Washington State
Department of Transportation

Publications Transmittal

Transmittal Number		Date
00-046		**May 2000**

Distribution

To: All *Design Manual* holders

Publication Title	Publication Number
Design Manual (Metric) Revision 00-01	**M 22-01**

Originating Organization

Environmental & Engineering Service Center - Design Office - Policy and Standards through **Finance & Administration Service Center - Engineering Publications**

Notice

The Washington State Department of Transportation is reverting to the English system of weights and measures for contract work. Future English revisions will be printed and distributed, but, this is the last printed metric revision to be distributed to holders of the metric *Design Manual.* Future metric revisions will be posted on the Internet and can be printed from there as needed.

There is a web page that offers both metric and English versions of the *Design Manual* (and the Standard Plans), current revisions and all supplements to both versions of the *Design Manual,* individual chapter files for faster downloading, and contact names and numbers. That web page is maintained by the Design Policy and Standards unit, in the Design Office, Environmental and Engineering Service Center, of WSDOT at:
http://www.wsdot.wa.gov/eesc/design/policy/index.htm

Design Manual users are encouraged to use an Internet manual to ensure that the most current guidance is being used and to avoid the work and time it takes to revise a printed manual. If needed, English printed manuals may be obtained from Engineering Publications in the Finance and Administration Service Center of WSDOT at:
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Both the metric and English *Design Manuals* are also available on the "Engineering Publications CD Library" for portability and for faster loading to slower computers. The CD-ROMs are reissued at approximately six-month intervals and are only current as of the date of production. The next CD-ROM will go into production in June 2000.

Engineering Publications has been building an e-mail address list of *Design Manual* holders who are interested in receiving their newsletters and heads-up messages. Now the Design Policy and Standards unit, which writes the manual, hopes to expand that list to include all *Design Manual* holders in order to send advance notices.
If you want to be on the list just send an e-mail titled "yes" to lovem@wsdot.wa.gov

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Remarks and Instructions

Instructions:

Remove			Insert		
Chapter	Pages	Sheets	Chapter	Pages	Sheets
Comment Request Form of April 1998	iii	1	Comment Form of May 2000	iii	1
Contents of November 1999	1 to 23	12	Contents of May 2000	1 to 23	12
120 "System Planning"	1 to 5	3	120 "Planning"	1 to 19	10
325 "Design Matrix Procedures"	1 to 15	10	325 "Design Matrix Procedures"	1 to 15	10
330 "Design Documentation, Approval, and Process Review"	3 & 4	1	330 "Design Documentation, Approval, and Process Review"	3 & 4	1
430 "Modified Design Level"	1 to 6	3	430 "Modified Design Level"	1 to 6	3
440 "Full Design Level"	9 to 12	2	440 "Full Design Level"	9 to 12	2
630 "Geometric Profile Elements"	1 & 2	1	630 "Geometric Profile Elements"	1 & 2	1
640 "Geometric Cross Section"	3 to 6	2	640 "Geometric Cross Section"	3 to 6	2
640 "Geometric Cross Section"	17 & 18	1	640 "Geometric Cross Section"	17 & 18	1
640 "Geometric Cross Section"	25 & 26	1	640 "Geometric Cross Section"	25 & 26	1
640 "Geometric Cross Section"	35 to 40	3	640 "Geometric Cross Section"	35 to 40	3
650 "Sight Distance"	7 to 9	2	650 "Sight Distance"	7 to 9	2
710 "Traffic Barriers"	1 to 21	11	710 "Traffic Barriers"	1 to 24	12
830 "Delineation"	1 to 7	4	830 "Delineation"	1 to 8	4
840 "Illumination"	1 to 7	4	840 "Illumination"	1 to 24	12
940 " Traffic Interchanges"	5 to 32	14	940 " Traffic Interchanges"	5 to 32	14
1040 "Weigh Stations"	1 to 14	7	1040 "Weigh Sites"	1 to 17	9
1120 " Bridges"	1 to 6	3	1120 " Bridges"	1 to 6	3
1350 "Soil Bioengineering"	1 to 4	2	1350 "Soil Bioengineering"	1 to 4	2
1425 "Access Point Decision Report"	1 to 5	3	1425 "Access Point Decision Report"	1 to 15	8
Index, November 1999	1 to 17	9	Index, May 2000	1 to 19	10
			Design Manual Supplement , May 3, 2000	1 & 2 *	1
Design Memorandum of Instruction July 6, 1994, Chapter 1040	1 to 7	7			
Design Memorandums and Letters of Instruction list of November 1999	1	1	*Design Manual* Supplements and Instructional Letters, May 2000	1	1

* Place in front of Chapter 1050

Changes are identified by a change bar in the margin adjacent to the changed word, sentence, or paragraph. When the bar in the margin does not clearly identify the extent of the change, the changed words are underlined. A chapter without change bars means it is a new or totally rewritten chapter

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DOT Form 761-003A EF
Revised 11/97

cc: Office of Policies, Studies, and Analysis 47400

Thank you, all 525 of you, who responded to our survey! We would thank you individually if we could but the responses are anonymous. You who asked questions, and are hoping for answers, will find your answers on our home page in the near future.

The *Design Manual* Revision Process Improvement Team (DMRPIT) will be evaluating all of the returns (including 2337 written comments!), identifying action items, prioritizing, and implementing.

Some items are being skimmed off the top as being either urgent or "quick fixes."

The most urgent item is the need for the *Design Manual* users and the Policy and Standards Unit (of the E&ESC Design Office) to be able to communicate directly and frequently with each other. We need to be able to tell you things (like: "A revision will go out in May.") and you need to be able to tell us things (like: "I couldn't find striping in the *Design Manual* but I know it's there, somewhere. I've seen it!")

But how do we reach you? All we can do, at this time, is send you this newsletter asking you to keep an eye on our home page at
http://www.wsdot.wa.gov/eesc/design/policy/index.htm
because we will be adding elements there that will serve as our attempt to communicate current events to you. We will be posting results of the survey and other tidbits as time goes by.

If you wish to e-mail any one of the *Design Manual* staff, the following are our names, phone numbers, addresses, and the topics we are responsible for**:**

Topics	Name	Phone # (360)	E-mail Address
· Traffic Barriers · Design Clear Zone	Dick Albin	705-7260	albind@wsdot.wa.gov
· Web Sites · DMRPIT Team Recorder	Sharon Dana	705-7466	danas@wsdot.wa.gov
· Design Geometrics	Ted Focke	705-7270	focket@wsdot.wa.gov
· Traffic	Larry Hinson	705-7540	hinsonl@wsdot.wa.gov
· All of the Other Topics · Format and Style · DMRPIT Team Leader	Miriam Jenks	705-7272	jenksm@wsdot.wa.gov
· *Design Manual* Graphics	Jamie Ryan	705-7266	ryanj@wsdot.wa.gov

Also, anyone can reach us by e-mail to **designmanual@wsdot.wa.gov** (WSDOT people can use "Design Manual" from the list in Microsoft Exchange). If all else fails, our FAX number is 705-6815 and our mailing address is on page iii of the *Design Manual*.

From: ______________________________

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Date: ______________

Phone: ______________

To: WSDOT (DesignManual@wsdot.wa.gov)
Olympia Service Center, Design Office
Mail Stop 47329
PO Box 47329
Olympia, WA 98504-7329

Subject: *Design Manual* Comment

Comment (marked copies attached):

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Contents

Division 3 Project Documentation

Division 7 Roadside Safety Elements

Date

Division 8 Traffic Safety Elements

Division 10 Auxiliary Facilities

Division 11 Structures

Division 14 Right of Way and Access Control

Figures

5:P65:DP/DMM

120.01 General

Planning is a decision making process used to solve complex, interrelated problems. Transportation needs are typically identified by various transportation interests including local, regional, and state governments; businesses; and community groups. The needs are then evaluated in the framework provided by local, regional, and state land use and transportation policies and by state and federal laws. Identified transportation needs are also evaluated based on projected fiscal constraints.

The result of the statewide planning process is a list of transportation strategies (projects, activities, and services); consistent with local, regional, and state policies; and supported by the general public through the public involvement process.

Ultimately, the planning process constrains the strategies, based on projected available resources, and determines which transportation projects may be selected for programming, design, and construction. The goal is to create an integrated transportation system capable of supporting a vital economy, vibrant communities, and a sustainable environment.

120.02 References

Transportation Equity Act for the 21st Century (TEA-21) of 1998

Code of Federal Regulations (CFR)
23 CFR 450 subpart B, "Statewide Transportation Planning"

23 CFR 450 subpart C, "Metropolitan Transportation Planning and Programming"

40 CFR, "Clean Air Act," parts 51 and 93

United States Code (USC) 23 USC 134, "Metropolitan planning"

23 USC 135, "Statewide planning"

Revised Code of Washington (RCW)
RCW 35.58.2795, "Public transportation systems — Six-year transit plans."

RCW 35.77.010(2), "Perpetual advanced six-year plans for coordinated transportation program expenditures — Nonmotorized transportation — Railroad right-of-way"

RCW 36.70A, "Growth management — Planning by selected counties and cities"

RCW 36.81.121(2), "Perpetual advanced six-year plans for coordinated transportation program, expenditures — Nonmotorized transportation — Railroad right-of-way"

RCW 47.05, "Priority Programming for Highway Development"

RCW 47.06, "State-Wide Transportation Planning"

RCW 47.38, "Roadside Areas - Safety Rest Areas"

RCW 47.39, "Scenic and Recreational Highway Act of 1967" and changes thereto

RCW 47.50, "Highway Access Management"

RCW 47.76.220, "State rail plan - Contents"

RCW 47.80, "Regional Transportation Planning Organizations"

RCW 70.94, "Washington Clean Air Act"

Washington Administrative Code (WAC)
WAC 468-51 and 52, "Highway Access Management"

WAC 468-86, "RTPO Planning Standards and Guidelines"

Roadside Manual, M 25-30, WSDOT

120.03 Definitions

ARB	Agency Request Budget
B/C	Benefit/Cost
CFR	*Code of Federal Regulations*
CLB	Current Law Budget
CMP	*Corridor Management Plan*
FAST Corridor	Freight Action Strategy for the Everett-Seattle-Tacoma Corridor
FGTS	Freight and Goods Transportation System
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GMA	Growth Management Act
HSP	*State Highway System Plan*
HSS	Highways of Statewide Significance
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
LOS	Level of Service
MTIP	Metropolitan Transportation Improvement Program
MPO	Metropolitan Planning Organization
OSC	Olympia Service Center
OUM	Office of Urban Mobility
PSRC	Puget Sound Regional Council
RCW	*Revised Code of Washington*
RDP	*Route Development Plan*
RTIP	Regional Transportation Improvement Program
RTPO	Regional Transportation Planning Organization
SEPA	State Environmental Policy Act
SHSP	*State Highway System Plan* also known as the HSP
STIP	Statewide Transportation Improvement Program
TDM	Travel Demand Management
TEA-21	Transportation Equity Act for the 21st Century of 1998
TIP	Transportation Improvement Program
TPO	Transportation Planning Office
USC	*United States Code*
WAC	*Washington Administrative Code*
WSDOT	Washington State Department of Transportation
WTP	*Washington's Transportation Plan*

120.04 Legislation and Policy Development

The Washington State Legislature requires the Washington State Department of Transportation (WSDOT) to plan, develop, maintain, and preserve the transportation network in accordance with all state laws and federal requirements. The Washington State Transportation Commission interprets these requirements into a set of policies that guide the process.

The Washington State Transportation Commission consists of seven members who are appointed by the Governor. This body serves as the board of directors for WSDOT and provides oversight to ensure that the department delivers a quality, multimodal transportation system that moves people and goods safely and efficiently. The Commission also develops plans and funding recommendations for Legislative approval.

The following are highlights of important federal and state legal requirements that influence or direct planning activities at WSDOT. These legal requirements must be satisfied for WSDOT to expend federal and state transportation funds.

(1) Federal Law: Transportation Equity Act (TEA-21)

The Transportation Equity Act (TEA-21), passed in 1998, authorizes highway safety, transit, and other surface transportation programs through the year 2004. TEA-21 continues the trend initiated in 1991 by the Intermodal Surface Transportation Efficiency Act (ISTEA). ISTEA brought closure to the federal Interstate highway construction era and ushered in new methods of distributing federal transportation dollars.

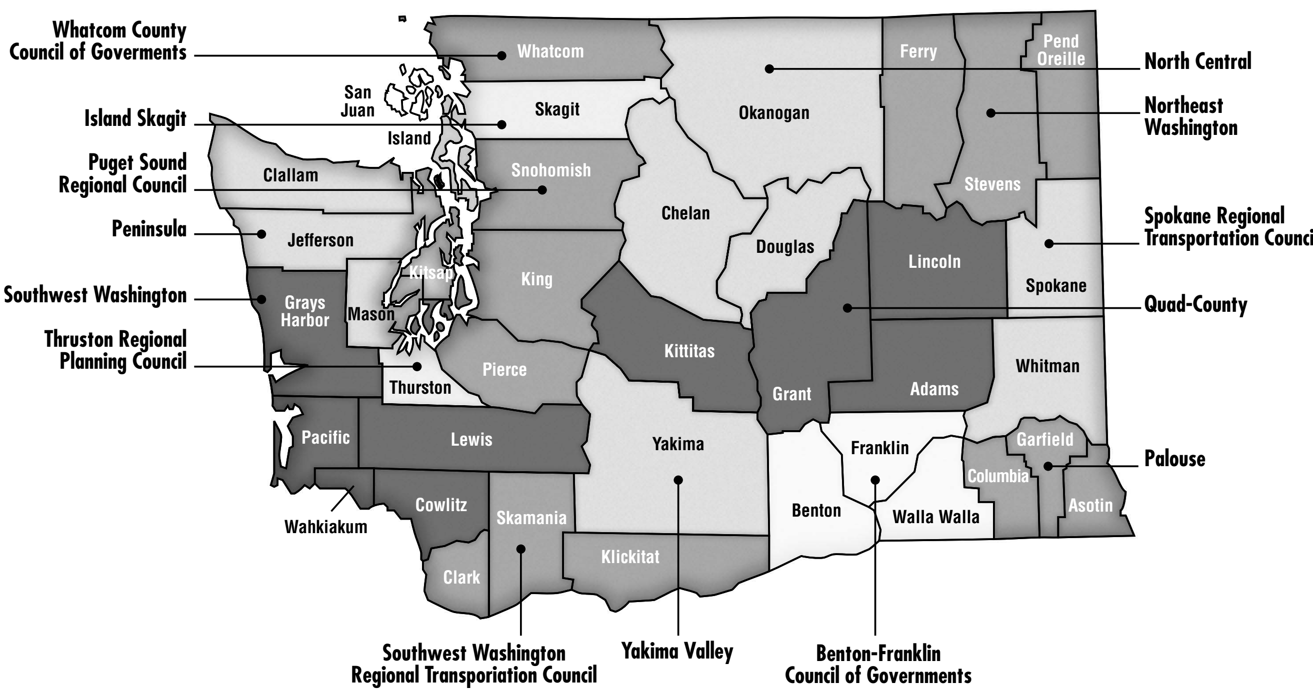
TEA-21 gives local agencies a strong voice and reaffirms the importance of statewide and metropolitan transportation planning activities at the state and regional levels. Below is a list of important federal planning requirements.

(a) **Statewide Planning**. 23 USC 135 and 23 CFR 450 — subpart B outline the federal requirements for statewide planning by state departments of transportation.

(b) **Metropolitan Planning.** 23 USC 134 and 23 CFR 450 subpart C — outline the federal requirements for Metropolitan Planning Organizations (MPO).

Each urbanized area (population 50,000 or more) must have an MPO to receive and expend federal transportation capital or operating assistance. Presently, there are eight MPOs in Washington state. (See Figure 120-1.) They are:

- Benton-Franklin Council of Governments (BFCOG)
- Southwest Washington RTPO (SWW) (Cowlitz-Wahkiakum area)
- Puget Sound Regional Council (PSRC)
- SWW Regional Transportation Council (RTC) (Clark County area)
- Spokane Regional Transportation Council (SRTC)
- Thurston Regional Planning Council (TRPC)
- Whatcom County Council of Governments (WCCOG)
- Yakima Valley Council of Governments (YVCOG)



Planning Organizations
Figure 120-1

These organizations include the metropolitan areas prescribed by federal law and also serve as the Regional Transportation Planning Organizations (RTPO) (in some cases covering a larger area). MPOs with a population over 200,000 are also designated as Transportation Management Areas.

Each MPO has a transportation policy board consisting of local elected officials from cities and counties, and representatives from ports, transit agencies, tribes, WSDOT, major employers, the general public, and other local transportation interests. Typically, each MPO also has a technical committee composed of staff from local planning and public works departments, and WSDOT regions.

The results of this transportation planning process are transportation plans and programs that are consistent with, and implement local comprehensive plans. The MPO planning process provides for:

- A forum for gaining local consensus on local transportation needs.
- The creation of a metropolitan transportation plan identifying future transportation facilities and services needed to support and implement local comprehensive plans.
- Targeted transportation studies used to develop the metropolitan transportation plan.
- A forum to decide how to allocate certain categories of transportation funds.
- The development of a three-year list of facilities and services (to be funded by member organizations) called the Metropolitan Transportation Improvement Program (MTIP).

Metropolitan transportation plans provide a main building block for the development of *Washington's Transportation Plan* created by WSDOT.

(2) State Laws: Planning Mandates Shape Project Selection

The state of Washington has adopted several important laws affecting transportation planning at various levels. These laws provide the framework for transportation decision making, ultimately guiding the programming, design, and construction of transportation facilities and services. The following is a list of the state laws having the most profound impact.

(a) **Statewide Transportation Planning** (RCW 47.06). This set of laws establishes that ". . . the state has an appropriate role in developing statewide transportation plans." RCW 47.06 specifies that state owned transportation facilities and services, as well as those of state interest, must be addressed in these plans and that these plans shall guide short-term investment decisions and long range vision for transportation system development.

(b) ***Washington's Transportation Plan* (WTP).** The WTP provides guidance for the development, maintenance, and operation of a comprehensive and balanced multimodal transportation system. The overall direction of the WTP, prepared pursuant to RCW 47.06, is provided by the Washington State Transportation Commission. The WTP provides the direction for investment decision-making at WSDOT for all modes of transportation.

The WTP includes the following subjects concerning all major transportation modes:

- Meeting the federal requirements identified in TEA-21.
- Critical factors affecting transportation.
- Important issues concerning each mode and strategies to solve the problems.
- Plans for development and integration of the various modes of transportation.
- Major improvements in facilities and services to meet transportation needs.
- Financial resources required to implement the recommendations.

The WTP is a dynamic plan that is updated on a regular basis to address changing conditions. Information and recommendations for the plan are received from WSDOT regions and the Olympia Service Center (OSC), Metropolitan Planning Organizations, Regional Transportation

Planning Organizations, local governmental agencies, private transportation operators, and the public.

The WTP addresses transportation facilities owned and operated by the state, including state highways, Washington State Ferries, and state-owned airports. It also addresses facilities and services that the state does not own, but has interest in. These include public transportation, freight rail, intercity passenger rail, marine ports and navigation, nonmotorized transportation, and aviation.

(c) ***State Highway System Plan* (SHSP or HSP).** The *State Highway System Plan* is the highway component of the broader WTP. The HSP defines *Service Objectives*, *Action Strategies,* and costs to plan for, maintain, operate, preserve, and improve the state highway system for the next 20 years.

The HSP is financially constrained, meaning that some of the transportation strategies in the plan can be constructed with projected financial resources. It also includes strategies that are excluded from the constrained plan but are, nonetheless, identified as needs to be met if and when funding is available.

Because needs listed in the HSP far outstrip projected revenue, the Transportation Commission established a set of priorities for funding projects. (See the *State Highway System Plan*.) The Commission has adopted ten Service Objectives and fifty-three Action Strategies as a way to establish a logical process for identifying and categorizing projects that will receive funding in the next 20 years. These service objectives and action strategies provide the framework for defining 20-years of needs on the state highway system for the HSP. Work that does not fit within one of these 53 action strategies will not be authorized and is not considered in the development of the HSP, the Statewide Transportation Improvement Program (STIP) or any budget proposal.

The HSP is updated every two years, in coordination with local plan updates, to reflect completed work and changing transportation needs, policies, and revenues.

A conceptual solution (project) must be included in the HSP for funding to be allocated to the improvement strategy.

(d) **The Growth Management Act** (RCW 36.70A). Enacted in March 1990, the state's Growth Management Act (GMA) requires cities and counties that meet certain population or growth-rate thresholds to adopt comprehensive plans. Jurisdictions that are required to or choose to plan under the GMA must also adopt and enforce ordinances that implement the policies adopted in the comprehensive plans.

A comprehensive plan is a series of coordinated policy statements and formal plans that direct growth. Comprehensive plans articulate how a community will be developed in the future. They include elements that address housing, utilities, capital facilities, economic development, land use, and transportation.

