require adding eight feet of width – enough to get two 12 foot wide travel lanes. If multiple lanes are needed, they should all be a minimum of 12 feet wide. More width may be needed to accommodate truck offtracking on relatively sharp curvature. Use a taper rate of at least 10:1 when adding the width. The width can be added either to the left or right of the horizontal alignment as appropriate. Always evaluate truck offtracking as part of the ramp design process.

Two-lane ramps are 40 feet wide. When standard shoulders are provided and barriers are present on two-lane ramps, no additional shoulder width is normally necessary (apart from the 2-foot “e” distance to right side barriers). When tighter horizontal geometry requires extra width for truck offtracking (as on loop ramps), or horizontal sight lines are restricted, more width may be necessary. The horizontal alignment for two-lane ramps is carried on the center of the traveled way (on the skip stripe between the two lanes). If more lanes are added past the gore, the location of the horizontal alignment remains the same.

Non-freeway ramps can take different forms, but have the same typical cross section dimensions. Refer to Figure 9-23 for those dimensions. The horizontal alignment is carried 2 feet from the left edge of traveled way. As with freeway style ramps, add 2 feet (also referred to as “e” distance) to the right shoulder width when roadside barriers are present, but not to the left shoulder.

Many non-freeway ramps are basically the same configuration as the freeway style with slightly reduced cross sectional dimensions. Jug-handle style ramps often have two-way operations and require a physical separator between directions of travel. Concrete median barrier is often not appropriate for this situation. A raised traffic separator (as shown in Standard Drawing RD706) is preferable. Each direction of travel on jug handle ramps needs to be the same width as shown in Figure 9-23 (22’ total).
Figure 9-22: Freeway Ramps StandardTypicals
NON-FREeways INTERCHANGE RAMP STANDARD TYPICAL SECTION

Figure 9-23: Non-Freeway Interchange Ramp Typical Section
9.7  LOOP RAMPS

Adjacent loop ramps on the same side of the freeway are not usually permitted unless the weaving section is carried on a Collector-Distributor (C-D) road. Loop ramps on the same side of the crossroad are discouraged due to the short weaving section normally available between the loop ramps.

Loop ramps should be as large as practical and with a minimum of a 36° curve. When designing an exit loop ramp where the crossroad is below the freeway, the maximum degree of curve should be 30°, and using spirals longer than the standard is recommended. Details for fitting loop ramp horizontal alignments are located in Appendix J, Figure J-8. Loop ramp connections usually come parallel to the crossroad using a spiral rather than an angled connection, but can also terminate at a regular intersection. Figure 9-24 & Figure 9-25 show details for loop intersections at crossroads.

Loop ramp intersections with the crossroad must make appropriate provision for bicycle and pedestrian traffic. For rural interchanges the configuration shown in Figure 9-24 is typically the appropriate design. In urban or urbanizing areas, the treatment in Figure 9-25 is often the most appropriate configuration. Each location must be evaluated for the most appropriate treatment to use, based on current and projected traffic conditions, the physical constraints on the roadway design, and other factors such as potential land use changes in the interchange area. HDM Chapter 13 and the ODOT Bicycle and Pedestrian Design Guide (HDM Appendix L) provide guidance for various design situations. Contact the ODOT Bicycle and Pedestrian Facilities Specialist for additional guidance.

Loop exit ramps have issues that make their use undesirable in some situations. Deceleration areas need to be substantially longer due to tight radii on the ramps, especially on downgrades. When the loop is located beyond a grade separation structure and fills, it is not as visible to approaching users. Increasing the length of the structure to provide greater visibility can create longer spans (or more short spans with barriers) and can be costly. Significant superelevation is needed on the sharper curves, and this can create problems in areas with snow and icing issues. Trucks also have more issues negotiating the sharper curves. When loops exit on a downgrade, such as in a depressed interchange, many of the above issues can combine to create operational problems. When considering new interchanges, designs that include loop exits should be used with caution. Existing loop exits need to be evaluated to make sure they sufficiently provide for the above concerns. It may be infeasible to deal with every issue, but opportunities for making incremental improvements should always be sought.
Figure 9-24: Partial Cloverleaf Intersection Detail

Notes:
1. Ramp skew angle may vary between 60° and 120°, 90° being preferred in most cases. Larger skew angles result in excessive pavement width.
2. Shoulder becomes common to both lines forming a median the width of the largest shoulder at the closest point.
2a. If median barrier is used add 2 ft. and other shoulder.
3. Truck turn movements require analysis for offtracking requirements.
FOLDED DIAMOND TERMINAL DETAIL

NOTE: ODOT PREFERRED PRACTICE DOES NOT USE A "FREE-FLOW" RIGHT TURN CONFIGURATION FOR FOLDED DIAMONDS. THE LOOP IS MADE PART OF A CONVENTIONAL "T" INTERSECTION (WITH A TYPICAL RIGHT TURN LANE).