The law requires that the transportation element be consistent with and support the land use element. In Washington, the comprehensive plan carries the force of law and must be developed with full participation by the general public.

Continuous coordination and open discussion during the development of local comprehensive plans are key to developing a valid plan for the growth of the community. Representatives from neighboring jurisdictions, special purpose districts, WSDOT, and others must be involved at the beginning of and throughout the planning process to ensure that the comprehensive plan is consistent with all other state and local plans.

Local comprehensive plans are important to WSDOT because they control how state facilities within the community will be addressed, how state highways will be impacted by local land use, and how access requirements will be met or maintained.

WSDOT seeks to work in partnership with local governments as they develop local comprehensive plans to ensure a balance between the need for mobility and access, while emphasizing design components that improve or maintain the livability of communities. WSDOT reviews and comments on local comprehensive plans and amendments whenever possible.

To avoid unnecessary conflicts and project delays, it is highly recommended that anyone involved in the design of a state facility review local comprehensive plans and initiate early contact with local governments before the design stage.

(e) **Regional Transportation Planning Organizations (RTPOs)** (RCW 47.80.020). Washington has two types of "regional" or "area wide" transportation planning organizations. One type, with populations over 50,000, the MPO, was already introduced in (1)(b) on federal laws. The other type, the Regional Transportation Planning Organization (RTPO), are voluntary organizations enabled under state law. Where MPOs existed before RTPOs were enabled, the MPOs became the RTPOs by including rural areas in their plans.

Although voluntary, all cities, counties, ports, tribes, and transit agencies are usually listed as members of an RTPO and their participation is their best way to influence local and statewide transportation planning.

RTPOs perform the same overall functions as MPOs and, like MPOs, provide a forum for information exchange and collective decision making between local governments and WSDOT. WSDOT is represented on each RTPO Policy Board and technical advisory committee.

Fourteen RTPOs exist in Washington State, covering all counties of the state except San Juan County. (See Figure 120-1.) In addition to the eight listed as including MPOs in 120.04(1)(b), there are the following six RTPOs:

- Skagit/Island RTPO
- North Central RTPO (NCRTPO)
- Palouse Economic Development Council RTPO
- Peninsula RTPO
- QUADCO RTPO (central)
- Northeastern Washington RTPO (N. E. W.)

(f) **Transportation Facilities and Services of Statewide Significance** (RCW 47.06.140). The Legislature has declared certain transportation facilities and services, which promote and maintain significant statewide travel and economic development, to be of statewide significance.

Transportation facilities and services of statewide significance are considered essential state public facilities. (See RCW 36.70A.200.) Essential state public facilities cannot be precluded from operation or expansion by local comprehensive plans and development regulations. This means that the state interest in these facilities and services takes precedence over local interests in the planning process.

Therefore, planning for these transportation facilities and services must be conducted with a statewide perspective in mind. WSDOT, in consultation with others, is responsible for development of a statewide, multimodal plan for these facilities and services. The balance between providing for the free movement of people and goods and the needs of local communities is the main consideration.

Highways of Statewide Significance (HSS) are one category of transportation facilities and services of statewide significance. The HSS system was established by the Washington State Transportation Commission, and approved by the Legislature, to identify significant state-owned transportation facilities. The HSS system was also established to define the state and MPO/RTPO roles regarding planning for these facilities.

The HSS includes the Interstate highway system, interregional state principal arterials, and ferry connections that serve statewide travel.

WSDOT, in consultation with others, makes the final decision regarding the acceptable Level of Service (LOS) for highways of statewide significance. The MPOs and the RTPOs, in consultation with WSDOT, set the acceptable LOS on other state highways.

(g) **Functional Classification of Highways and Roadways** (RCW 47.05.021). Functional classification is the grouping of highways, roads, and streets that serve similar functions into distinct systems or classes within the total existing or future highway network. The objective of functional classification is to define the appropriate role (mobility versus access) of various highways in providing service and influencing development. Generally, the higher functional classification routes provide mobility with higher travel speed and serve longer distance travel. The lower functional classification routes focus on providing access to the land. Functional classification is important in:

- Identifying routes for inclusion in the National Highway System.
- Providing the basis for administering the Surface Transportation Program.
- Determining design levels for a specific route.
- Planning.
- Determining and establishing jurisdictional responsibility.
- Establishing access control.
- Providing information for land use plans and decisions.
- Conducting needs assessments and cost allocation studies.
- Helping to determine the level of maintenance.
- Conducting the priority programming process.

All state highways are subdivided into three functional classifications. See Chapter 440, "Full Design Level," for definitions of the collector, minor arterial, and principal arterial classifications.

(h) **Freight and Goods Transportation System (FGTS).** The FGTS is an effort caused by the increasing interest in freight mobility. The FGTS is required by RCW 47.05.021 section 4. It states:

> "The transportation commission shall designate a freight and goods transportation system. This statewide system shall include state highways, county roads, and city streets. The commission, in cooperation with cities and counties, shall review and make recommendations to the legislature regarding policies governing weight restrictions and road closures which affect transportation of freight and goods."

The FGTS established the tonnage classifications for each state highway, county road, and city street. Ultimately, tonnage influences the funding and design of new facilities or reconstruction of existing facilities.

(i) **Access Control** (RCW 47.50, WAC 468-51, and WAC 468-52). Access control is a program that combines traffic engineering and land use regulatory techniques. Access control balances the desire for access (from adjacent properties to streets and highways) with other elements such as safety, preservation of capacity, support for alternative transportation modes, and preservation and enhancement of communities.

There are two forms of access control: limited access control and managed access control. (See Chapter 1420, "Access Control Design Policy.") For limited access control, WSDOT purchases the right to limit access to a highway. Managed access control is a regulatory program established by a state law that requires that access to state highways in unincorporated areas be managed by WSDOT to protect the public and preserve highway functionality.

WSDOT has established plans for access control that are consulted when planning transportation improvement strategies. They are the Master Plan for Limited Access Highways and the regional Highway Access Management Classification Reports.

120.05 Planning at WSDOT

The role of planning at WSDOT is to identify transportation needs and facilitate the development and implementation of sound, innovative investments and strategies. Many groups within WSDOT conduct planning activities that directly or indirectly influence the design of transportation facilities.

Several modes of transportation are represented by these groups, which advocate, provide technical assistance, and fund and implement programs, projects, and services.

The following is a list of those groups, their roles, and their effect on the design of transportation facilities.

(1) Transportation Planning Office

Three major responsibilities of the Transportation Planning Office (TPO), of the Planning and Programming Service Center in OSC, are to:

- Oversee the development of *Washington's Transportation Plan* (WTP).
- Coordinate planning activities and provide technical assistance to WSDOT regions, Metropolitan Planning Organizations (MPOs), and Regional Transportation Planning Organizations (RTPOs).
- Collect and process data, conduct studies, and develop travel forecasts.

(a) ***Washington's Transportation Plan* (WTP).** The Transportation Planning Office coordinates the development of the WTP in partnership with other WSDOT organizations and the MPOs and RTPOs. See 120.04(2)(b) for a description of the WTP.

(b) **OSC Regional Planning.** The Regional Planning Branch of the Transportation Planning Office coordinates planning activities and provides technical assistance to WSDOT regions, the Office of Urban Mobility, eight MPOs, and fourteen RTPOs.

The Regional Planning Branch provides management oversight of the MPOs to ensure fulfillment of federal urban transportation planning regulations in 23 USC 134, and the RTPOs regarding state requirements in RCW 47.80, WAC 468-86, and the WSDOT Regional Planning Standards. The Regional Planning Branch also administers federal and state planning grants for these organizations

(c) **Travel Forecasting.** Travel forecasting and analysis are fundamental to planning and project development at WSDOT. These technical methods provide data for:

- Determining the location of congestion and the extent to which various strategies solve congestion problems.
- Benefit/cost analyses.
- Project design.
- Safety analyses.
- System performance.

See Chapter 130 regarding the data and services available.

(2) Public Transportation and Rail Division

The Public Transportation and Rail Division works to enhance mobility options by managing, coordinating, and advocating for rail and public transportation programs throughout the state. The division's mission is to improve transportation choices, connections, coordination, and efficiency. The division promotes freight rail programs and, in cooperation with Amtrak, passenger rail programs. The division also provides planning, project oversight, financial, and technical assistance to public transportation providers in urban and rural areas. Division staff oversees the State Commute Trip Reduction Program and provides technical assistance and grants to help reduce vehicle miles traveled by commuters in urban regions of the state.

Public Transportation and Rail Division's plans and programs add value to highway and roadway design decisions by emphasizing enhancement, improvement, and coordination of intermodal connections. It is recommended that these plans and programs be referenced during the design process to ensure intermodal coordination and efficiency.

(a) **Public Transportation Office.** Programs of the Public Transportation Office support passenger transportation systems and services through grants, technical assistance, research, and planning. The office works in partnership with local communities and governments to promote, improve, and expand public transportation resources, and accessibility to those resources, for the state. The major emphases in the Public Transportation program are:

- Implement projects and strategies identified in the *Public Transportation and Intercity Rail Passenger Plan for Washington State* and *Washington's Transportation Plan*.

- Identify, support, coordinate, and monitor the planning, capital, and operating funding needs of small urban and rural public transportation providers.
- Improve effectiveness and efficiency of public transportation through training, technical assistance, and coordination to all agencies engaged in public transportation including nonprofit agencies, and private-for-profit bus and taxi companies.
- Establish mobility options in areas where public transportation is limited or does not exist.
- Develop, implement, and manage grant programs to enhance and sustain statewide mobility.
- Monitor compliance for safety, including the drug and alcohol programs of rural public transportation providers.

(b) **Rail Office.** Intercity passenger rail and freight rail are the focus of this office. Amtrak intercity rail service and freight rail service are an important part of our state transportation system. Moving people and goods by rail is often safer and more environmentally friendly than adding traffic to our already congested highways. Improvements to the state's rail system, whether funded by the private sector or the public sector, can help mitigate the impacts of our fast growing economy and population.

The *Intercity Rail Passenger Plan for Washington State* defines a system that links major population centers throughout the state and provides the blueprint for needed improvements to these intercity rail systems. The plan emphasizes incrementally upgrading the Amtrak passenger rail system along the Pacific Northwest Rail Corridor in western Washington. The vision is to reduce travel times and provide better passenger rail service in the Pacific Northwest. Additional activities are underway in the corridor, requiring extensive coordination among various agencies and private organizations. The corridor also serves some of the world's busiest ports. WSDOT is working with the Puget Sound Regional Council and other area agencies through the Freight Action Strategy for the Everett-Seattle-Tacoma Corridor (FAST Corridor) project to plan for the elimination of at-grade highway/railroad crossing conflicts and to improve port access.

The *Washington State Freight Rail Plan* fulfills a Federal Railroad Administration requirement that the state establish, update, and revise a rail plan. It also fulfills the Washington State Legislative directive (RCW 47.76.220) that WSDOT prepare and periodically revise a state rail plan that identifies, evaluates, and encourages essential rail services. The plan identifies the abandonment status of various rail lines, provides analysis of the various alternatives to these proposed abandonment's, and provides recommendations that are incorporated into *Washington's Transportation Plan*.

(c) **Transportation Demand Management Office.** The Transportation Demand Management (TDM) Office advocates for, creates, and develops effective solutions to capacity constraints within the state transportation system. TDM Office staff provide support and technical assistance within WSDOT, and for external transportation organizations, so demand management programs can be implemented whenever such programs are appropriate and cost effective. Program support is provided in areas such as land use planning, TDM research, parking management, high capacity transportation planning, and policy development for the state's freeway high occupancy vehicle system.

The office also assists public and private employers, jurisdictions, and other interested parties with implementation of RCW 70.94.521 through 551. The goal of the commute trip reduction portion of this law is to reduce air pollution, traffic congestion, and the consumption of fossil fuels. Its focus is to get employees who drive to work alone to consider commute trip alternatives.

The TDM Office provides leadership through developing policies and guidelines that help direct public and private investment in the state's transportation system. A key emphasis of the TDM Office is to develop and maintain a TDM Strategic Plan for WSDOT. This plan will help ensure that *Washington's Transportation Plan* and all other internal planning processes incorporate TDM activities. Regional and local TDM activities and planning functions are further supported by the TDM Office through coordination and implementation of statewide TDM programs, providing public information and marketing tools, and providing training opportunities. The office also administers local TDM grant programs and planning grants that facilitate high capacity transportation development in certain urban areas of the state. The TDM Office also manages the program to monitor safety and security on light rail systems in Washington State.

(3) Highways and Local Programs Service Center

The Highways and Local Programs Service Center includes many important subprograms and offices. The Service Center helps Washington's local agencies develop their local transportation projects and qualify for federal and state funding to cover some of their project costs. This Service Center provides oversight, technical support, and training to help ensure effective delivery of projects being developed by cities, counties, ports, transit, tribes, Metropolitan Planning Organizations, Regional Transportation Planning Organizations, scenic byway organizations, other state and federal agencies, and private nonprofit agencies.

This Service Center coordinates the development of the *State Highway System Plan* (HSP) and the Statewide Transportation Improvement Program (STIP) in partnership with other WSDOT organizations and the MPOs and RTPOs. See discussions of the HSP at 120.04(2)(c), and the STIP at 120.06(3).

Another role of the Highways and Local Programs Service Center is to advocate for meeting highway and local roadway needs and to help to preserve, operate, and enhance Washington's roadways, walkways, and bike routes. This service center is Washington's designated state scenic byways agency.

(a) **Bicycle and Pedestrian Program Office (Nonmotorized).** The Highways and Local Programs Service Center is responsible for developing bicycle and pedestrian plans and programs to implement the nonmotorized objectives established by the Transportation Commission. The Bicycle and Pedestrian Program Office in the Olympia Service Center assists design engineers with mode-specific questions. To guide the actions of this office, and those working in the design offices, the Transportation Commission has adopted a *Bicycle Policy Plan* and a *Pedestrian Policy Plan*.

The *Bicycle Policy Plan* addresses four policy issues; bicycle facilities, funding, safety education and enforcement, and promoting bicycling commuting and touring. The plan also identifies the existing state roadway system as the basic network for bicycle travel. The Plan also calls for the road and bridge system to be maintained and improved to help ensure safe access by bicyclists.

WSDOT has a Bicycling Advisory Committee made up of seven citizens. Each citizen represents a region (two for the Northwest Region). The role of the committee is to advise the department on policies, issues, and needed bicycle projects and to provide insight into local bicycle issues and use around the state.

The *Pedestrian Policy Plan* focuses on local and areawide planning for pedestrians, and necessary pedestrian facility types and locations. It calls for:

- Providing pedestrian facilities that complement local business activity.
- Enhancing intermodal access (especially for those with mobility impairments).
- Maintaining the existing transportation system adequately to maximize pedestrian use.

The *State Highway System Plan* identifies four categories of bicycle and pedestrian projects:

- Urban Bicycle Projects: Building short sections of trails along or across state highways to complete local bicycle networks.
- Rural Bicycle Touring Routes: Shoulder improvements along sections of designated state routes.

- Pedestrian Accident Locations: Projects on sections of state routes that have four or more pedestrian-and-motor-vehicle collisions over a six year period.
- Pedestrian Risk Locations: Projects on sections of state routes that have a risk for pedestrian-and-motor-vehicle collisions because of pedestrian activity, traffic conditions, and roadway geometrics.

(b) **Heritage Corridors Program Office.** The purpose of the Heritage Corridors Program is to preserve the unique scenic character along Washington's transportation corridors, and to provide travelers with a continuing opportunity to appreciate and obtain information regarding unique natural, recreational, cultural, and historical features that are near to or accessible by transportation routes.

The highways, waterways, and trails in Washington State are evaluated by diversely staffed committees to select the most significant corridors to be designated as Scenic Byways or Heritage Tour Routes. Once designated, the routes are identified on the Designated (scenic and recreational) State Highways map (available from the Heritage Corridors Program office). They then become eligible for grants and partnering efforts designed to sustain visual quality and to provide access to features of interest. Scenic Byway and Heritage Tour Route designations along with roadside classification categories (see the *Roadside Manual*) are the means to focus attention on roadside visual elements and the department's role in resource stewardship.

For designated routes, the use of Design Visualization technology is recommended (during the project definition phase) to help in the selection of roadside features such as guard-rail and retaining walls. (See Chapter 710.) If requested early enough, supplemental funding for visual enhancements might be available through the Heritage Corridors Program.

The Heritage Corridors Program office, in the Olympia Service Center, works with the regions and various external entities to develop a Corridor Management Plan (CMP) for each designated route. Information from the CMPs is incorporated into Route Development Plans and from there the projects become part of the *State Highway System Plan*. This process implements the Transportation Commission's service objectives and action strategies related to heritage resources, thus implementing federal and state laws.

The *State Highway System Plan* includes projects designed to:

- Refurbish safety rest areas.
- Ensure public access to safety rest areas.
- Cooperatively promote and interpret heritage resources.
- Provide incentives for alternatives to outdoor advertising.
- Provide multimodal and visual access to heritage resources.
- Develop a statewide network of traveler information services.

Safety rest area information is in Chapter 610 of the *Roadside Manual.*

If a project is on a designated route that has an existing CMP, it will provide considerable information useful to highway designers including:

- Locations of hazards or poorly designed features and possible corrections.
- Plans for accommodating commercial and multimodal traffic.
- A signing plan.

The Heritage Corridors Program office also coordinates the following programs, products, and activities:

- National scenic byways grant administration and outreach.
- Visual & route assessment.
- Corridor Management Plan technical assistance.
- Safety rest area and traveler services plan.
- Route signing guidelines.
- Highway interpretative markers.

- Directional signing for the Watchable Wildlife Program.
- Alternatives to outdoor advertising
- Byway orientation panels.
- Heritage tour guides & brochures.

(4) WSDOT Regions and the Office of Urban Mobility

The roles of planning at WSDOT regions and at the Office of Urban Mobility (OUM) are similar in many ways. What follows are descriptions of the roles of planning at WSDOT regions and the OUM.

(a) **WSDOT Region Planning.** Each WSDOT region has a Planning Office that has several roles, such as:

- Conducting and overseeing special long range planning studies.
- Coordinating with other planning groups.
- Assisting in development of prioritized plans.
- Administering internal WSDOT programs.
- Exercising access control.
- Performing Developer Services.

For the Olympic and Northwest Regions, many of these planning functions are assigned to the Office of Urban Mobility.

The region Planning Office conducts long range planning studies such as for the *Route Development Plan*s, Corridor Master Plans, and site-specific transportation alternatives and studies. These studies evaluate alternative solutions for both existing and projected transportation needs, initiate the long-range public involvement process, and ultimately provide the foundation for inclusion of identified improvement strategies into *Washington's Transportation Plan* (WTP) and the *State Highway System Plan* (HSP).

The region Planning Office coordinates with and assists the local Metropolitan Planning Organization (MPO) and Regional Transportation Planning Organization (RTPO). (See Figure 210-1.) In some cases, the region Planning Office provides the staff support for the local RTPO.

The region works with the Washington State Patrol to include their weigh site and other highway related needs in WSDOT projects.

Often, the region Planning Office is responsible for administering internal WSDOT programs such as traffic modeling, the Travel Demand Management program (TDM), and responding to citizen concerns about pedestrian, bicycle, and other transportation related issues.

Developer Services is the process of reviewing new developments affecting state highways, such as master planned communities, major subdivisions, and commercial projects. Developers provide mitigation for their impacts to the state highway system under the State Environmental Policy Act (SEPA).

The region's Planning Office also reviews and comments on local Comprehensive Plans so development regulations, local transportation elements, and WSDOT goals and interests can be consistent.

(b) **The Office of Urban Mobility in Seattle.** The Office of Urban Mobility (OUM), in the Planning and Programming Service Center, has a similar role to a region Planning Office yet the OUM role is more specialized. The OUM oversees long range planning efforts of WSDOT in the four-county Central Puget Sound area of King, Pierce, Snohomish, and Kitsap Counties. This is the same area covered by the MPO called the Puget Sound Regional Council (PSRC), located in Seattle. The four-county region is geographically split between WSDOT's Olympic and Northwest Regions. OUM also has the responsibility of coordinating future plans developed by Washington State Ferries with the strategies contained in the *State Highway System Plan*.

The creation of OUM was a response to challenging transportation issues in the rapidly growing Puget Sound area. As transportation challenges have required more intensive coordination in the Puget Sound area, the manner in which WSDOT approached these challenges also needed to change. OUM has greatly improved the coordination of transportation planning efforts between WSDOT, the Puget Sound Regional Council, the local cities, and the four counties.

The Office of Urban Mobility also participates in the review of documents mandated by the Growth Management Act (GMA). This includes the review of draft Comprehensive Plans as well as the Draft Environmental Impact Statements that provide supporting documentation to the Comprehensive Plans. In addition, OUM reviews Draft Environmental Impact Statements for local agency proposals that might affect the operation of state facilities.

Developer Services responsibilities remain with the Northwest and Olympic Region's Planning Offices.

(5) Washington State Ferries Division

The *Long Range Ferry System Plan*, prepared by the Washington State Ferries Division, considers recent trends in ferry ridership, system costs, regional economy, and other system and site factors. It is recommended that designers contact the Washington State Ferries planning office during the design phase of any conceptual solution occurring near a ferry terminal or one that might add significant traffic to or around a ferry terminal.

(6) Aviation Division

The Aviation Division is a nonregulatory agency that:

- Provides general aviation airport aid, including an award-winning lighting program.
- Provides technical assistance for airspace and incompatible land use matters.
- Coordinates all air search and rescue and air disaster relief.
- Administers pilot and aircraft registration.

This division is responsible for development of the *Washington State Airport System Plan.* The division also operates seventeen state airports strategically placed throughout the state.

120.06 Linking Transportation Plans

The main concern of the traveling public is that the transportation system allows them to move from point A to point B quickly, safely, and with the least inconvenience and expense. To fulfill the public demand, coordination of transportation planning efforts is essential to the creation of the seamless transportation system.

(1) Coordination of Planning Efforts

Coordination of planning efforts between city, county, MPO, RTPO, public and private transportation provider, and state transportation plans is not only required by federal and state laws — it makes good business sense. Coordination of transportation planning is a cyclical process and begins as a bottom-up approach. Figure 120-2 is a diagram that explains the general relationships between the various transportation planning processes and organizations.

Cities and counties explore their needs and develop *comprehensive plans.* Among other components, each comprehensive plan contains a land use element and a transportation element, which must be consistent with each other. The transportation element (sometimes known as the *local transportation plan*) supports the land use element. The requirements in the Growth Management Act (see 120.04 (2)(d)) guide most of the comprehensive plans developed in the state of Washington.

MPOs and RTPOs coordinate and develop metropolitan and regional transportation plans. These plans cover multiple cities and, for RTPOs, encompass at least one county. The purpose of metropolitan transportation plans and regional transportation plans is to ensure that the policies, plans, and programs of each jurisdiction are consistent with neighboring jurisdictions.

Planning is undertaken to ensure consistent policy among all the various jurisdictions; whether state, regional, or local. It does not matter where the planning process begins because the process is both cyclic and iterative. If one component of a plan changes it may or may not affect other components. If any one plan changes significantly, it can affect each of the other plans in the cycle. Early communication and coordination of conceptual solutions are critical to ensuring project delivery.

(2) Transportation Improvement Programs

Figure 120-3 shows the coordination of effort that produces consistent and comprehensive transportation plans and programs.

From these transportation plans, each town, city, county, and public transportation provider develops a detailed list of projects that will be constructed in the next three or six years. This detailed list of transportation projects is called the six year Regional Transportation Improvement Program also known as the Six-Year RTIP or the three-year Metropolitan Transportation Improvement Program (MTIP).

The six-year RTIP and the three-year MTIP must be financially constrained, meaning that the total cost of all projects cannot exceed the established revenue authority. Financially constraining the RTIP and the MTIP is one method used to ensure that the list of projects represents what the local agency intends to build in the near future to implement local transportation plans. Once each town, city, and county develops its individual TIP, the RTPO and the MPO compile these individual TIPs into a regional or metropolitan TIP.

See Figure 120-3.

Each RTPO/MPO completes a Regional or Metropolitan Improvement Program (RTIP or MTIP) at least once every two years (RCW 47.80.023). The RTIP/MTIPs must meet the requirements of both federal and state laws regarding transportation improvement programs and plans. To achieve this, the RTIP/MTIP:

- Is cooperatively developed by local government agencies, public transit agencies, and the Department of Transportation within each area.
- Includes all federally funded WSDOT Highway Construction Program projects.
- Includes all significant transportation projects, programs, and transportation demand management measures proposed to be implemented during each year of the next period.
- Identifies all significant projects, whether funded by state or federal funds.
- Includes all significant projects from the local transit development plans and comprehensive transportation programs required by RCW 35.58.2795, 35.77.010(2), and 36.81.121(2) for transit agencies, cities, towns, and counties.
- Includes all transportation projects funded by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA).
- Includes all federally funded public lands transportation projects.
- Includes all WSDOT projects regardless of funding source and clearly designates regionally significant projects as such.
- Complies with all state (RCW 70.94) and federal (40 CFR 51 & 93) Clean Air Act requirements (where applicable).
- Includes only projects consistent with local, regional, and metropolitan transportation plans.
- Includes a financial section outlining how the RTIP/MTIP is financially constrained, showing sources and amounts of funding reasonably expected to be received for each year of the ensuing six/three-year period, and includes an explanation of all assumptions supporting the expected levels of funding.

Funding agencies give preference to jointly sponsored transportation projects. RTPOs and MPOs can develop jointly sponsored projects since they represent multiple agencies. Major projects backed by an RTPO or an MPO have an excellent chance of receiving funding.

(3) Development of the STIP

An important role of the WSDOT Highways and Local Programs Service Center is to collect all RTIP, MTIP, and HSP projects and assemble all of the state and federally funded projects, and the projects of regional significance, into the (three-year) Statewide Transportation Improvement Program (STIP).

Development of a new STIP every two years is required by federal law in order to expend federal transportation dollars. The state of Washington, however, develops a new STIP each year to enhance project flexibility and to ensure project delivery.

The Governor's approval of the MTIPs; plus the Federal Highway Administration's, and the Federal Transit Administration's approval of the STIP; are required prior to expenditure of federal funds.

120.07 Linking WSDOT Planning to Programming

Figure 120-4 is a process flow chart describing the overall process that a conceptual solution must go through to receive funding. This chart also generally describes the links (the symbiotic relationship) between planning and program development. Project Definition is presented in Chapter 330, Design Matrices are in Chapter 325, and Environmental Documentation is in Chapter 220.

The role of WSDOT planning is to determine *what* facilities or services will be provided *where*. The role of WSDOT programming is to determine *when* the improvements will be provided. The WSDOT Program Management Office prioritizes the projects that are selected from the financially constrained *State Highway System Plan* component of *Washington's Transportation Plan*. (See 120.04(2)(b).)

See Chapter 140, "Programming," for a discussion of the programming process as a whole. Chapter 150, "Project Development," relates planning and programming to the process of developing a project.

(1) The Role of the Program Management Office

Taking the HSP from the planning stage through the programming stage is the role of the Program Management Office of the Planning and Programming Service Center. The Program Management Office manages the statewide highway construction program including:

- Recommending subprogram funding levels.
- Developing project priorities.
- Preparing, executing, and monitoring the highway construction program.

One of the important processes the Program Management Office oversees is a process termed the *Programming Process*. The legislative authorization for this process is in RCW 47.05 under Priority Programming. The Programming Process is really the prioritization of projects that have been identified in the HSP. The Programming Process determines the order in which the needs (identified in each improvement category in the financially constrained HSP) are solved.

Subprogram categories for the service objectives and action strategies have been established, by the Transportation Commission, within WSDOT's budget to allow decision makers to determine timing and the amount of money to invest in solving transportation needs. (See the HSP for the service objectives and action strategies.) The order of the needs within each subprogram category is usually prioritized based on benefit/cost methodology: however, some subprograms do not have a prioritization methodology attached to them (such as Economic Initiatives).

The Commission may combine projects that are scheduled to be within a six-year time period to eliminate constructing projects at the same location just a few years apart.

Following completion of construction, the department evaluates the effectiveness that solving those needs had on the performance of the transportation system.

(2) WSDOT Budgets

WSDOT uses the financially constrained *State Highway System Plan* component of the twenty-year *Washington's Transportation Plan* as the basis for prioritizing and programming to select projects for the Agency Request Budget (ARB) and Current Law Budget (CLB). To be selected, a project must already be included in the HSP and, if federally funded, the STIP.

Currently, WSDOT operates on a two-year funding cycle. This is primarily because the state Legislature appropriates state transportation funds on a biennial basis. To better implement the intent of federal and state laws influencing transportation and land use, to encourage a longer range perspective in the funding of transportation projects, and to be consistent with local and regional transportation planning processes, the Washington State Transportation Commission is developing a Six Year Plan Element. WSDOT's Six Year Plan Element will be used by the Commission to develop the two-year budget proposals.

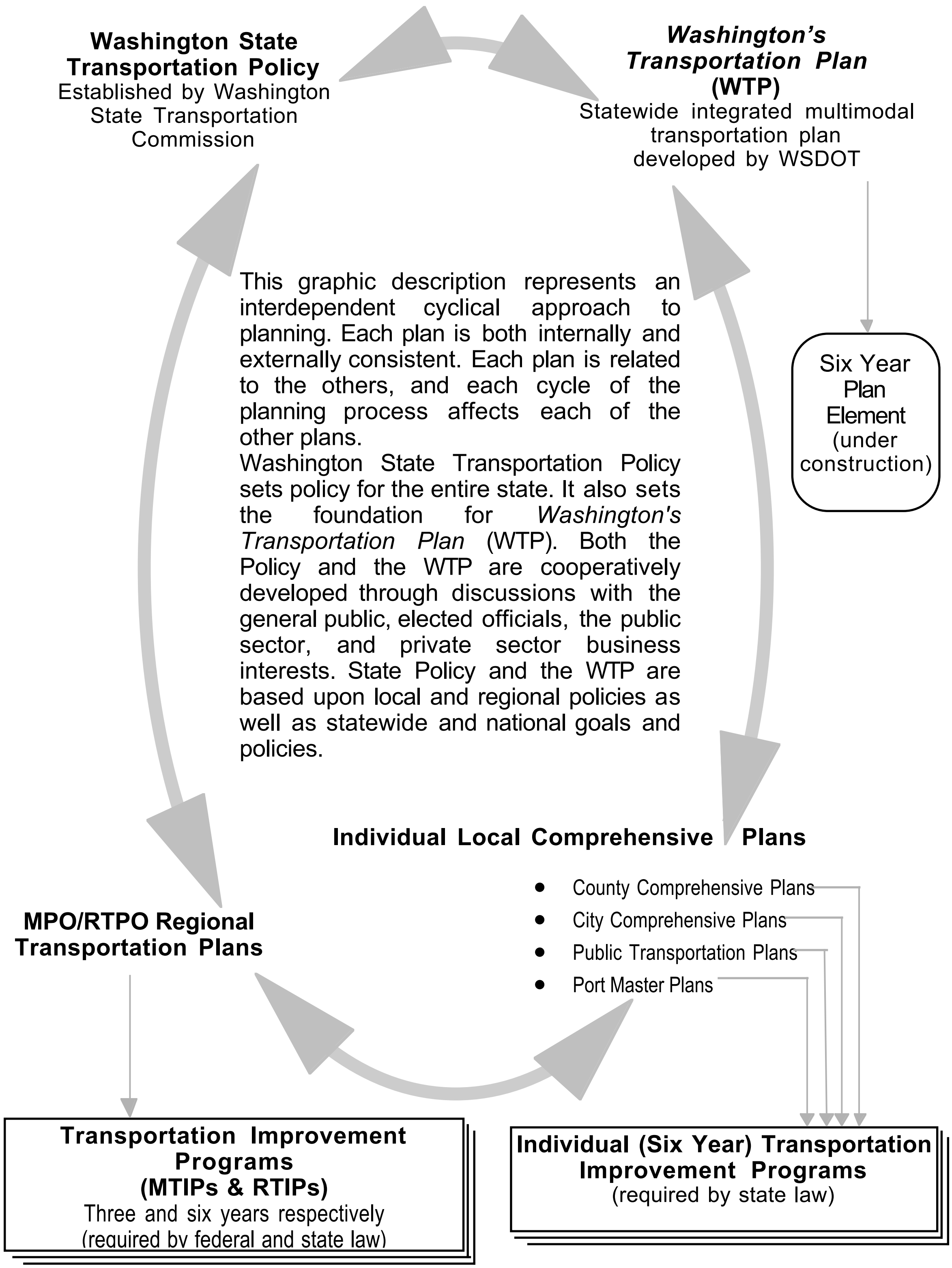
When appropriated by the Legislature, WSDOT's two-year budget is forwarded to the appropriate RTPOs and MPOs for any needed revisions to the RTIPs and MTIPs.

(3) Key Points of Planning and Programming at WSDOT

Below is a list of key points to remember about the planning and programming process:

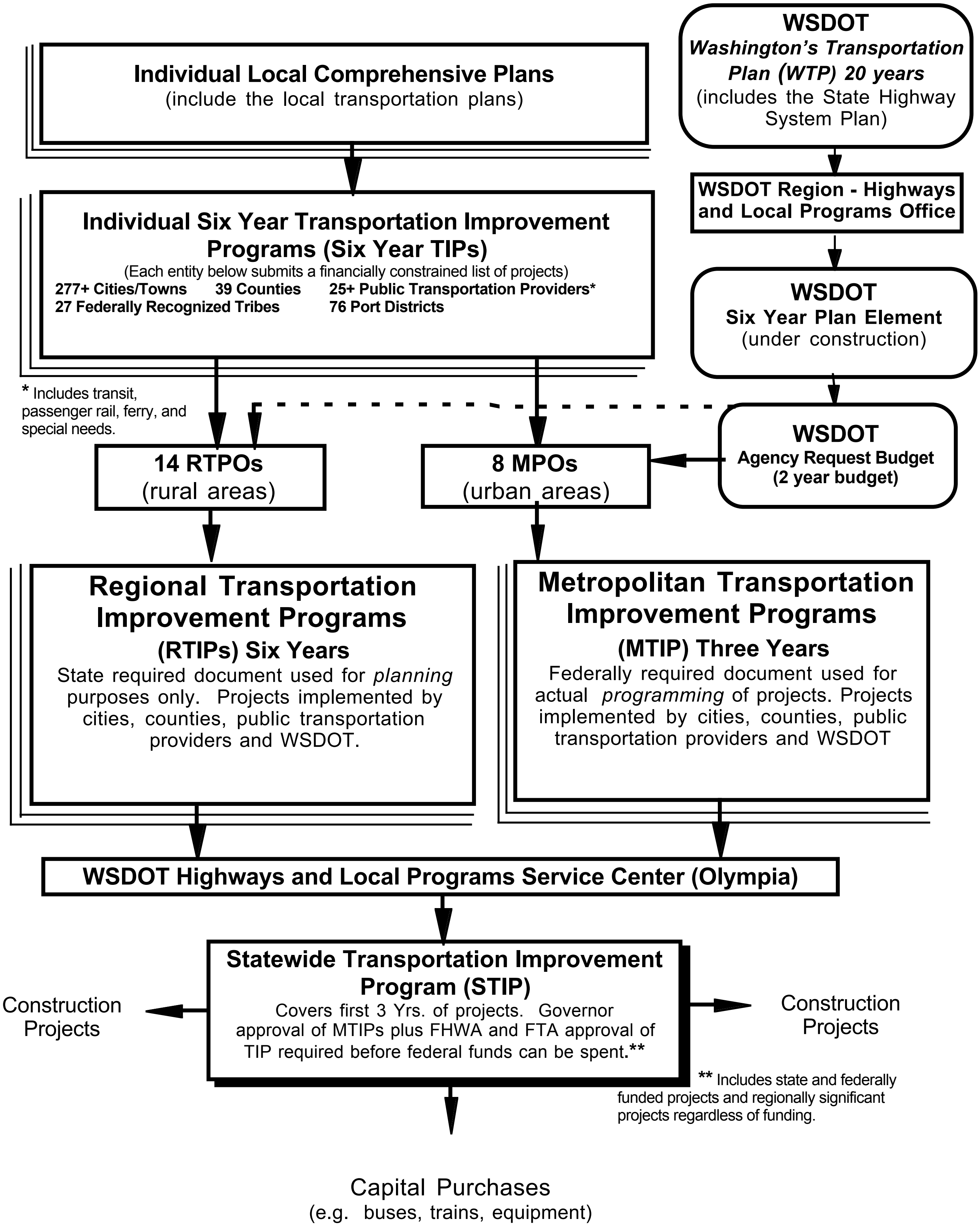
- Commission Policy sets the direction for *Washington's Transportation Plan* (WTP).
- Federal transportation laws and state transportation and land use laws guide our solutions to the needs for transportation facilities and services.
- The WTP is developed in partnership with MPOs and RTPOs and is tied directly to the land use plans of towns, cities, and counties.
- The region's Planning Offices have the main responsibility for meeting many of the state and federal planning requirements.
- The *State Highway System Plan* is a component of the WTP.
- The *State Highway System Plan* sets forth service objectives and action strategies to implement Commission policy.
- A budget structure is developed to implement each action strategy.
- Conceptual solutions are prioritized within most budget categories based on benefit/cost analyses to obtain the greatest benefit.
- Tradeoffs between project categories are made by policy choice through a multitiered process (executives, Commission, and Legislature).
- An improvement strategy must be listed in the *State Highway System Plan* to be considered for project funding.
- If federally funded, a strategy must be listed in the Statewide Transportation Improvement Program to be considered for funding.

P65:DP/DMM



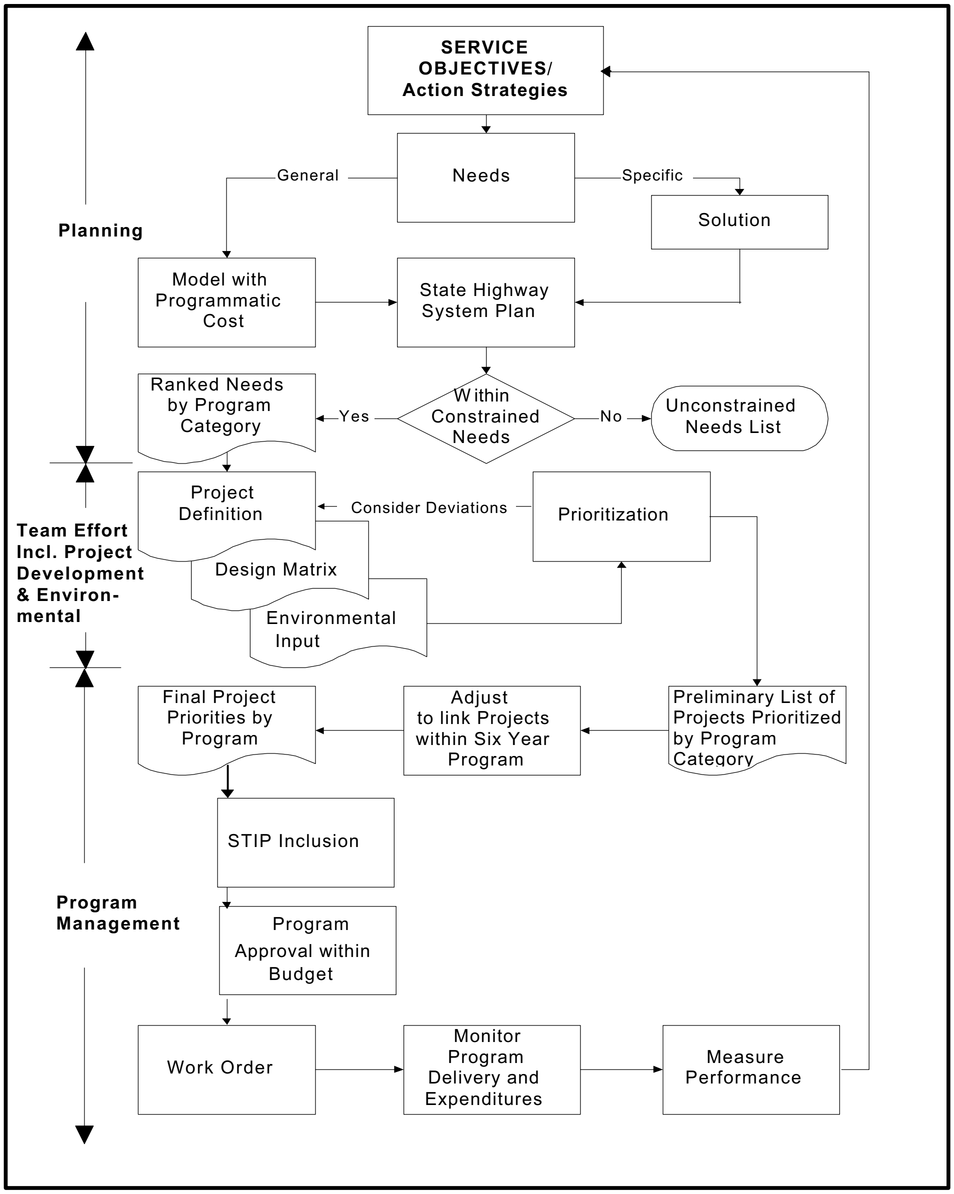
Transportation Plan Relationships

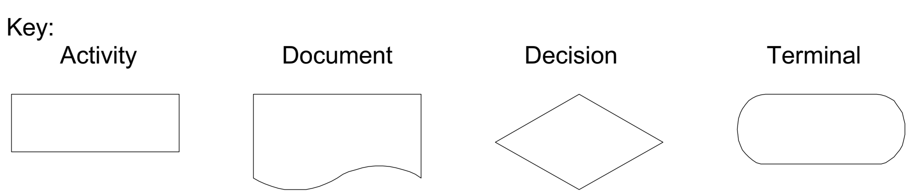
Figure 120-2



RTIP, MTIP, and STIP Development Process

Figure 120-3





Planning and Programming Links

Figure 120-4

325.01 General

This highway *Design Manual* provides guidance for three levels of design for highway projects: the basic, modified, and full design levels. The design matrices in this chapter are used to identify the design level(s) for a project and the associated processes and approval authority for allowing design variances. The matrices address the majority of preservation and improvement projects and focus on those design elements that are of greatest concern in project development.