NOTE: Accommodation for Bike/Ped movement through these connections shall be made in accordance with the ODOT Bicycle and Pedestrian Design Guide (HDM Appendix N) guidelines. Contact the Bike/Ped Facilities Specialist for guidance.

NOTE: Gore nose @ 8 ft Offset between EPs.

Physical nose 10 ft at edges of travel.

Convergence angle varies from 0° (parallel) to 15°- 8° being the desirable angle.

NOTES:
The 10 ft separation between ramp edges of travel at the physical nose provides several benefits to the terminal intersection:

1. It permits the vertical alignments and the super-elevation rates for the ramps to act (be designed) independently.
2. It provides adequate space between the ramps to install a median barrier. We find a barrier advantageous for traffic separation and the installation of glare-shields. Generally, a barrier is not always needed; but we recommend using them when it is possible.
3. The 10 ft separation also provides extra area at the terminal for truck off-tracking.

Figure 9-25: Folded Diamond Terminal Detail
9.8 FRONTAGE ROADS AND OUTER SEPARATIONS

The area between the traveled ways of a through traffic roadway and a frontage road or street is called the outer separation. Outer separations shall be a minimum of 33 feet (desirably 40 feet) between edge of travel lanes for one-way frontage roads with traffic proceeding in the same direction as the adjacent freeway or expressway traffic. A minimum of 40 feet (desirably 50 feet) is the required outer separations for frontage roads having two-way traffic. These same minimums also apply between ramps and frontage roads. Screening of headlight glare should be used on frontage roads with two-way traffic or traffic opposing the main roadway or ramp traffic. These outer separation requirements should not be confused with the ramp terminal and roadway spacing standards (OAR Section 734-051 criteria).

A thorough study should be made to determine appropriate widths of outer separations on ground level freeways. The outer separation should be as wide as can be economically attained to provide a safe buffer zone (see AASHTO’s “A Policy on Geometric Design of Highways and Streets – 2011”, page 8-5).

At intersections on major streets and on expressways, outer separations shall be minimum of 40 feet (desirably 65 feet) to provide room for turning movements.

Intersections of roads or streets with a crossroad having a structure shall be located 200 feet or more from the end of the structure to improve sight distance for vehicles on the intersecting facilities, unless the intersections are signalized. This applies to grade separations without ramps (non-interchanges). Spacing to crossroad intersections (including frontage roads) in the vicinity of interchanges is subject to OAR Chapter 734-051 criteria.
9.9 SAFETY REST AREAS

Safety rest areas provide the driver an opportunity to pull off the highway and rest, thus making the highway safer. Rest areas also provide picnic areas, water and sanitary areas, and motorist service information. Rest areas are located on freeways and other highways where there is a need.

The design of rest areas will vary depending upon location and need. Some rest areas are quite large while other rest areas only serve a few vehicles and are more of a wayside than rest area. Roadway Engineering should be contacted concerning the design of rest areas.

Rest areas located on the freeway system should be designed with exit and entrance ramps. The exit and entrance ramps should be designed in the same manner as interchanges. Because rest areas accommodate large numbers of trucks, the design should consider the use of exit and entrance ramps that better accommodate trucks. Trucks can be better accommodated by using longer speed change lanes. Providing relatively flat geometry in the portions of the rest area where vehicles transition to and from ramps is another method of dealing with truck operations.

As mentioned above, rest areas have different functions. One of those functions is providing travel information. Many times the rest area will be closed for long periods of time and this has an impact on the travel information provider. In cases where the rest area requires remodeling or repair, the designer should see that tourist information facilities are kept in service if possible or look at ways of minimizing the closure time.
9.10 NON-FREEWAY INTERCHANGE DESIGN

9.10.1 GENERAL

The types of interchange designs on highways other than freeways are quite varied. They can range from freeway designs to intersection right in/out jug handles. Many of the design standards for freeway interchange design are also applicable to non-freeway interchange design. Unless otherwise noted below, the freeway design standards generally apply to non-freeway designs as well. However, other design elements and issues related to non-freeway design are also discussed below.

9.10.2 INTERCHANGE SPACING

Table 9-1 shows the access spacing standards for non-freeway locations. The spacing shown is measured crossroad to crossroad centerline distance. Other access management spacing standards such as the distance between the ramp terminal and the first approach or first full intersection, and the distance between start and end of tapers of adjacent interchanges need to comply with the OAR Chapter 734-051 spacing standards or obtain a spacing deviation.

9.10.3 DESIGN SPEED

As with freeway style interchanges, the design speed of the ramps should be between 50% and 85% of the design speed of the mainline. However, the ramp design speed should never be below 25 mph.

9.10.4 TYPICAL SECTION

The design of the crossroad should be the same as for freeways. The ramp sections are different, however. Non-freeway ramp design should be in conformance with Figure 9-23.