The design matrices are five tables that are identified by route type. Two of the matrices apply to Interstate highways. The other three matrices apply to preservation and improvement projects on non-Interstate highways.

325.02 Terminology

The **National Highway System (NHS)** consists of highways designated as a part of the Interstate System, other urban and rural principal arterials, and highways that provide motor vehicle access between such an arterial and a major port, airport, public transportation facility, or other intermodal transportation facility. The NHS includes a highway network that is important to the United States strategic defense policy and provides defense access, continuity, and emergency capabilities for the movement of personnel, materials, and equipment during times of war and peace. It also includes major network connectors that provide motor vehicle access between major military installations and other highways that are part of the strategic highway network.

The **Preventive Maintenance** mentioned under project type on Interstate Design Matrices 1 and 2 includes roadway work such as pavement patching; restoration of drainage system; panel replacement; joint and shoulder repair; and bridge work such as crack sealing, joint repair, seismic retrofit, scour countermeasures and painting. Preventive maintenance projects must not degrade any existing safety or geometric aspects of the facility.

In Design Matrices 1 and 2 and in Figure 330-1, the term ***New/Reconstruction*** includes the following types of work:

- Capacity changes: add a through lane, convert a general purpose (GP) lane to a special purpose lane (such as an HOV lane), or convert an HOV lane to GP.
- Other lane changes: add or eliminate a collector-distributor or auxiliary lane. (A rural truck climbing lane that, for its entire length, meets the warrants in Chapter 1010 is not considered new/reconstruction.)
- Pavement reconstruction: full depth PCC or AC pavement replacement.
- New interchange
- Changes in interchange type such as diamond to directional
- New or replacement bridge (main line)

The **HAL, HAC, PAL, and Risk location** mentioned in the notes on Design Matrices 3, 4, and 5 are high accident locations (HAL), high accident corridors (HAC), pedestrian accident locations (PAL), and locations that have a high probability of run-off-the-road accidents based on existing geometrics (Risk).

The **Non-Interstate Freeway** mentioned on Design Matrices 3, 4, and 5 is multilane, divided highway with full access control.

The **Master Plan for Access Control** mentioned in the notes on Design Matrices 3, 4, and 5 is available from the Olympia Service Center, Design Office, Access and Hearings Unit.

The **corridor or project analysis** mentioned in notes 2 and 4 (on Design Matrices 3, 4, and 5) is the justification needed to support a change in design level from the indicated level. The analysis can be based on route continuity, and other existing features, as well as the recommendations for future improvements in an approved Route Development Plan.

(1) Project Types

Diamond Grinding is grinding a concrete pavement to remove surface wear or joint faulting.

Milling with AC Inlays is removal of a specified thickness of asphalt surfacing, typically from the traveled lanes, and then overlaying with asphalt concrete at the same specified thickness.

Nonstructural Overlay is an asphalt concrete pavement overlay that is placed to minimize the aging effects and minor surface irregularities of the existing asphalt concrete pavement structure. The existing pavement structure is not showing extensive signs of fatigue (longitudinal or alligator cracking in the wheel paths). Nonstructural overlays are typically less than 40 mm thick.

AC Structural Overlay is an asphalt concrete pavement overlay that is placed to increase the load carrying ability of the pavement structure. Structural overlay thickness is greater than or equal to 40 mm.

PCC Overlay is a Portland cement concrete pavement overlay of an existing PCC or AC pavement.

Dowel Bar Retrofit is re-establishing the load transfer efficiencies of the existing concrete joints and transverse cracks by the cutting of slots, placement of epoxy coated dowel bars, and placement of high-early strength, non-shrink concrete.

Bridge Deck Rehabilitation is repair of any delaminated concrete bridge deck and adding a protective overlay that will prevent further corrosion of the reinforcing steel.

Safety, All Others includes collision reduction, collision prevention, channelization, and signalization projects.

Safety, At Grade is a project on a multilane highway to build grade separation facilities that replace the existing intersection.

Bridge Restriction projects are listed under economic development because these bridges do not have any structural problems. However, if the vertical or load capacity restrictions are removed, then it will benefit the movement of commerce.

(2) Design Elements

The following elements are shown on the Design Matrices. If the full design level applies, see the chapters listed below. If basic design level applies, see Chapter 410. If the modified design level applies, see Chapter 430.

Horizontal Alignment is the horizontal attributes of the roadway including horizontal curvature, superelevation, and stopping sight distance; all based on design speed. (See Chapter 620 for horizontal alignment, Chapter 640 for superelevation, Chapter 650 for stopping sight distance, and Chapter 440 for design speed.)

Vertical Alignment is the vertical attributes of the roadway including vertical curvature, profile grades, and stopping sight distance; all based on design speed. (See Chapter 630 for vertical alignment, Chapters 440 and 630 for grades, Chapter 650 for stopping sight distance, and Chapter 440 for design speed.)

Lane Width is the distance between lane lines. (See Chapter 640.)

Shoulder Width is the distance between the outside or inside edge line and the edge of in-slope, or face of barrier. (See Chapter 640.)

Lane and Shoulder Taper (pavement transitions) are the rate and length of transition of changes in width of roadway surface. (See Chapters 440 and 620.)

Median Width is the distance between inside edge lines. (See Chapters 440 and 640.)

Cross Slope, Lane is the rate of elevation change across a lane. This element includes the algebraic difference in cross slope between adjacent lanes. (See Chapter 640.)

Cross Slope, Shoulder is the rate of elevation change across a shoulder. (See Chapter 640.)

On/Off Connection is the widened portion of the main line beyond the ramp terminal. (See Chapter 940.)

Fill/Ditch Slope is downward slope from edge of shoulder to bottom of ditch or catch. (See Chapter 640.)

Access is means of entering or leaving a public street or highway from an abutting private property or another public street or highway. (See Chapter 1420.)

Clear Zone is the total roadside border area, starting at the edge of the traveled way, available for use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a nonrecoverable slope, and/or a clear run-out area. (See Chapter 700.)

Signing, Delineation, Illumination are signs, guide posts, pavement markings, and lighting. (See Chapter 820 for signing, Chapter 830 for delineation, and Chapter 840 for illumination.)

Basic Safety is the safety items listed in Chapter 410.

Bridge Lane Width is the distance between lane lines on a structure. (See Chapters 440, 640 and 1120.)

Bridge Shoulder Width is the distance between outside or inside edge line and face of curb or barrier, whichever is less. (See Chapters 440, 640 and 1120.)

Bridge Vertical Clearance is the minimum height between the roadway including shoulder and an overhead obstruction. (See Chapter 1120.)

Bridge Structural Capacity is the load bearing ability of a structure. (See Chapters 440 and 1120.)

Intersections Turning Radii See Chapter 910 for definition.

Intersections Angle See Chapter 910 for definition.

Intersections Sight Distance See Chapter 910 for definition.

Barriers Terminals and Transitions Section — **Terminals** are crashworthy end treatment for longitudinal barriers that is designed to reduce the potential for spearing, vaulting, rolling, or excessive deceleration of impacting vehicles from either direction of travel. Impact attenuators are considered terminals and beam guardrail terminals include anchorage. — **Transitions** are sections of barriers used to produce a gradual stiffening of a flexible or semi-rigid barrier as it connects to a more rigid barrier or fixed objects. (See Chapter 710 and 720.)

Barriers Standard Run are guardrail and other barriers excluding terminals, transitions, attenuators, and bridge rails. (See Chapter 710.)

Barriers Bridge Rail is barrier on a bridge excluding transitions. (See Chapter 710.)

325.03 Design Matrix Procedures

When scoping, or designing a project, the following steps are used to select and apply the design matrix. Each step is further explained in this chapter.

- *Select a design matrix* by identifying the route: Interstate, NHS, or non-NHS
- Within the design matrix: for Matrices 1 and 2 *select the row* by the type of work and for Matrices 3, 4 and 5 *select the row* by identifying the project type
- *Use the design matrix* to determine the design level for the design elements of the project. Apply the appropriate design levels and document the design decisions as required by this chapter and Chapter 330.

325.04 Selecting a Design Matrix

Selection of a design matrix is based on highway system (Interstate, non-NHS and other NHS) and location (main line, interchange). (See Figure 325-1.) Figures 325-2a and 2b provide a list of NHS highways in the state of Washington. The design matrices are shown in Figures 325-4 through 325-8. Follow *Design Manual* guidance for all projects except as noted in the design matrices and elsewhere as applicable.

Route	Project	
	Main Line	**Interchange Area**
Interstate	Matrix 1	Matrix 2
NHS	Matrix 3	Matrix 4
Non-NHS	Matrix 5	Matrix 4

Design Matrix Selection Guide
Figure 325-1

325.05 Project Type

In the design matrices, row selection is based on project type or type of work. The Project Summary defines and describes the project. (Project Summary is discussed in Chapter 330.) For non-NHS and NHS routes, the project's program/subprogram might be sufficient information for identifying project type.

For project types not listed in the design matrices, consult the OSC Design Office for guidance.

See Figures 325-3a through 3c for program and subprogram titles and definitions. The various sources of funds for these subprograms carry eligibility requirements that the designers and program managers must identify and monitor throughout project development — especially if the type of work changes — to ensure accuracy when writing agreements and to avoid delaying advertisement for bids.

Some projects involve work from several subprograms. In such cases, identify the various limits of the project that apply to each subprogram. Where the project limits overlap, apply the higher design level to the overlapping portion.

325.06 Using a Design Matrix

The column headings on a design matrix are **design elements.** They are based on the following thirteen FHWA controlling design criteria: design speed, lane width, shoulder width, bridge width, structural capacity, horizontal alignment, vertical alignment, grade, stopping sight distance, cross slope, superelevation, vertical clearance, and horizontal clearance. For the column headings, some of these controlling criteria have been combined (for example, design speed is part of horizontal and vertical alignment).

For Improvement type projects, full design level applies to all design elements except as noted in design matrices and in *Design Manual* chapters as applicable.

A **blank cell** on a design matrix signifies that the design element will not be addressed because it is beyond the scope of the project.

(1) Design Levels

In the Interstate matrices, full design level applies unless otherwise noted.

In the non-Interstate matrices, design levels are noted in the cells by B, M, F, and a number corresponding to a footnote on the matrix.

The design levels of basic, modified, and full (B, M, and F) were used to develop the design matrices. Each design level is based on the investment intended for the route type and type of work. (For example, the investment is higher for Interstate reconstruction than for an overlay on a non-NHS route.)

Basic design level (B) preserves pavement structures, extends pavement service life, and maintains safe operations of the highway. See Chapter 410.

Modified design level (M) preserves and improves existing roadway geometrics, safety, and operational elements. See Chapter 430.

Full design level (F) improves roadway geometrics, safety, and operational elements. See Chapter 440 and other applicable *Design Manual* chapters for design guidance.

(2) Design Variances

Types of design variances are design exceptions (DE), evaluate upgrades (EU), and deviations.

Design exception (DE) in a matrix cell indicates an existing condition that is not standard, relative to the current design level. The condition will not be corrected unless a need has been identified in the Highway System Plan and prioritized in accordance with the programming process. A design exception must be identified in the project documents but no further justification is required.

Evaluate upgrade (EU) in a matrix cell indicates that analysis of an existing nonstandard condition is required to determine the impacts and cost effectiveness of upgrading to the standards of the applicable design level. The analysis and justification must be provided in the project documentation.

A **deviation** is required when an existing or proposed design element does not meet or exceed the applicable design level for the project and neither DE nor EU processing is indicated. Documentation of a deviation must contain justification and it must be approved at the appropriate approval level. See the Design Approval Level table in Chapter 330. Justification for a deviation must be supported by at least two of the following:

- Accident history or potential
- Benefit/cost analysis
- Engineering judgment
- Environmental issues
- Route continuity

P65:DP/DMM

State Route	NHS Route Designation	Beginning SR MP	Begin ARM	Ending SR MP	End ARM
US 2	I-5 to Idaho State Line	0.00	0.00	334.51	326.64
US 2 Couplet	Everett Couplet	0.00	0.00	1.64	0.87
US 2 Couplet	Brown Street Couplet	287.45	0.00	288.08	0.63
US 2 Couplet	Division Street Couplet	289.19	0.00	290.72	1.53
SR 3	SR 101 to SR 104	0.00	0.00	60.02	59.81
SR 4	SR 101 to I-5	0.00	0.00	62.28	62.27
I-5	Oregon State Line to Canadian Border	0.00	0.00	276.56	276.62
SR 8	SR 12 to SR 101	0.00	0.00	20.67	20.67
SR 9	SR 539 to Canadian Border	93.61	93.52	98.17	98.08
SR 9 Spur	Sumas Spur	98.00	0.00	98.25	0.24
SR 11	I-5 to Alaskan Ferry Terminal	19.93	19.93	21.28	21.28
US 12	SR 101 to Idaho State Line	0.00	0.00	434.19	430.76
US 12 Couplet	Aberdeen Couplet	0.33	0.00	0.68	0.35
SR 14	I-5 to SR 97	0.00	0.00	101.02	100.93
SR 14 Spur	Maryhill Spur	100.66	0.00	101.05	0.39
SR 16	I-5 to SR 3	0.00	0.00	29.19	27.01
SR 16 Spur	SR 16 to SR 3	28.74	0.00	29.13	0.39
SR 17	SR 395 to I-90	7.43	0.00	50.89	43.40
SR 18	So. Federal Way Park & Ride to I-5	2.20B	0.00	0.00	0.53
SR 18	I-5 to I-90	0.00	0.53	27.91	28.41
SR 20	SR 101 to I-5	0.00	0.00	59.54	59.49
SR 20 Spur	SR 20 to San Juan Ferry	47.89	0.00	55.67	7.78
SR 22	SR 97 to I-82	0.70	0.00	4.00	3.31
SR 26	I-90 to US 195	0.00	0.00	133.53	133.61
SR 26 Spur	SR 26 to US 195	133.44	0.00	133.51	0.07
SR 28	SR 2 to SR 281	0.00B	0.00	29.77	33.91
I-82	I-90 to Oregon State Line	0.00	0.00	132.60	132.57
I-90	I-5 to Idaho State Line	1.94	0.00	299.82	297.52
I-90 Reverse Lane	Reversible lane	1.99	0.00	9.44	7.45
SR 96	McCollum Park and Ride to I-5	0.00	0.00	0.52	0.52
US 97	Oregon State Line to SR 22	0.00B	0.00	61.44	61.30
US 97	I-90 to Canadian Border	133.90	118.80	336.48	321.62
US 97 Couplet	Maryhill Couplet	2.59	0.00	2.68	0.09
US 97 Spur	SR 97 to SR 2 (Orondo)	213.36	0.00	213.62	0.26
US 97 Y	SR 970 to SR 97				
SR 99	188th to SeaTac Airport	18.35	14.70	18.77	15.12
SR 99	SR 509 to SR 104	26.04	22.40	43.60	39.84
US 101	Oregon State Line to SR 401	0.00	0.00	0.46	0.46
US 101	SR 4 to I-5	28.89	28.89	367.41	365.78
US 101 Couplet	Aberdeen Couplet	87.49	0.00	91.66	4.17
US 101 Couplet	Port Angeles Couplet	249.65	0.00	251.32	1.67
SR 104	SR 101 to I-5	0.20	0.00	29.67	29.14
SR 109	Pacific Beach Access	0.00	0.00	30.25	30.29
SR 125	Oregon State Line to SR 12	0.00	0.00	6.09	6.08
SR 125 Spur	SR 125 to SR 12	6.09	0.00	6.76	0.67
SR 127	SR 12 to SR 26	0.03	0.00	27.05	27.05
SR 128	SR 12 to Idaho State Line	0.00	0.00	2.30	2.30
This list provided by the OSC Planning Office					

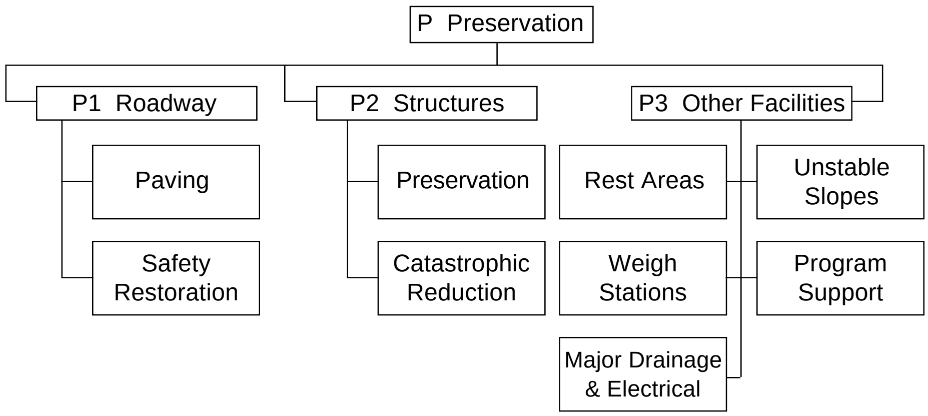
NHS Highways in Washington

Figure 325-2a

State Route	NHS Route Designation	Beginning SR MP	Begin ARM	Ending SR MP	End ARM
SR 166	Naval Fuel Depot	0.02	0.00	3.40	3.38
SR 167	I-5 to I-405	0.00	0.00	27.28	28.60
I-182	I-82 to US 395	0.00	0.00	15.19	15.19
US 195	Idaho State Line to I-90	0.00B	0.00	95.99	93.37
US 195 Spur	US 195 to Idaho State Line	0.06	0.00	0.60	0.54
I-205	Oregon State Line to I-5	26.59	0.00	37.16	10.57
SR 240	Hanford Access	30.63	28.86	34.87	33.10
SR 270	SR 195 to Idaho	0.00	0.00	9.89	9.89
SR 270	Pullman Couplet	2.67	0.00	2.90	0.23
SR 270	SR 195 Y Connection	0.00	0.00	0.38	0.38
SR 281	SR 28 to I-90	0.00	0.00	10.55	10.55
SR 281 Spur	SR 281 to I-90	2.65	0.00	4.34	1.69
SR 303	SR 3 to SR 304	0.00B	0.00	8.73	8.89
SR 304	SR 16 to Bremerton Ferry	0.00	0.00	3.51	3.24
SR 305	SR 3 to Winslow Ferry	0.02	0.00	13.52	13.50
SR 307	SR 305 to SR 104	0.00	0.00	5.25	5.25
SR 310	SR 3 to SR 304	0.00	0.00	1.84	1.84
US 395	Congressional High Priority Route	13.05	13.05	270.26	275.09
SR 401	SR 101 to SR 4	0.00	0.00	12.13	12.13
I-405	I-5 to I-5	0.00	0.00	30.32	30.30
SR 432	SR 4 to I-5	0.00	0.00	10.33	10.32
SR 433	Oregon State Line to SR 432	0.00	0.00	0.94	0.94
SR 500	I-5 to SR 503	0.00	0.00	5.96	5.96
SR 501	I-5 to Port of Vancouver	0.00	0.00	3.83	3.42
SR 502	I-5 to SR 503	0.00B	0.00	7.56	7.58
SR 503	SR 500 to SR 502	0.00	0.00	8.09	8.09
SR 509	SR 99 to 12th Place S	24.35B	26.13	29.83	33.11
SR 509	Pacific Ave. to Marine View Drive	0.22	1.44	3.20	4.42
SR 512	I-5 to SR 167	0.00	0.00	12.06	12.06
SR 513	Sandpoint Naval Air Station	0.00	0.00	3.35	3.35
SR 516	I-5 to SR 167	2.03	2.02	4.72	4.99
SR 518	I-5 to SR 509	0.00	0.00	3.81	3.42
SR 519	I-5 to Seattle Ferry Terminal	0.00	0.00	1.14	1.14
SR 520	I-5 to SR 202	0.00	0.00	12.83	12.82
SR 522	I-5 to SR 2	0.00	0.00	24.68	24.68
SR 524	Lynnwood Park and Ride to I-5	4.64	4.76	5.20	5.32
SR 524 Spur	Cedar Way Spur - Lynnwood Park and Ride to I-5	4.64	0.00	5.14	0.50
SR 525	I-5 to SR 20	0.00	0.00	30.49	30.72
SR 526	SR 525 to I-5	0.00	0.00	4.52	4.52
SR 529	Everett Homeport	0.00	0.00	2.20	2.20
SR 539	I-5 to Canadian Border	0.00	0.00	15.16	15.16
SR 543	I-5 to Canadian Border	0.00	0.00	1.09	1.09
SR 546	SR 539 to Canadian Border	0.00	0.00	8.02	8.02
I-705	I-5 to Schuster Parkway	0.00	0.00	1.50	1.50
SR 970	I-90 to SR 97	0.00	0.00	10.31	10.31
SR 970 Y	Y connection to US 97	0.00	0.00	0.10	0.10
This list provided by the OSC Planning Office					

NHS Highways in Washington (continued)
Figure 325-2b

Highway Capital Preservation Program



P **Preservation** — Preserve the highway infrastructure cost effectively to protect the public investment.

P1 **Roadway**

1. Repave highways at regular intervals to minimize long-term costs.
2. Restore existing safety features.

P2 **Structures**

1. Rehabilitate or replace existing bridges and other structures to preserve operational and structural integrity.
2. Reduce the risk of naturally caused catastrophic bridge failures.

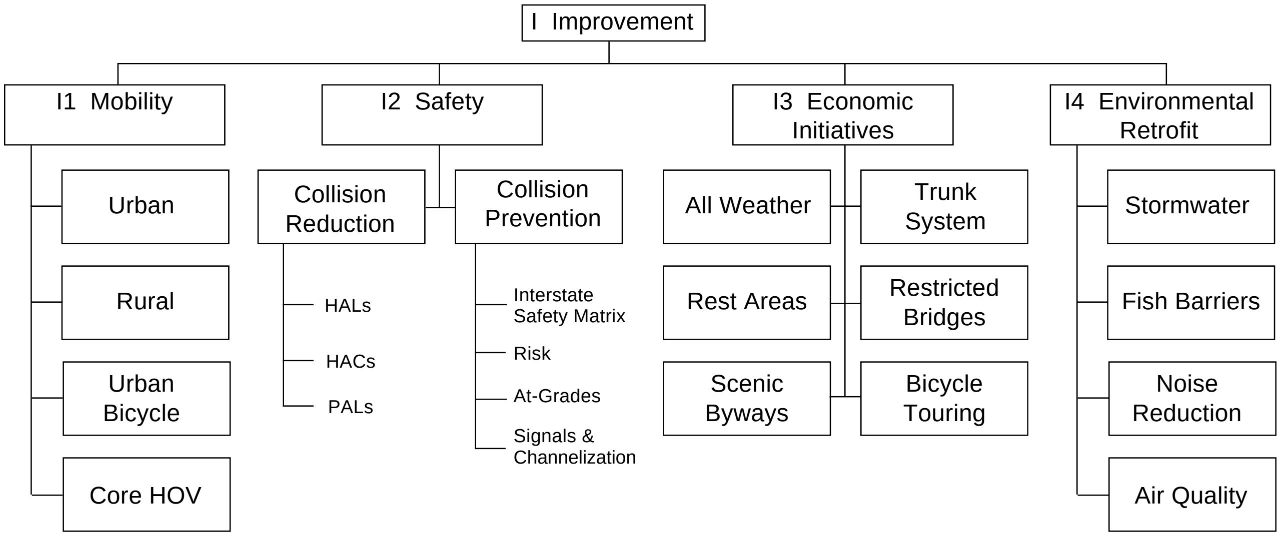
P3 **Other Facilities**

1. Refurbish rest areas to extend service life and improve safety.
2. Construct weigh facilities to ensure enforcement across the entire highway system.
3. Refurbish electrical systems, electronics, and mechanical systems to extend service life and improve safety. Rehabilitate or replace existing major drainage features to preserve operational and structural integrity.
4. Stabilize known unstable slopes.
5. The program support subcategory consists of critical construction support items that are required to maintain efficiency and ensure continued progress of the construction programs.

Paraphrased excerpt from the *State Highway System Plan*, State Highway System Plan Service Objectives and Action Strategies.

Preservation Program
Figure 325-3a

Highway Capital Improvement Program



I Improvement

I1 Mobility — Improve mobility within congested highway corridors.

1. Mitigate congestion on urban highways in cooperation with local and regional jurisdictions when the peak period level of service falls below Level of Service D.
2. Provide uncongested condition (Level of Service C) on rural highways.
3. Provide bicycle connections along or across state highways within urban growth areas to complete local bicycle networks.
4. Complete the Freeway Core HOV Lane System in the Puget Sound region.
5. Provide uncongested conditions (Level of Service C) on high occupying vehicle (HOV) lanes.

I2 Safety — Provide the safest possible highways within available resources.

1. Improve highway sections that have a high accident history.
2. Improve geometrics of the Interstate System per the Federal Highway Administration (FHWA)/WSDOT Stewardship Agreement.
3. Improve roadways where geometrics, traffic volumes, and speed limits indicate a high accident potential.
4. Eliminate major at-grade intersections on multilane highways with speed limits of 45 mph or higher.
5. Construct intersection channelization, signals, or both when traffic volume warrants (thresholds) are met.

Paraphrased excerpt from the *State Highway System Plan*, State Highway System Plan Service Objectives and Action Strategies.

Improvement Program
Figure 325-3b

I3 Economic Initiatives — Support efficient and reliable freight movement on state highways. Support tourism development and other Washington industries.

1. Upgrade state highways on the Freight and Goods Transportation System (FGTS) to have an all-weather surface capable of supporting legal loads year-round
2. Provide four-lane limited access facilities on a trunk system consisting of all FGTS highways with a T-1 classification (truck travel exceeding 10,000,000 tons per year).
3. Ensure public access to appropriately sized, rest room equipped facilities every 60 miles on the NHS and Scenic & Recreational (S & R) highways.
4. Where cost effective, replace or modify structures on the Interstate System with restricted vertical clearance.
5. Where cost effective, replace or modify structures that cannot carry legal overloads.
6. Cooperatively promote and interpret the heritage resources along S & R highways, including providing incentives for alternatives to outdoor advertising.
7. On rural bicycle touring routes, provide a minimum of 1.2 m shoulders (structures are not included).

I4 Environmental Retrofit — Retrofit state highway facilities as appropriate to reduce existing environmental impacts.

1. Reconstruct storm water discharge facilities as opportunities arise.
2. Remove identified fish passage barriers.
3. Reduce the public's exposure to noise from state highway facilities where local land use authorities have adopted development regulations which reduce future exposure to excessive noise levels near highway facilities.
4. Implement the WSDOT Transportation Control Measures required by the Statewide Implementation Plan for Air Quality.

Paraphrased excerpt from the *State Highway System Plan,* State Highway System Plan Service Objectives and Action Strategies

Improvement Program (continued)
Figure 325-3c

DESIGN MATRIX 1

Interstate Routes (Main Line)

Figure 325-4

⇩ Project Type															Bridges			Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width (13)	On/Off Conn't.	Median Width	Cross Slope Lane	Cross Slope Shldr	Fill/Ditch Slopes	Clear Zone	Sign. (10)	Delini. (9)	Illumin.	Vert. Clear. (11)	Lane Width	Shldr Width	Structural Capacity	Term. & Trans. Section (12)	Std Run	Bridge Rail (14)
(1-1) Preventive Maintenance																				
Pavement Restoration																				
(1-2) Diamond Grinding										EU	EU	F		DE				F	EU	F
(1-3) Milling with ACP Inlays									EU	F	EU	F		DE				F	EU	F
(1-4) Nonstructural Overlay				DE			EU	EU	EU	F	EU	F		EU				F	F	F
Pavement Rehab./Resurf.																				
(1-5) ACP Structural Overlays	EU	DE	F	F	F	DE	F	EU	F	F	EU	F	F	F	F	DE		F	F	F
(1-6) PCCP Overlays	EU	DE	F	F	F	DE	F	EU	F	F	EU	F	F	F	F	DE		F	F	F
(1-7) Dowel Bar Retrofit	EU	DE	F	F	F	DE	DE		F	F	EU	F	F	DE		DE		F	F	F
Bridge Rehabilitation																				
(1-8) Bridge Deck Rehabilitation												F		F	F	DE	(11)	F (6)		F
Reconstruction (16)																				
(1-9) New/Reconstruction	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

☐ Not Applicable
F Full design level
M Modified design level. See Chapter 430.
DE Design Exception to full design level.
EU Evaluate Upgrade to full design level.

(6) Applies only to bridge end terminals and transition sections.
(9) Continuous shoulder rumble strips required in rural areas. See Chapter 700.
(10) See Chapter 820.
(11) See Chapter 1120.
(12) Impact attenuators are considered as terminals.
(13) See Chapter 440 and 640.
(14) Includes crossroad bridge rail.
(16) For design elements not in the matrix headings, apply full design level as found in the applicable *Design Manual* chapters.

DESIGN MATRIX 2

Interstate Interchange Areas

Figure 325-5

⇩ Project Type	Ramps and Collector Distributors																			Cross Road										
														Ramp Terminals			Barriers											Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane & Shldr. Taper	On/Off Conn't.	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Limited Access	Clear Zone	Vertical Clear. (11)	Sign., Del., Illumin.	Turn Radii	Angle	I/S Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail	Lane Width	Shldr Width	Vert. Clear.	Ped. & Bike	Limited Access	Fill/ Ditch Slopes	Clear Zone	Sign., Del., Illumin.	Term. & Trans. Section (12)	Std . Run	Bridge Rail
(2-1) **Preventive Maintenance**																														
Pavement Restoration																														
(2-2) Diamond Grinding											EU		F (15)				F	EU	F							EU	F (15)	F	EU	F
(2-3) Milling with ACP Inlays									EU		F	F	F (15)				F	F	F						EU	F	F (15)	F	F	F
(2-4) Nonstructural Overlay							EU	EU	EU		F	F	F (15)				F	F	F						EU	F	F (15)	F	F	F
Pavement Rehab./Resurf.																														
(2-5) ACP Structural Overlays	EU	DE	F	F	F	F	F	EU	F	F	F	F	F (15)	F	F	F	F	F	F	DE	DE	F	DE	F	DE	F	F (15)	F	F	F
(2-6) PCCP Overlays	EU	DE	F	F	F	F	F	EU	F	F	F	F	F (15)	F	F	F	F	F	F	DE	DE	F	DE	F	DE	F	F (15)	F	F	F
(2-7) Dowel Bar Retrofit	DE		DE	DE	F	F	DE		F	F	F	DE	F (15)	F	F	F	F	F	F					F			F (15)	F	F	F
Bridge Rehabilitation																														
(2-8) Bridge Deck Rehabilitation												F					F (6)		F			F						F (6)		F
Reconstruction (16)																														
(2-9) New/Reconstruction	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

☐ Not Applicable
F Full design level
M Modified design level. See Chapter 430.
DE Design Exception to full design level.
EU Evaluate Upgrade to full design level.

(6) Applies only to bridge end terminals and transition sections.
(10) See Chapter 820.
(11) See Chapter 1120.
(12) Impact attenuators are considered as terminals.
(15) EU for signing and illumination.
(16) For design elements not in the matrix headings, apply full design level as found in the applicable *Design Manual* chapters.

DESIGN MATRIX 3

NHS Routes (Main Line)

Figure 325-6

⇩ Project Type														BRIDGES				INTERSECTIONS			BARRIERS		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane & Shldr Taper	Median Width	Cross Slope Lane	Cross Slope Shldr	On/Off Conn.	Fill/ Ditch Slopes	Access (3)	Clear Zone	Sign., Del., Illumin.	Basic Safety	Lane Width	Shldr Width	Vertical Clear-ance	Structural Capacity	Turn Radii	Angle	Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail
Preservation																								
Roadway																								
(3-1) Non-Interstate Freeway	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F		B	B	DE/F	DE/F	F					B	B	F
(3-2) ACP/PCCP/BST Overlays	DE/M	DE/M	DE/M	DE/M	DE/F	DE/M	DE/M	DE/M	DE/F	DE/M			B	B	DE/M	DE/M	F				B	B	B	F
(3-3) Repl. ACP w/ PCCP at I/S	DE/M	DE/M	EU/M	EU/M	DE/F	DE/M	EU/M	DE/M		DE/M			B	B	DE/M	DE/M	F				B	B	B	F
Structures																								
(3-4) Bridge Replacement	F (2)	F (2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F (2)		F	F		F (2)	F (2)	F	F (11)	F (2)	F (2)	F	F	F	F
(3-5) Bridge Deck Rehab.													B	B			F					B (6)		F
Improvements (16)																								
Mobility																								
(3-6) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F (11)	F	F	F	F	F	F
(3-7) Urban	F (2)	F (2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F (11)	F (2)	F (2)	F	F	F	F
(3-8) Rural	F (2)	F (2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F (11)	F (2)	F (2)	F	F	F	F
(3-9) HOV	F (2)	F (2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F (11)	F (2)	F (2)	F	F	F	F
(3-10) Bike/Ped. Connectivity	(5)	(5)	(5)	(5)	(5)		(5)	(5)		(5)	(5)	(5)	(5)		(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Safety																								
(3-11) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F		F	F	F	F	F	F
(3-12) All Others (1)	M(4)	M(4)	M (4)	M (4)	F	M (4)	M (4)	M (4)	M (4)	M (4)	EU/F	F	F		M (4)	M (4)	F		M (4)	M (4)	F	F	F	F
Economic Development																								
(3-13) Freight & Goods (Frost Free) (8)	F(2)	F(2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F (2)	EU/F	F	B		DE/F	DE/F	F	F (11)	EU/F	EU/F	EU/F	F	F	F
(3-14) 4-Lane Trunk System	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F (11)	F	F	F	F	F	F
(3-15) Rest Areas (New)	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F (11)	F	F	F	F	F	F
(3-16) Bridge Restrictions	F(2)	F(2)	F(2)	F(2)	F	F(2)	F(2)	F(2)	F(2)	F(2)		F	F		F(2)	F(2)	F	F (11)	F (2)	F (2)	F	F	F	F
(3-17) Bike Routes (Shldrs)			EU/M	(7)	EU/F			EU/M		EU/M			B	B	EU/M	EU/M	F				B	F	B	EU/F

☐ Not Applicable
F Full design level
M Modified design level. See Chapter 430.
B Basic design level. See Chapter 410.
DE Design Exception
EU Evaluate Upgrade

(1) Collision Reduction (HAL, HAC, PAL), or Collision Prevention (Risk, At Grade Removal, Signalization & Channelization). Specific deficiencies that created the project must be upgraded to design level as stated in the matrix.
(2) Modified design level may apply based on a corridor or project analysis. See 325.02.
(3) If designated in Limited Access Master Plan apply limited access standards, if not access management standards apply. See Chapter 920.
(4) Full design level may apply based on a corridor or project analysis. See 325.02.
(5) For bike/pedestrian design see Chapter 1020.
(6) Applies only to bridge end terminal and transition sections.
(7) 1.2 m minimum shoulders.
(8) If all weather structure can be achieved with spot digouts and overlay, Modified Design Level Applies.
(11) See Chapter 1120.
(12) Impact attenuators are considered as terminals.
(16) For design elements not in the matrix headings, apply full design level as found in the applicable *Design Manual* chapters.

Design Matrix 3
NHS Routes (Main Line)
Figure 325-6

DESIGN MATRIX 4

Non-Interstate Interchange Areas

Figure 325-7

⇩ Project Type	Ramps and Collector Distributors													Ramp Terminals			Barriers			Cross Road									Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane & Shldr. Taper	On/Off Conn.	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Access (3)	Clear Zone	Sign., Del., Illumin.	Basic Safety	Turn Radii	Angle	I/S Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail	Lane Width	Shldr Width	Vert. Clear.	Ped. & Bike	Access (3)	Sign., Del., Illumin.	Fill/ Ditch Slopes	Clear Zone	Basic Safety	Term. & Trans. Section (12)	Std . Run	Bridge Rail
Preservation																															
Roadway																															
(4-1) Non-Interstate Freeway	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F		B	B	DE/F	DE/F	DE/F	B	B	F	DE/F	DE/F	F			B	DE/F		B	B	B	F
(4-2) ACP/PCCP/BST Overlays												B	B			B	B	B	F			F			B			B	B	B	F
Ramps																															
Structures																															
(4-3) Bridge Replacement	F(2)	F(2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F	F	F		F	F	F	F	F	F	F (2)	F (2)	F	F	F	F	F (2)	F		F	F	F
(4-4) Bridge Deck Rehab												B	B				B (6)		F			F			B			B	B (6)		F
Improvements (16)																															
Mobility																															
(4-5) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F
(4-6) Urban	F(2)	F(2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F	F	F	F (2)	F (2)	F	F	F	F	F (2)	F		F	F	F
(4-7) Rural	F(2)	F(2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F	F	F	F (2)	F (2)	F	F	F	F	F (2)	F		F	F	F
(4-8) HOV By Pass	F(2)	F(2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F	F	F	F (2)	F (2)	F	F	F	F	F (2)	F		F	F	F
(4-9) Bike/Ped. Connectivity	(5)	(5)	(5)	(5)	(5)		(5)	(5)	(5)	(5)	(5)	(5)		(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)		(5)	(5)			(5)	(5)	(5)
Safety																															
(4-10) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F		F	F	F	F		F	F	F
(4-11) At Grade (1)	F(2)	F(2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F	F	F	F (2)	F (2)	F	F	F	F	F (2)	F		F	F	F
(4-12) All Others (1)	M(4)	M(4)	M (4)	M (4)	F	M (4)	M (4)	M (4)	M (4)	EU/F	F	F		M (4)	M (4)	F	F	F	F	F (2)	F (2)	F		EU/F	F	M (4)	F		F	F	F
Economic Development																															
(4-13) Four-Lane Trunk System	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F		F	F	F	F		F	F	F

☐ Not Applicable
F Full design level
M Modified design level. See Chapter 430.
B Basic design level. See Chapter 410.
DE Design Exception
EU Evaluate Upgrade

(1) Collision Reduction (HAL, HAC, PAL), or Collision Prevention (Risk, Signalization & Channelization). Specific deficiencies that created the project must be upgraded to design level as stated in matrix.
(2) Modified design level may apply based on a corridor or project analysis. See 325.02.
(3) If designated in limited access master plan apply limited access standards, if not access management standards apply. See Chapter 920.
(4) Full design level may apply based on a corridor or project analysis. See 325.02.
(5) For bike/pedestrian design see Chapter 1020.
(6) Applies only to bridge end terminals and transition sections.
(7) 1.2 m minimum shoulders.
(12) Impact attenuators are considered as terminals.
(16) For design elements not in the matrix headings, apply full design level as found in the applicable *Design Manual* chapters.

DESIGN MATRIX 5
Non-NHS Routes
Figure 325-8

⇩ Project Type														Bridges				Intersections			Barriers		
Design Elements ⇨	Horiz. Align.	Vert. Align.	Lane Width	Shldr Width	Lane & Shldr Taper	Median Width	Cross Slope Lane	Cross Slope Shldr	Fill/ Ditch Slopes	Access (3)	Clear Zone	Sign, Del., Illumin.	Basic Safety	Lane Width	Shldr Width	Vertical Clear.	Structural Capacity	Turn Radii	Angle	Sight Dist.	Term. & Trans. Section (12)	Std Run	Bridge Rail
Preservation																							
Roadway																							
(5-1) ACP/PCCP												B	B			F				B	B	B	F
(5-2) BST																							
(5-3) BST Routes/Basic Safety												B	B							B	B	B	F
(5-4) Replace ACP with PCCP at I/S			EU/M	EU/M		EU/M	EU/M					B	B			F					B	B	F
Structures																							
(5-5) Bridge Replacement	M	F	M	M	F		M	M	M		F	F		F (2)	F (2)	F	F(11)	M	M	F	F	F	F
(5-6) Bridge Repl. (Multi-Lane)	F (2)	F (2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)		F	F		F (2)	F (2)	F	F(11)	F (2)	F (2)	F	F	F	F
(5-7) Bridge Deck Rehab												B	B								B (6)	F	F
Improvements (16)																							
Mobility																							
(5-8) Urban (Multilane)	F (2)	F (2)	F (2)	F (2)	F	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F	F (11)	EU/F	EU/F	F	F	F	F
(5-9) Urban	M	M	M	M	F		M	M	M	F	F	F		M	M	F	F (11)	EU/M	EU/M	F	F	F	F
(5-10) Rural	M	M	M	M	F	M	M	M	M	F	F	F		M	M	F	F (11)	EU/M	EU/M	F	F	F	F
(5-11) HOV	M	M	M	M	F	M	M	M	M	F	F	F		M	M	F	F (11)	EU/M	EU/M	F	F	F	F
(5-12) Bike/Ped. Connectivity	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)		(5)	(5)	(5)	(5)	(5)	(5)	5	(5)	(5)	(5)
Safety																							
(5-13) Non-Interstate Freeway	F(2)	F (2)	F (2)	F (2)	F (2)	F (2)	F (2)	F (2)	F (2)	F	F	F		F (2)	F (2)	F		F (2)	F (2)	F	F	F	F
(5-14) All Others (1)	EU/M	EU/M	EU/M	EU/M	EU/F	EU/M	EU/M	EU/M	EU/M	EU/F	F	EU/F		EU/M	EU/M	EU/F		EU/M	EU/M	EU/F	F	F	EU/F
Economic Development																							
(5-15) Freight & Goods(Frost Free)(8)	EU/M	EU/M	EU/M	EU/M	EU/F	EU/M	M	M	EU/M		F	B	B	EU/M	EU/M	F		EU/M	EU/M	EU/F	F	B	F
(5-16) Rest Areas(New)	F	F	F	F	F	F	F	F	F	F	F	F		F	F			F	F	F	F	F	F
(5-17) Bridge Restrictions	M	F	M	M	F	M	M	M	M		F	F		M	M	F	F(11)	M	M	F	F	F	F
(5-18) Bike Routes (Shldrs)			EU/M	(7)	EU/F			EU/M	EU/M			B	B	EU/M	EU/M					B	F	B	EU/F

☐ Not Applicable
F Full design level
M Modified design level. See Chapter 430
B Basic design level. See Chapter 410
EU Evaluate Upgrade

(1) Collision Reduction (HAL, HAC, PAL), or Collision Prevention (Risk, Signalization & Channelization). Specific deficiencies that created the project must be upgraded to design level as stated in matrix.
(2) Modified design level may apply based on a corridor or project analysis. See 325.02.
(3) If designated in Limited Access Master Plan, apply limited access standards. If not, access management standards apply. See Chapter 920.
(5) For bike/pedestrian design see Chapter 1020.
(6) Applies only to bridge ends terminal and transition sections.
(7) 1.2 m minimum shoulders.
(8) If all weather structure can be achieved with spot digouts and overlay, basic design level applies. See Chapter 820.
(11) See Chapter 1120.
(12) Impact attenuators are considered as terminals.
(16) For design elements not in the matrix headings, apply full design level as found in the applicable *Design Manual* chapters.