9.10.5 ACCESS CONTROL

In addition to controlling access at the ramp terminals at the crossroad, access control along the mainline needs to be acquired upstream and downstream of the deceleration and acceleration lanes. Access needs to be controlled one mile (urban)/two miles (rural) in advance of a deceleration lane and one mile (urban)/two miles (rural) downstream of an acceleration lane.
Achieving the access spacing may be very difficult on already developed existing roadways and may require a design deviation. OAR Chapter 734-051 contains information on access management requirements.

### 9.10.6 DECELERATION LANES

All exit ramps for non-freeway interchanges require a deceleration lane. The deceleration lane can be a freeway style exit taper with gore area or an intersection right turn deceleration lane. Either option is adequate for loop ramp or jug handle style ramps. Interchanges that look like a standard diamond should use freeway style deceleration design.

### 9.10.7 ACCELERATION LANES

The decision to use acceleration lanes will vary depending upon the speed of the highway, ramp volume, highway volume, number of lanes, level of service, and the highway roadside culture downstream from the ramp.

Acceleration lanes should generally only be used when merging with a multilane highway. Only where safety is not compromised, could acceleration lanes be considered on two lane two-way roadways. Safety can be compromised when intersections or road approaches are located in the area of the acceleration lane (even on multi-lane facilities), or if the length of the lane is inappropriate for the specific situation. Acceleration lanes that are longer than necessary may encourage their use as a passing section, while those that are too short will probably not be used effectively. Where acceleration lanes are used, they should conform to the lengths shown on Figure 9-11. Non-freeway acceleration lanes may or may not use the entrance angle design associated with freeway interchanges. Consistency among ramps and throughout sections should be maintained as much as possible. If the exit ramps utilize an exit angle, the following acceleration lane should use the entrance angle. However, each interchange and ramp needs to be evaluated separately to determine the appropriate design. Typically, if the facility uses a “freeway style” interchange, exit and entrance angles should be used. “Jughandle style” interchanges should use parallel deceleration and acceleration ramps. Refer to Figure 9-26 and Figure 9-27 for non-freeway interchange design concepts.

Acceleration lanes for at-grade intersections that are not associated with non-freeway interchange design shall follow the requirements outlined in Section 8.3.11 of this manual.

### 9.10.8 TRANSITIONAL AND COMBINATION TYPE FACILITIES

Facilities that are transitioning from at-grade to grade separated connections require special attention. Mixing of at-grade and interchange type controls can create safety and operational problems. An example of this situation is when an at-grade intersection is located near the end of an interchange acceleration lane, setting up conflicting speed/lane change maneuvers.
It is also very undesirable to have an at-grade intersection in between two interchanges, even those with jughandle style ramps. It is preferable to proceed with grade separating and adding ramps in a more “linear” fashion, adding the grade separations from one intersection to the next in progression. Traffic demand, existing development, and other factors can make this approach impractical. Consideration must always be given to the likely operational and safety effects of transitioning a corridor in a non-linear fashion. Tables 6 and 7 in OAR Chapter 734-051 give minimum spacing criteria to guide on planning and design for non-freeway facilities. A basic purpose of these criteria is to provide for safe operating conditions.

As a practical matter, meeting these criteria may require developing frontage road systems for local access. It may suffice to complete missing elements of the local road network (where terrain and existing development allow for it). Grade separations without ramps spaced at regular intervals provide for connectivity across the main facility.

Long-term planning for transitioning facilities should consider the need for and impact of future improvements. An example of this is the future conversion of a jughandle type interchange to a standard freeway style set of ramps. In cases where it is expected that a grade separation might be converted to an interchange, adequate spacing between other features is necessary.

Coordination between planning and project development is very important in this context. Good communication can help to minimize difficult, expensive, and sometimes not too effective afterthought fixes. Planners and engineering staff must strive to get a common understanding of problems, needs, and constraints from each others viewpoint.
Figure 9-26: Non-Freeway Interchange
NON-FREeway INTERCHANGE EXAMPLE AND FUTURE IMPROVEMENTS

Figure 9-27: Non-Freeway Interchange Example And Future Improvements
9.11 ACCOMMODATING BICYCLES AND PEDESTRIANS

Bicycle and pedestrian movements must be accommodated through interchanges, even in rural locations. Even in urban or suburban areas where sidewalks are in place, the existing accommodations may not be suitable for current needs. It is equally important to develop the design for bikes and peds as well as vehicles. Some interchange configurations (such as the Single Point or Diverging Diamond) require multi-stage crossings and refuge islands. Occasionally it is necessary to provide separated facilities through complex interchanges. Overhead illumination may also be needed. Each discipline involved in the design (geometry, traffic, structure) needs to coordinate to ensure the needs of various users are met.

The primary conflict points for these modes are at the ramp intersections. The following references provide details for planning and design of bike/ped accommodation at interchanges:

- HDM Chapters 8 (Intersections) and 13 (Pedestrian and Bicycle).
- Oregon Bicycle and Pedestrian Design Guide, Chapter 6

For all interchange projects, designers should coordinate with the ODOT Bike/Ped Facility Specialist or Region Coordinators.