Definition states the needs, the purpose of the project, program categories, and the design matrices that were used to develop the Project Definition. This information determines the level of documentation and evaluation that is needed for approval of the design. The Project Summary is completed in the project definition phase.

Once the project has been formally adopted into the WSDOT operating program, project development continues. Design of projects is further refined by a project manager through an interdisciplinary team process. Projects continue with the development of environmental and design documentation.

330.06 Design Documentation

(1) FHWA Requirements

For projects on the Interstate system, the level of FHWA oversight varies according to the type of project, the agency doing the work, and the funding source. See Figure 330-1 for details.

FHWA operational acceptance is required for any new or revised access point on the Interstate system, regardless of funding. (See Chapter 1425.)

Documentation for projects requiring FHWA review and approval is submitted through the Olympia Service Center (OSC) Design Office. Include the following items if applicable to the project:

- Project Definition (form)
- Environmental Review Summary (form)
- Design Decisions Summary (form)
- Design Variance Inventory (form) with support information for EUs and deviations
- Cost estimate
- NEPA documentation
- Design Clear Zone Inventory (form)
- Interchange plans, and profiles (and roadway sections if appropriate)
- Traffic projections and analysis
- Accident analysis
- The report requesting new or revised access points

The forms listed above (Project Definition, Environmental Review Summary, Design Decisions Summary) are generated by the Project Summary database. Specific on-line instructions for filling them out are contained in the database.

(2) Design Documents

The design portion of the project file preserves the decision documents generated during the design process. A summary (list) of these documents is recommended because projects vary in scope and the documents applicable to the project vary accordingly.

The design documents commonly included in the project file for all but the simplest projects are listed below. The ERS, PD, and DDS forms are in the Project Summary database which includes on-line instructions.

- Documentation of any design decision to do more, or less, than WSDOT guidance indicates and documentation of design decisions for components not addressed by WSDOT guidance. (These may be separate documents or portions of the documents listed below.)
- Environmental Review Summary (ERS form)
- Project Definition (PD form)
- Design Decisions Summary (DDS form)
- Corridor or project analysis. See Chapter 325 for definition and Figures 330-5a and 5b.
- Design Variance Inventory (form) with support information for EUs and deviations
- Cost Estimate
- Design Clear Zone Inventory (form)
- Copies of interchange plans, intersection plans, and profiles (and roadway sections if appropriate)
- SEPA and NEPA documentation
- Work Zone Traffic Control Strategy
- Other project components: Provide documentation in the project file as detailed in the applicable *Design Manual* chapters.

Documentation is not required for components not related to the project.

The Design Variance Inventory is required for NHS roadway preservation projects only. This form lists all design exceptions, evaluate upgrades not upgraded to the applicable design level, and deviations. See Figure 330-6 for a sample evaluate upgrade and Figures 330-7a and b and 8a and b for sample deviations.

The Project Definition and Environmental Review Summary are required for all projects.

The Design Decisions Summary form is not required for the following project types unless they involve reconstructing the lanes, shoulders, or fill slopes. Since these project types are not included in the design matrices, evaluate them with respect to modified design level (M) for non-NHS routes and full design level (F) for all others.

- Bridge painting
- Crushing and stockpiling
- Pit site reclamation
- Lane marker replacement
- Guidepost replacement
- Signal rephasing
- Signal upgrade
- Seismic retrofit
- Bridge joint repair
- Navigation light replacement
- Signing upgrade
- Illumination Upgrade
- Rumble Strips
- Electrical upgrades
- Major Drainage
- Slope Stability*
- Bridge scour
- Fish passage
- Other projects as approved by OSC Design

*Address rock scour within the project limits whenever feasible.

330.07 Design Approval

Design Approval is the approval of the design file. When the design file is complete, the region takes an action to make an approval that becomes part of the file. Figure 330-1 identifies the approval levels for design, evaluate upgrades (EUs), and deviations. The following items must be approved prior to design approval:

- Required environmental documentation (NEPA, SEPA)
- Project Summary (includes Project Definition, Design Decision Summary, and Environmental Review Summary)
- Design Variance Inventory (includes evaluate upgrades and deviations)
- Cost estimate

See Figures 330-1 through 4 for review and approval levels for project design and PS&E documents. Figures 330-2, 330-3, and 330-4 are summaries of information provided in other WSDOT documents.

330.08 Process Review

The process review is done to provide reasonable assurance that projects are prepared in compliance with established standards and procedures and that adequate records exist to show compliance with state and federal requirements.

The design and PS&E process review is performed in each region at least once each year by the OSC Project Development Branch. Four documents are used in the review process: the Design Review Check List, PS&E Review Check List, Design Review Summary, and PS&E Review Summary. These are generic forms used for all project reviews. Copies of these working documents are available for reference when assembling project documentation. OSC Design Office, Project Development maintains current copies on Exchange and on the Internet. For paper copies or a specific electronic address contact the OSC Project Development Branch.

Each project selected for review is examined completely and systematically beginning with the project definition and the project summary phase and continuing through contract plans and (when

430 Modified Design Level

430.01 General

Modified design level (M) preserves and improves existing roadway geometrics, safety, and operational elements. This chapter provides the design guidance that is unique to the modified design level.

Design elements that do not have modified design level guidance include:

- Access control, see Chapter 1420
- Access management, see Chapter 920
- Basic safety, see Chapter 410
- Clear zone, see Chapter 700
- Traffic barriers, see Chapter 710
- Gore area lighting, see Chapter 840
- Interchange areas, see Chapter 940

Design elements that have both modified and full design level components include:

- Horizontal alignment, see Chapter 620
- Superelevation and shoulder cross slope, see Chapter 640
- Vertical alignment, see Chapter 630

430.02 Design Speed

When applying modified design level to a project, select a design speed for use in the design process that reflects the character of the terrain and the type of highway. Select a speed that is not less than the posted speed, the proposed posted speed, or the operating speed, whichever is higher. Document which speed was used, include any supporting studies and data.

430.03 Roadway Widths

The design of a project must not decrease the existing roadway width.

Lane and shoulder widths are shown in Figures 430-3 and 4. Consider joint use with other modes of transportation in shoulder design.

Review route continuity and roadway widths. Select widths on the tangents to be consistent throughout a given section of the route. Make any changes where the route characteristics change.

(1) Turning Roadway Widths

It may be necessary to widen the roadway on curves to accommodate large vehicles. The total two-lane roadway width of a curve may not be less than that shown in Figure 430-5 or, if the internal angle (delta) is less than 90 degrees, Figure 430-6. The proposed roadway width for a curve may not be less than that of the adjacent tangent sections.

The total roadway width from Figure 430-5 or Figure 430-6 may include the shoulder. When the shoulder is included, full-depth pavement is required.

Widening of the total roadway width of a curve by less than 0.6 m is not required for existing two-lane roadways that are to remain in place.

(2) Median Width

See Figure 430-3.

430.04 Ramp Lane Widths

Ramp lane widths are shown in Figure 430-1 and in Figure 430-10. For ramps with radii less than 100 m apply full design level see Chapter 640.

Curve Radius	Lane Width
Tangent - 1200 m	3.9 m
900 m - 600 m	4.2 m
300 m - 100 m	4.5 m

Turning Ramp Lane Widths
Modified Design Level
Figure 430-1

430.05 Stopping Sight Distance

(1) Existing Stopping Sight Distance for Vertical Curves

For crest vertical curves use the existing algebraic difference in grades and the length of curve to compare the existing condition to Figure 430-7. If corrective action is required by Figure 430-7, apply full design level and see Chapter 650.

When modified design level is being applied, sag vertical curves are not normally addressed.

(2) Stopping Sight Distance for Horizontal Curves

For modified design level, use the existing lateral clearance to the sight obstruction and the curve radius to compare the existing condition to Figure 430-8. If corrective action is required by Figure 430-8, apply full design level and see Chapter 650.

For Figure 430-8, an obstruction is any object with a height of 0.6 m or more above the roadway surface on the inside of a curve. Examples of possible obstructions are median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings.

430.06 Profile Grades

When applying modified design level, profile grades generally are not flattened. However, corrective action may be justified for combinations of steep grades and restricted horizontal or vertical curvature. Identify major modifications to horizontal and vertical alignment in the Project Decisions Summary. Total removal of pavement and reconstruction of the subgrade are examples of major modifications.

430.07 Cross Slope

On all tangent sections, the normal cross slopes of the traveled way are 2 percent. Cross slopes up to 2 percent have a barely perceptible effect on vehicle steering, but cross slopes steeper than 2 percent can be noticeable.

The algebraic difference in cross slopes is an operational factor during a passing maneuver on a two-lane road. Its influence increases when increased traffic volumes decrease the number and size of available passing opportunities.

If a longitudinal contiguous section of pavement is to be removed or is on a reconstructed alignment, or if a top course is to be placed over existing pavement, design the restored pavement to a cross slope of 2 percent.

A somewhat steeper cross slope may be necessary to facilitate pavement drainage in areas of intense rainfall, even though this might be less desirable from the operational point of view. In such areas, the design cross slopes may be increased to 2.5 percent with an algebraic difference of 5 percent.

For existing pavements, cross slopes within a range of 1 to 3 percent may remain if there are no operational or drainage problems and— on a two-way, two-lane road — the following conditions are met:

- The algebraic difference is not greater than 4 percent where the ADT is greater than 2000.
- The algebraic difference is not greater than 5 percent where the ADT is 2000 or less.
- The algebraic difference is not greater than 6 percent and the road is striped or signed for no passing.

If the existing pavement does not meet the conditions above, correct the cross slope(s) to be within the range of 1.5 to 2.5 percent. For a two-way, two-lane road, provide an algebraic difference to meet the appropriate conditions stated above except when facilitating drainage in areas of intense rainfall. When applying modified design level to a road with bituminous surface treatment (BST), cross slope correction is not required on the basis of algebraic differences alone.

To maintain or restore curb height, consider lowering the existing pavement level and correcting cross slope by grinding before an asphalt overlay. On urban highways, the cross slope of the outside shoulder may be steepened to minimize curb height and other related impacts. The shoulder may be up to 6 percent with a rollover between the traveled way and the shoulder of no more than 8 percent.

430.08 Fill Slopes and Ditch Inslopes

Foreslopes (fill slopes and ditch inslopes) and cut slopes are designed as shown in Figure 430-9 for modified design level main line roadway sections. After the foreslope has been determined, use the guidance in Chapter 700 to determine the need for a traffic barrier.

When a crossroad or road approach has steep foreslopes, there is the possibility that an errant vehicle might become airborne. Therefore, flatten crossroad and road approach foreslopes to 1:6 where practical and at least to 1:4. Provide smooth transitions between the main line foreslopes and the crossroad or road approach foreslopes. Where possible, move the crossroad or road approach drainage away from the main line. This can locate the pipe outside the design clear zone and reduce the length of pipe required.

430.09 Intersections

(1) General

Except as given below, design intersections to meet the requirements in Chapter 910.

(2) Design Vehicle

Figure 430-2 is a guide for determining the design vehicle. Perform a field review to determine intersection type, type of vehicle that use the intersection, and adequacy of the existing geometrics.

Intersection Type	Design Vehicle
Junction of Major Truck Routes	WB-20
Junction of State Routes	WB-12
Ramp Terminals	WB-12
Other Rural	SU[1]
Urban Industrial	SU[1]
Urban Commercial	P[1]
Residential	P[1]

[1]When the intersection is on a transit or school bus route, use the BUS design vehicle. See Chapter 1060 for additional guidance for transit facilities and for the BUS turning path templates.

Design Vehicles
Modified Design Level
Figure 430-2

(3) Angle

The allowable angle between any two respective legs is between 60° and 120°. When realignment is required to meet this angle requirement, consider realigning to an angle between 75° and 105°.

430.10 Bridges

Design all new and replacement bridges to full desing level (Chapter 440) unless a corridor or project anlaysis justifies the use of modified design level lane and shoulder widths. Evaluate bridges to remain in place using Figures 430-3 and 4. Whenever possible, continue the roadway lane widths across the bridge and adjust the shoulder widths.

Consider joint use with other modes of transportation in lane and shoulder design. See Chapter 1020, Facilities for Nonmotorized Transportation, Chapter 1050, High Occupancy Vehicle Facilities, and Chapter 1060, Transit Benefit Facilities.

430.11 Documentation

The following documents are to be preserved in the project file. See Chapter 330.

- ☐ Design speed selection
- ☐ Existing roadway widths
- ☐ Stopping sight distance evaluation
- ☐ Justification for profile grade modification
- ☐ Existing crown and superelevation
- ☐ Intersection field review

	Multilane Divided				Multilane Undivided			
	Trucks Under 10%		Trucks 10% and Over		Trucks Under 10%		Trucks 10% and Over	
Design Class	MDL-1	MDL-2	MDL-3	MDL-4	MDL-5	MDL-6	MDL-7	MDL-8
Current ADT (1)	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000
Design Speed	The posted speed, the proposed posted speed, or the operating speed, whichever is higher.							
Traffic Lanes Number Width	4 or more 3.3 m	4 or more 3.3 m	4 or more 3.3 m	4 or more 3.6 m	4 or more 3.3 m	4 or more 3.3 m	4 or more 3.3 m	4 or more 3.6 m
Parking Lanes Urban	None	None	None	None	2.4 m	2.4 m (2)	2.4 m	2.4 m (2)
Median Width Rural Urban	Existing Existing	Existing Existing	Existing Existing	Existing Existing	0.6 m 0.6 m	1.2 m 0.6 m	1.2 m 0.6 m	1.2 m 0.6 m
Shoulder Width Right (3) Left (4)	1.2 m 0.6 m	1.8 m 0.6 m	1.2 m 0.6 m	1.8 m 0.6 m	1.2 m	1.8 m (5)	1.2 m	1.8 m (5)
Minimum Width for Bridges to Remain in Place (6)(7)(8)	7.3 m (9)	7.9 m (9)	7.3 m (9)	7.9 m (10)	14.6 m (9)	15.2 m (9)(11)	15.2 m (9)(11)	16.5 m (10)(11)
Minimum Width for Rehabilitation of Bridges to Remain in Place (6)(12)(8)	8.4 m (9)	9.0 m (9)	8.4 m (9)	9.6 m (10)	16.2 m (9)	18.0 m (9)(11)(13)	16.8 m (9)(11)	19.2 m (10)(11)(13)
Minimum Width for Replacement	Full Design Level Applies (14)							
Access Control	See Chapter 1420 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region’s Highway Access Management Classification Report							

(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.

(2) Parking restricted when ADT is over 15,000.

(3) For lanes 3.3 m or more in width, the minimum shy distance from the edge of traveled way to the face of the curb is 0.6 m on the right. However, for noncontinuous curbs or where bicycles are anticipated, the minimum shy distance from the edge of traveled way to the face of the curb is 0.9 m on the right.

(4) For lanes 3.3 m or more in width, the minimum shy distance to the face of the curb is 0.3 m on the left.

(5) May be reduced by 0.6 m under urban conditions.

(6) Width is the clear distance between curbs or rails, whichever is less.

(7) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.

(8) For median widths 7.5 m or less, see Chapter 1120.

(9) Add 3.3 m for each additional lane.

(10) Add 3.6 m for each additional lane.

(11) Includes a 1.2 m median which may be reduced by 0.6 m under urban conditions.

(12) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.

(13) Includes 1.8 m shoulders — may be reduced by 0.6 m on each side under urban conditions.

(14) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

Modified Design Level for Multilane Highways and Bridges
Figure 430-3

	Two-Lane Highways					
	Trucks Under 10%			Trucks 10% and Over		
Design Class	MDL-9	MDL-10	MDL-11	MDL-12	MDL-13	MDL-14
Current ADT(1)	Under 1000	1000-4000	Over 4000	Under 1000	1000-4000	Over 4000
Design Speed	The posted speed, the proposed posted speed, or the operating speed, whichever is higher.					
Traffic Lane(2) Width	3.3 m	3.3 m	3.3 m	3.3 m	3.6 m	3.6 m
Parking Lanes Urban	2.4 m	2.4 m	2.4 m(3)	2.4 m	2.4 m	2.4 m(3)
Shoulder Width(4)	0.6 m	0.9 m(5)	1.2 m	0.6 m	0.9 m(5)	1.2 m
Minimum Width for Bridges to Remain in Place (6)(7)	6.6 m(8)	7.2 m	8.5 m	6.6 m(8)	7.2 m	8.5 m
Minimum Width for Rehabilitation of Bridges to Remain in Place (7)(9)	8.4 m(10)	9.6 m	9.6 m	8.4 m(10)	9.6 m	9.6 m
Minimum Width for Replacement	Full Design Level Applies(11)					
Access Control	See Chapter 1420 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Management Classification Report.					

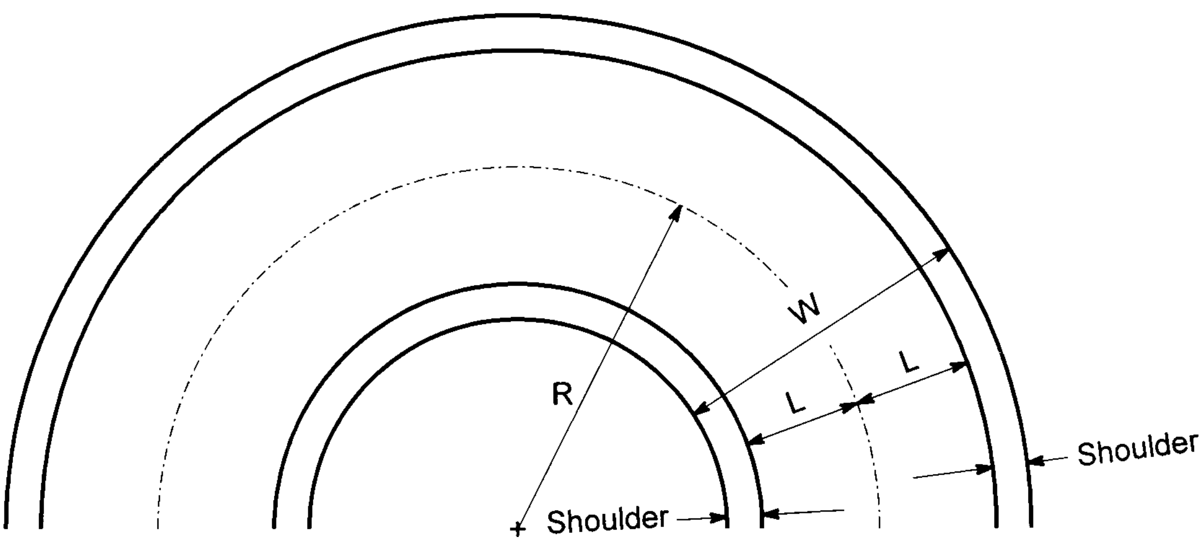
(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.
(2) See Figures 430-5 and 430-6 for turning roadways.
(3) Parking restriction recommended when ADT exceeds 7,500.
(4) For lanes 3.3 m or more in width, the minimum shy distance from the edge of traveled way to the face of the curb is 0.6 m. However, for noncontinous curbs or where bicycles are anticipated, the minimum shy distance from the edge of traveled way to the face of the curb is 0.9 m.
(5) For design speeds of 50 mph or less on roads of 2,000 ADT or less, width may be reduced by 0.3 m, with justification.
(6) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.
(7) Width is the clear distance between curbs or rails, whichever is less.
(8) 6.0 m when ADT 250 or less.
(9) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.
(10) 7.8 m when ADT 250 or less.
(11) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

Modified Design Level for Two-Lane Highways and Bridges
Figure 430-4

Radius of Center Line R (m)	Minimum Total Roadway Width W (m)	Minimum Lane Width L (m)
Tangent	7.8	3.3
300	7.8	3.3
200	8.3	3.6
150	8.6	3.6
120	9.0	3.6
100	9.3	3.6
90	9.6	3.9
80	9.9	3.9
70	10.2	3.9
60	10.8	3.9
50	11.5	3.9

Notes: Also see minimums from Figure 430-4.

If the minimum total roadway width is greater than the sum of the shoulders and lane widths, apply the extra width to the inside of the curve.



Minimum Total Roadway Widths for Two-Lane Highway Curves
Modified Design Level
Figure 430-5

Principal Arterial Notes:

1 Justify the selection of a P-6 standard.
2 The design year is 20 years after the year the construction is scheduled to begin.
3 Where DHV exceeds 700, provide four lanes. For lower volumes, when the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes on a P-3 design class highway, perform an investigation to determine if a P-2 design class highway is justified.
4 When considering a multilane highway, perform an investigation to determine if a truck climbing lane will satisfy the need.
5 See Chapter 1420 for access control requirements.
6 All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
7 Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
8 The preferred design speed is within the range. Design speeds above the range may be selected, with justification. The lower end of the range is the minimum design speed for the design class.
9 3.6 m lanes are required when the truck DHV is 6% or greater.
10 Minimum left shoulder width is to be as follows: four lanes — 1.2 m: six or more lanes — 3.0 m. For 6-lane roadways, existing 1.8 m left shoulders may remain when no other widening is required.
11 When curb section is used, a 1.8 m shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs.
12 On freeways or expressways requiring less than eight lanes within the 20-year design period, provide sufficient median or lateral clearance and right of way to permit addition of a lane in each direction if required by traffic increase after the 20-year period.
13 When signing is required in the median of a six-lane section, the minimum width is 1.8 m. If barrier is to be installed at a future date, a 2.4 m minimum median is required.
14 Parking restricted when ADT is over 15,000.
15 Submit Form 223-528, Pavement Type Determination.
16 Provide right of way width 3 m desirable, 1.5 m minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
17 19 m from edge of traveled way.
18 Make right of way widths not less than those required for necessary cross section elements.
19 See Chapter 1120 for the minimum vertical clearance.
20 For median widths 7.8 m or less, address bridges in accordance with Chapter 1120.
21 For pedestrian, bicycle, and sidewalk requirements see Chapter 1020. Curb requirements are in Chapter 910. Lateral clearances from the face of curb to obstruction are in Chapter 700.
22 Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

Geometric Design Data, Principal Arterial
Figure 440-4b

Design Class	Divided Multilane		Two-Lane						Undivided Multilane	
	M-1		M-2		M-3		M-4		M-5[1]	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year[2] NHS Non NHS	Over 701		201-700[3] 401-700		61-200[4] 201-400		60 and Under 200 and Under		Over 701	
Access Control[5]	Partial		Partial		Partial or None		None		Special Cases	
Separate Cross Traffic Highways Railroads	Where Warranted All		Where Warranted All[6]		Where Warranted Where Warranted[7]		Where Warranted Where Warranted[7]		Where Warranted Where Warranted [7]	
Design Speed Range (mph)[8]	70 50		70 50	60 40	70 50	60 40	60 40	60 30	70 40	60 30
Traffic Lanes Number Width (m)	4 or 6 divided 3.6		2 3.6		2 3.6		2 3.6		4 3.6	4 or 6 3.3[9]
Shoulder Width (m) Right of Traffic Left of Traffic	3.0 Variable[10]		2.4		1.8		1.2		2.4	2.4[11]
Median Width (m) 4 lane 6 lane	18 18	4.8 6.6							1.2	0.6[12]
Parking Lanes Width (m) — Minimum	None		None		None	3.0	None	3.0	None	3.0[13]
Pavement Type[14]	High		As required						High or Intermediate	
Right of Way[15] — Min Width (m)	(16)	(17)	36	24	36	24	30	24	45	24
Structures (m)[18]	Full Roadway Width[19]		12.0		10.8		9.6		Full Roadway Width	
Other Design Considerations-Urban			(20)		(20)		(20)		(20)	

Grades (%)[21]									
	Rural — Design Speed (mph)					Urban — Design Speed (mph)			
Type of Terrain	40	50	60	70	80	30	40	50	60
Level	5	4	3	3	3	8	7	6	5
Rolling	6	5	4	4	4	9	8	7	6
Mountainous	8	7	6	5	5	11	10	9	8

Geometric Design Data, Minor Arterial

Figure 440-5a

Minor Arterial Notes:

1 Justify the selection of an M-5 standard.
2 The design year is 20 years after the year the construction is scheduled to begin.
3 Where DHV exceeds 700, provide four lanes. For lower volumes, when the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes an M-2 design class highway, perform an investigation to determine if an M-1 design class highway is justified.
4 When considering a multilane highway, perform an investigation to determine if a truck climbing lane will satisfy the need.
5 See Chapter 1420 for access control requirements.
6 All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
7 Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
8 The preferred design speed is within the range. Design speeds above the range may be selected, with justification. The lower end of the range is the minimum design speed for the design class.
9 When the truck DHV is 6% or greater, consider 3.6 m lanes.
10 The minimum left shoulder width is 1.2 m for four lanes and 3.0 m for six or more lanes. For 6-lane roadways, existing 1.8 m left shoulders may remain when no other widening is required.
11 When curb section is used, a 1.8 m shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs.
12 When signing is required in the median of a six-lane section, the minimum width is 1.8 m. If barrier is to be installed at a future date, a 2.4 m minimum median is required.
13 Parking restricted when ADT is over 15,000.
14 Submit Form 223-528, Pavement Type Determination.
15 Provide right of way width 3 m desirable, 1.5 m minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
16 19 m from edge of traveled way
17 Make right of way widths not less than those required for necessary cross section elements.
18 See Chapter 1120 for the minimum vertical clearance.
19 For median widths 7.8 m or less, address bridges in accordance with Chapter 1120.
20 For pedestrian, bicycle, and sidewalk requirements see Chapter 1020. Curb requirements are in Chapter 910. Lateral clearance from the face of curb to obstruction are in Chapter 700.
21 Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

Geometric Design Data, Minor Arterial
Figure 440-5b

Design Class	Undivided Multilane		Two-Lane					
	C-1		C-2		C-3		C-4	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year(1) NHS / Non NHS	Over 901		301-900(2) / 501-900		201-300(3) / 301-500		200 and under / 300 and Under	
Access Control	(4)							
Separate Cross Traffic Highways	Where Warranted		Where Warranted		Where Warranted		Where Warranted	
Railroads	Where Warranted(5)		All(5)		Where Warranted(5)		Where Warranted(5)	
Design Speed Range (mph)(6)	70 / 40	60 / 30	70 / 50	60 / 40	70 / 50	60 / 40	60 / 40	60 / 30
Traffic Lanes Number	4	4 or 6	2		2		2	
Width (m)	3.6	3.3(7)	3.6		3.6		3.6	
Shoulder Width (m)	2.4	2.4(8)	2.4		1.8		1.2	
Median Width — Minimum (m)	1.2	0.6(9)						
Parking Lanes Width (m) — Minimum	None	3.0	None		None	3.0	None	3.0
Pavement Type(10)	High or Intermediate		As required					
Right of Way(11) (m)	45	24	36	24	36	24	30	24
Structures Width (m)(12)	Full Roadway Width		12.0		10.8		9.6	
Other Design Considerations-Urban		(13)		(13)		(13)		(13)

Grades (%)(14)									
Type of Terrain	Rural — Design Speed (mph)					Urban — Design Speed (mph)			
	30	40	50	60	70	30	40	50	60
Level	7	7	6	5	4	9	9	7	6
Rolling	9	8	7	6	5	11	10	8	7
Mountainous	10	10	9	8	6	12	12	10	9

Geometric Design Data, Collector
Figure 440-6a

630.01 General

Vertical alignment (roadway profile) consists of a series of gradients connected by vertical curves. It is mainly controlled by:

- Topography
- Class of highway
- Horizontal alignment
- Safety
- Sight distance
- Construction costs
- Drainage
- Adjacent land use
- Vehicular characteristics
- Aesthetics

This chapter provides guidance for the design of vertical alignment. See the following chapters for additional information:

Chapter	Subject
440	Maximum grade for each functional class
620	Horizontal alignment
650	Sight distance

630.02 References

Washington Administrative Code (WAC) 468-18-040, "Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings"

Plans Preparation Manual, M 22-31, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, M 24-01, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

A Policy on Geometric Design of Highways and Street, 1994, AASHTO

630.03 Vertical Alignment

(1) Design Controls

The following are general controls for developing vertical alignment (also see Figures 630-1a and 1c):

- Use a smooth grade line with gradual changes, consistent with the class of highway and character of terrain. Avoid numerous breaks and short grades.
- Avoid "roller coaster" or "hidden dip" profiles by use of gradual grades made possible by heavier cuts and fills or by introducing some horizontal curvature in conjunction with the vertical curvature.
- Avoid grades that will affect truck speeds and, therefore, traffic operations.
- Avoid broken back grade lines with short tangents between two vertical curves.
- Use long vertical curves to flatten grades near the top of long steep grades.
- Where at-grade intersections occur on roadways with moderate to steep grades, it is desirable to flatten or reduce the grade through the intersection.
- Establish the subgrade at least 0.3 m above the high water table (real or potential) or as recommended by the region Materials Engineer. Consider the low side of superelevated roadways.

- When a vertical curve takes place partly or wholly in a horizontal curve, coordinate the two as discussed in 630.04.

(2) Minimum Length of Vertical Curves

The minimum length of a vertical curve is controlled by design speed, the requirements for stopping sight distance, and the change in grade. See Chapter 650 to design vertical curves to meet sopping sight distance requirements.

In addition to stopping sight distance requirements, the minimum length of a vertical curve, in meters, is equal to the design speed, in miles per hour. For aesthetics, the desirable length of a vertical curve is two to three times the length required for stopping sight distance.

(3) Maximum Grades

Analyze grades for their effect on traffic operation because they may result in undesirable truck speeds. Maximum grades are controlled by functional class of the highway, terrain type, and design speed (Chapter 440).

(4) Minimum Grades

Minimum grades are used to meet drainage requirements. Avoid selecting a "roller coaster" or "hidden dip" profile merely to accommodate drainage.

Minimum ditch gradients of 0.3% on paved materials and 0.5% on earth can be obtained independently of roadway grade. Medians, long sag vertical curves, and relatively flat terrain are examples of areas where independent ditch design may be justified. A closed drainage system may be needed as part of an independent ditch design.

(5) Length of Grade

The desirable maximum length of grade is the maximum length on an upgrade at which a loaded truck will operate without a 15 mph reduction. Figure 630-2 gives the desirable maximum length for a given percent of grade. For grades that are not at a constant percent, use the average. For grades longer than the desirable maximum, consider an auxiliary climbing lane (Chapter 1010).

When long steep downgrades are unavoidable, consider an emergency escape ramp (Chapter 1010).

(6) Alignment on Structures

Avoid high skew, vertical curvature, horizontal curvature, and superelevation on structures, but do not sacrifice safe roadway alignment to achieve this.

630.04 Coordination of Vertical and Horizontal Alignments

Do not design horizontal and vertical alignment independently. Coordinate them to obtain safety, uniform speed, pleasing appearance, and efficient traffic operation. Coordination can be achieved by plotting the location of the horizontal curves on the working profile to help visualize the highway in three dimensions. Perspective plots will also give a view of the proposed alignment. Figures 630-1a and 1b show sketches of desirable and undesirable coordination of horizontal and vertical alignment.

Guides for the coordination of the vertical and horizontal alignment are as follows:

- Balance curvature and grades. Using steep grades to achieve long tangents and flat curves, or excessive curvature to achieve flat grades, are both poor design.
- Vertical curvature superimposed on horizontal curvature generally results in a more pleasing facility. Successive changes in profile not in combination with horizontal curvature may result in a series of dips not visible to the driver.
- Do not begin or end a horizontal curve at or near the top of a crest vertical curve. This condition can be unsafe, especially at night, if the driver does not recognize the beginning or ending of the horizontal curve. Safety is improved if the horizontal curve leads the vertical curve, that is, the horizontal curve is made longer than the vertical curve in both directions.

(a) **Two-lane two-way roadways.** Figure 640-7a shows the traveled way width W for two-lane two-way roadways. For values of R between those given, interpolate W and round up to the next tenth of a meter.

Minimum traveled way width W based on the delta angle of the curve is shown in Figure 640-7b. Round W to the nearest tenth of a meter.

(b) **Two-lane one-way roadways.** Figure 640-8a shows the traveled way width for two-lane one-way turning roadways, including two lane ramps and four lane divided highways. For values of R between those given, interpolate W and round up to the next tenth of a meter. Treat each direction of travel of multilane divided facilities as a one-way roadway.

Minimum width W based on the delta angle of the curve is shown in Figure 640-8b. Round W to the nearest tenth of a meter.

To keep widths to a minimum, traveled way widths for Figures 640-8a and 8b were calculated using the WB-12 design vehicle. When volumes are high for both trucks larger than the WB-12 and other traffic, consider using the widths from Figures 640-7a and 7b.

(c) **One-lane one-way roadways.** Figure 640-9a shows the traveled way width for one-lane one-way turning roadways, including one lane ramps. For values of R between those given, interpolate W and round up to the next tenth of a meter.

For minimum widths based on the delta angle of the curve, use Figure 640-9b for one-lane road-ways using the radius to the outer edge of the traveled way and Figure 640-9c for one-lane roadways using the radius on the inner edge of the traveled way. Round W to the nearest tenth of a meter.

Build shoulder pavements at full depth for one-lane one-way roadways because, to keep widths to a minimum, traveled way widths were calculated using the WB-12 design vehicle which may force larger vehicles to encroach on the shoulders.

(d) **Other roadways.**

- For multilane two-way undivided roadways use the following:

  $$W = \frac{W_a \times N}{2}$$

  Where:

  W = The multilane roadway width.

  W_a = The width from 640.04(2)(a) for a two-lane two-way roadway.

  N = The total number of lanes.

- For one-way roadways with more than two lanes, for each lane in addition to two, add the standard lane width for the highway functional class from Chapter 440 to the width from 640.04(2)(b).
- For three-lane ramps with HOV lanes, see Chapter 1050.

(e) **All roadways.** Full design shoulder widths for the highway functional class or ramp are added to the traveled way width to determine the total roadway width.

If the total roadway width deficiency is less than 0.6 m on existing roadways that are to remain in place, correction is not required.

When widening

- Traveled way widening may be constructed on the inside of the traveled way or divided equally between the inside and outside.
- Place final marked center line, and any central longitudinal joint, midway between the edges of the widened traveled way.
- Provide widening throughout the curve length.
- For widening on the inside, make transitions on a tangent, where possible.
- For widening on the outside, develop the widening by extending the tangent. This avoids the appearance of a reverse curve that a taper would create.
- For widening of 1.8 m or less, use a 1:25 taper, for widths greater than 1.8 m use a 1:15 taper.

(3) Shoulders

Pave the shoulders of all highways where high or intermediate pavement types are used. Where low pavement type is used, treat the roadway full width.

Shoulder cross slopes are normally the same as the cross slopes for adjacent lanes. With justification, shoulder slopes may be increased to 6%. The maximum difference in slopes between the lane and the shoulder is 8%. Examples of locations where it may be desirable to have a shoulder grade different than the adjacent lane are:

- Where curbing is used.
- Where shoulder surface is bituminous, gravel, or crushed rock.
- Where overlays are planned and it is desirable to maintain the grade at the edge of the shoulder.
- On divided highways with depressed medians where it is desirable to drain the runoff into the median.
- On the high side of the superelevation on curves where it is desirable to drain storm water or melt water away from the roadway.

When asphalt concrete curb is used, see the Standard Plans for required widening. Widening is normally required when traffic barrier is installed (see Chapter 710).

It is preferred that curb not be used on high speed facilities. In some areas, curb may be needed to control runoff water until ground cover is attained to prevent erosion. Plan for the removal of the curb when the ground cover becomes adequate. Arrange for curb removal with regional maintenance as part of the future maintenance plans. When curb is used in conjunction with guardrail, see Chapter 710 for guidance.

Figures 640-10a and 10b represent shoulder details and requirements.

640.05 Superelevation

To maintain the desired design speed, highway and ramp curves are usually superelevated to overcome part of the centrifugal force that acts on a vehicle.

(1) Superelevation Rates for Open Highways and Ramps

The maximum superelevation rate allowed for open highways or ramps is 10%. (See Figure 640-11a.)

Base superelevation rate and its corresponding radius for open highways on Figure 640-11a, Superelevation Rate (10% Max), with the following exceptions:

- Figure 640-11b, Superelevation Rate (6% Max), may be used under the following conditions:

  1. Urban conditions without limited access

  2. Mountainous areas or locations that normally experience regular accumulations of snow and ice

  3. Short-term detours (generally implemented and removed in one construction season). For long-term detours, consider a higher rate up to 10%, especially when associated with a main line detour.

- Figure 640-11c, Superelevation Rate (8% Max), may be used for existing roadways and for the urban, mountainous, and snow and ice conditions that are less severe or where the 6% rate will not work; for example, where a curve with a radius less than the minimum for the design speed from Figure 640-11b is required.

Design the superelevation for ramps the same as for open highways. With justification, ramps in urban areas with a design speed of 35 mph or less, Figure 640-12 may be use to determine the superelevation.

Round the selected superelevation rate to the nearest full percent.

Document which set of curves is being used and, when a curve other than the 10% maximum rate is used, document why the curve was selected.

Depending on design speed, construct large radius curves with a normal crown section and superelevate curves with smaller radii in accordance with the appropriate superelevation from Figures 640-11a through 11c. The minimum radii for normal crown sections are shown in Figure 640-1.

Design Speed (mph)	Minimum Radius for Normal Crown Section (m)
25	750
30	1020
35	1335
40	1695
45	2095
50	2540
55	3030
60	3565
70	4480
80	5510

Minimum Radius for Normal Crown Section
Figure 640-1

(2) Existing Curves

Evaluate the superelevation on an existing curve to determine its adequacy. Use the following equation:

$$R = \frac{2.04V^2}{e + f}$$

Where:

R = The minimum allowable radius of the curve in meters.

V = Design speed in mph

e = Superelevation rate in percent

f = Side friction factor from Figure 640-2

Superelevation is deficient when the radius is less that the minimum from the equation.

For preservation projects, where the existing pavement is to remain in place, the superelevation on existing curves may be evaluated with a ball banking analysis.

Address deficient superelevation as provided in 640.05 (1).

Design Speed (mph)	Side Friction Factor *f*
20	17
25	16
30	16
35	15
40	15
45	14
50	14
60	12
70	10
80	8

Side Friction Factor
Figure 640-2

(3) Turning Movements at Intersections

Curves associated with the turning movements at intersections are superelevated assuming greater friction factors than open highway curves. Since speeds of turning vehicles are not constant and curve lengths are not excessive, higher friction factors can be tolerated. Use superelevation rates as high as practical, consistent with curve length and climatic conditions. Figure 640-12 shows acceptable ranges of superelevation for given design speed and radius. It is desirable to use the values in the upper half or third of the specified range whenever possible. Use judgment in considering local conditions such as snow and ice. When using high superelevation rates on short curves, provide smooth transitions with merging ramps or roadways.

(4) Superelevation Runoff for Highway Curves

For added comfort and safety, provide uniform superelevation runoff over a length adequate for the likely operating speeds.

Provide transitions for all superelevated highway curves as specified in Figures 640-13a through 13e. Which transition to use depends on the location of the pivot point, the direction of the curve, and the roadway cross slope.

Consider the profile of the edge of traveled way. To be pleasing in appearance, do not let it appear distorted. The combination of superelevation transition and grade may result in a hump or dip in the profile of the edge of traveled way. When this happens, the transition may be lengthened to eliminate the hump or dip. If the hump or dip cannot be eliminated this way, pay special attention to drainage in the low areas.

When reverse curves are necessary, provide sufficient tangent length for complete super-elevation runoff for both curves (that is, from full superelevation of the first curve to level to full superelevation of the second curve). If tangent length is longer than this but not sufficient to provide standard super transitions (that is, from full superelevation of the first curve to normal crown to full superelevation of the second curve), increase the superelevation runoff lengths until they abut. This provides one continuous transition, without a normal crown section, similar to Designs C2 and D2 in Figures 640-13c and 3d except full super will be attained rather than the normal pavement slope as shown.

Superelevation runoff is permissible on structures but not desirable. Whenever practical, strive for full super or normal crown slopes on structures.

(5) Superelevation Runoff for Ramp Curves

Superelevation transition lengths for one-lane ramps are shown in Figure 640-14a and 14b. For multilane ramps, use the method for highway curves (Figures 640-13a through 13e).

Superelevation transition lengths (L_T) given in Figures 640-14a and 14b are for a single 4.5 m lane. They are based on maximum cross slope change between the pivot point and the edge of the traveled way over the length of the superelevation transition. Maximum relative slopes for specific design speeds are similar to those given for highway curves.

For a single 4.5 m lane, use the distances given in the L_T column for L_R wherever possible. The L_B distances will give the maximum allowable rate of cross slope change. Use the L_B distances only with justification where the L_T distance cannot be achieved.

For ramps wider than 4.5 m, adjust the L_B distance by the equation for L_R. If the result is larger than the L_T distance, round upward to the next whole meter; if it is smaller, use the L_T distance.

640.06 Medians and Outer Separations

(1) Purpose

The main function of a median is to separate opposing traffic lanes. The main function of an outer separation is to separate the main roadway from a frontage road. Medians and outer separations also provide space for:

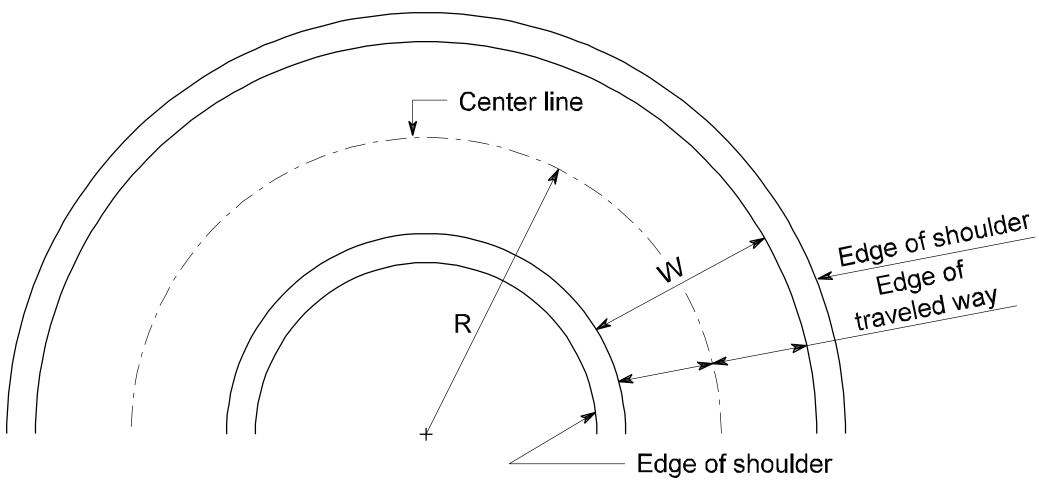
- Drainage facilities
- Undercrossing bridge piers
- Vehicle storage space for crossing and left turn movements at intersections
- Headlight glare screens, including planted or natural foliage
- Visual buffer of opposing traffic
- Safety refuge areas for errant or disabled vehicles
- Storage space for snow and water from traffic lanes
- Increased safety, comfort, and ease of operations

(2) Design

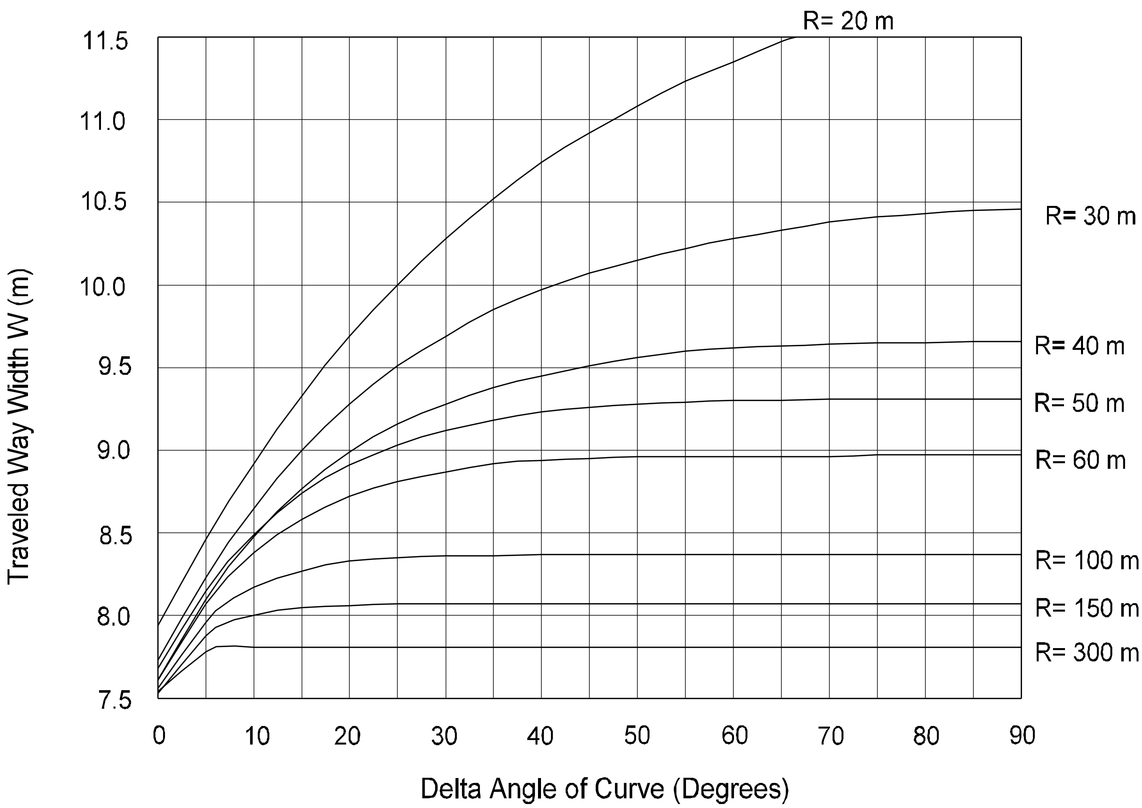
In addition to Figures 640-15a through 15c, refer to other applicable sections for minimum design requirements. Median widths in excess of the minimums are highly desirable. No attempt has been made to cover all the various grading techniques that are possible on wide, variable-width medians. Considerable latitude in treatment is intended, provided the requirements of minimum geometrics, safety, and aesthetics are met or exceeded.

When the horizontal and vertical alignments of the two roadways of a divided highway are independent of each other, determine median slopes in conformance with Figure 640-3. Unnecessary clearing, grubbing, and grading

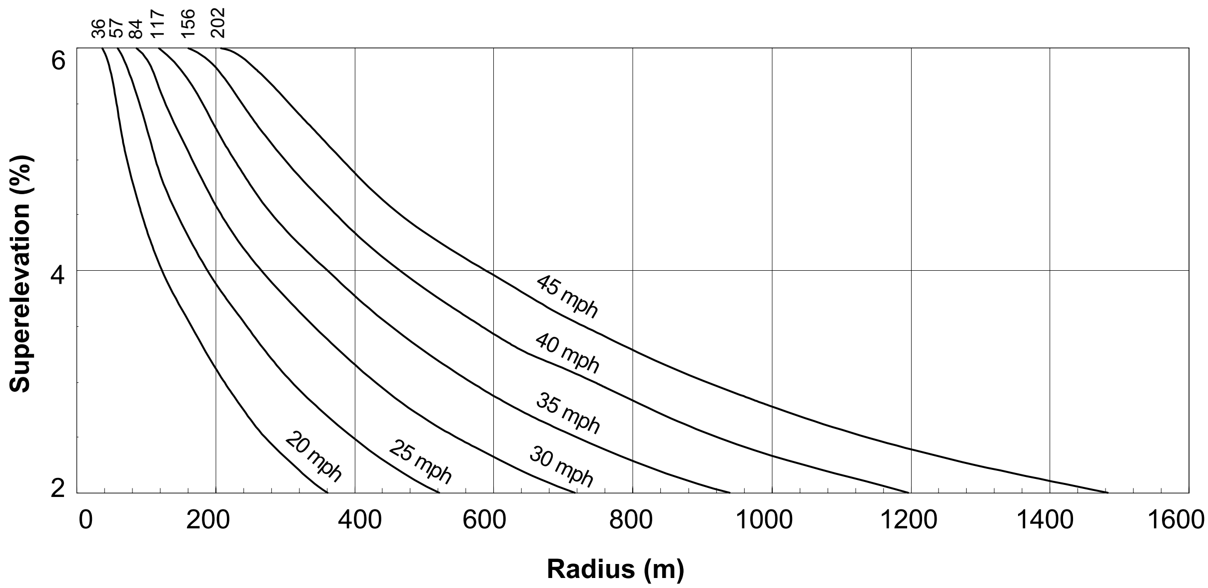
Radius on center line of traveled way (m)	Design traveled way width (W) (m)
900 to tangent	7.2
300 to 899	7.5
299	7.8
150	8.1
100	8.4
60	9.0
50	9.3
40	9.7
30	10.5

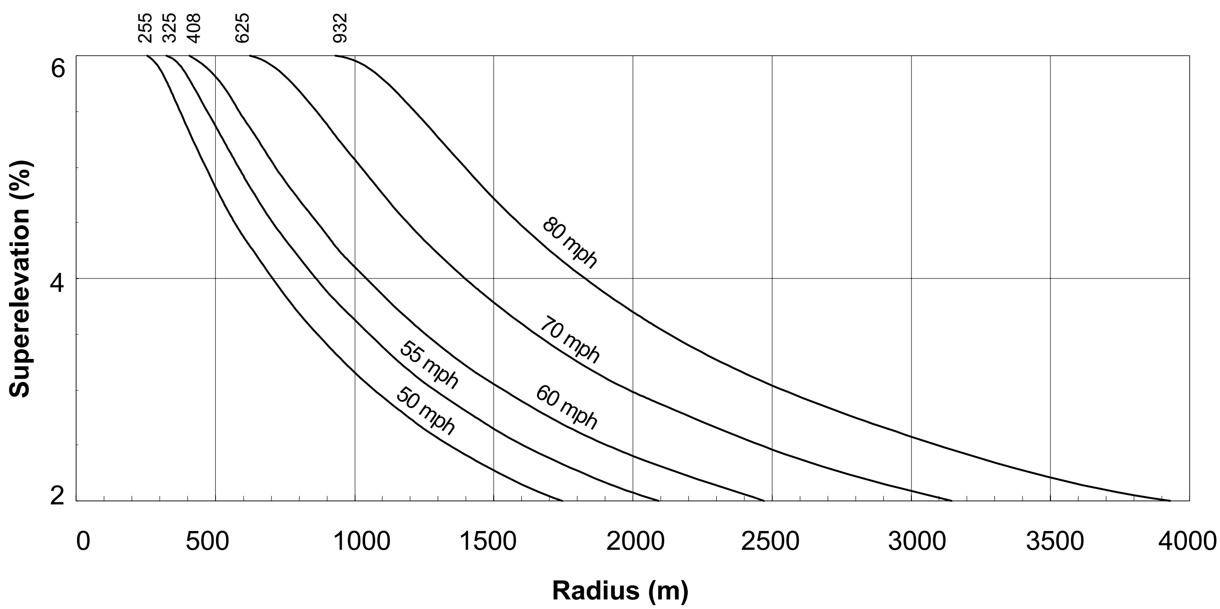


Traveled Way Width for Two-Lane One-Way Turning Roadways
Figure 640-8a

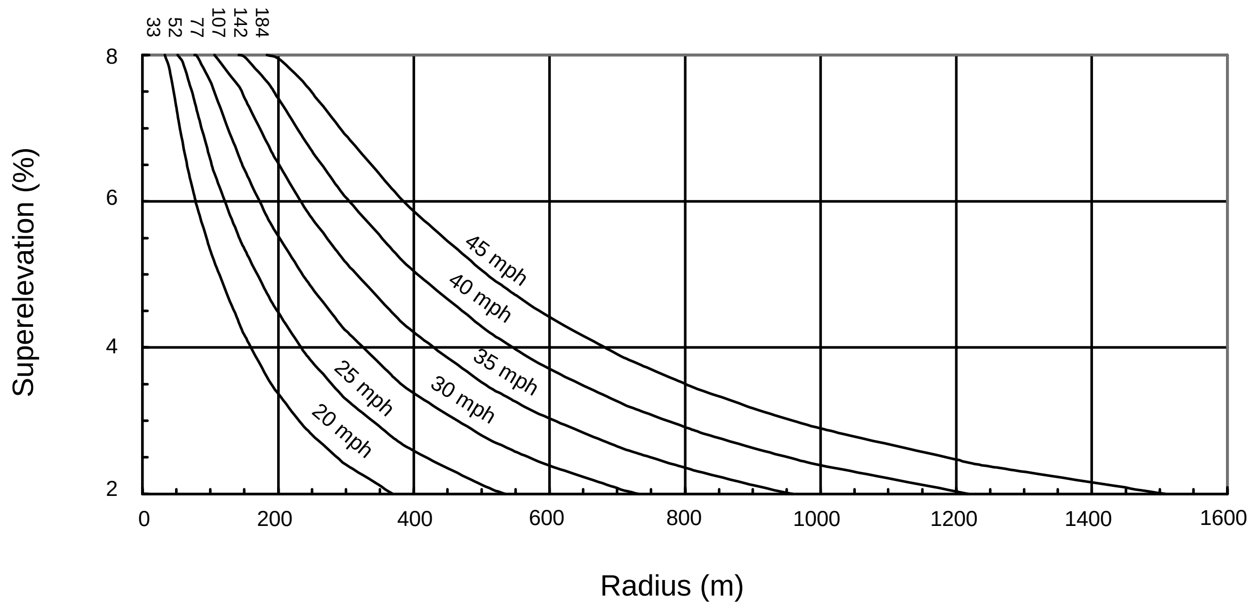


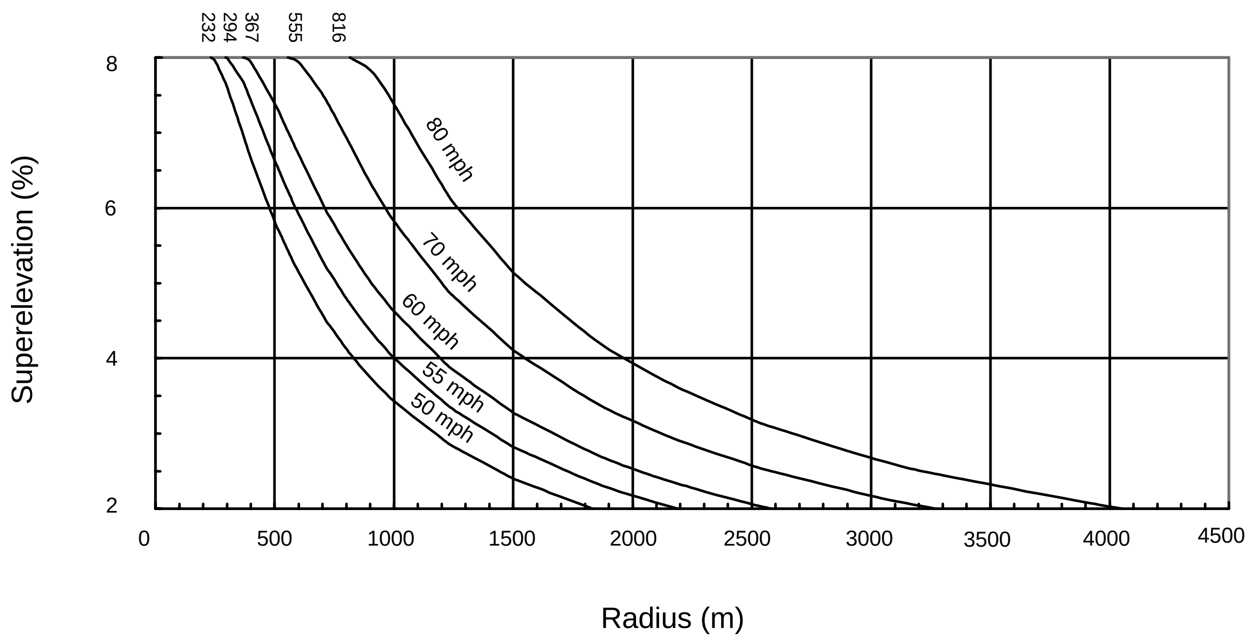
Traveled Way Width for Two-Lane One-Way Turning Roadways
Figure 640-8b



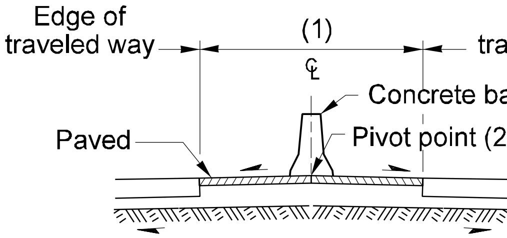


Superelevation Rates (6% max)
Figure 640-11b

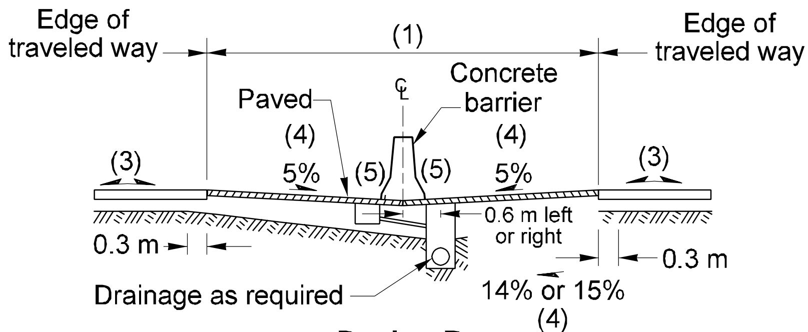




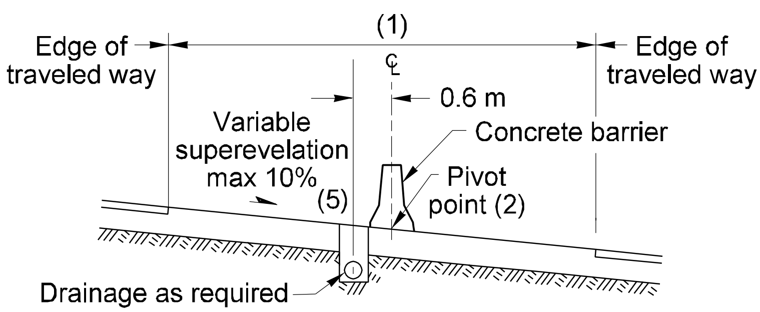
Superelevation Rates (8% max)
Figure 640-11c



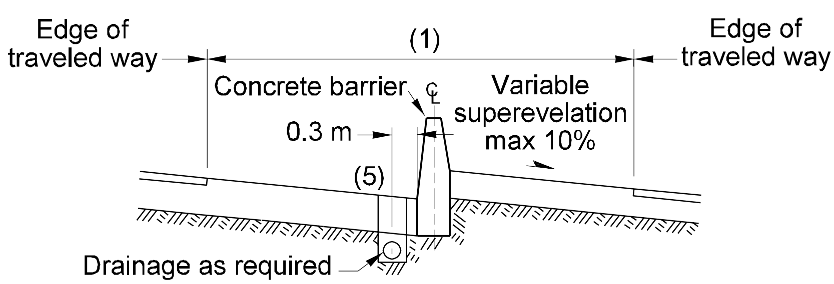
Design A
Crowned Median



Design B
Depressed Median (2)



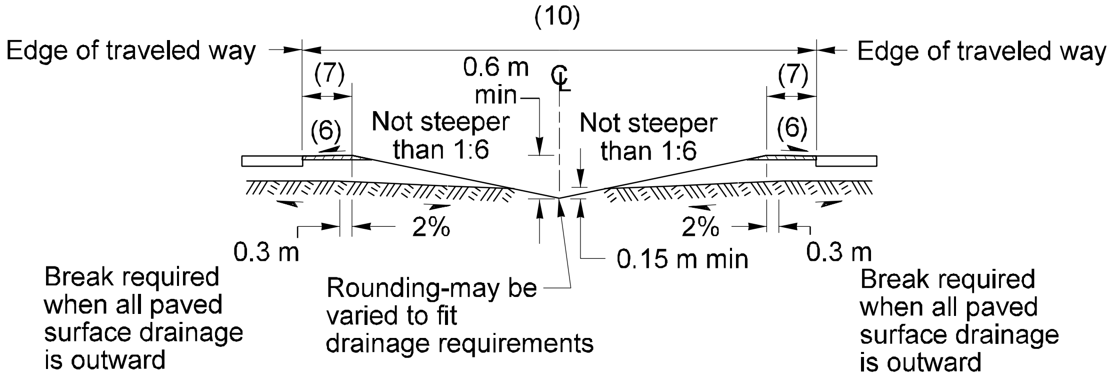
Alternate Design 1
Single Pivot Point



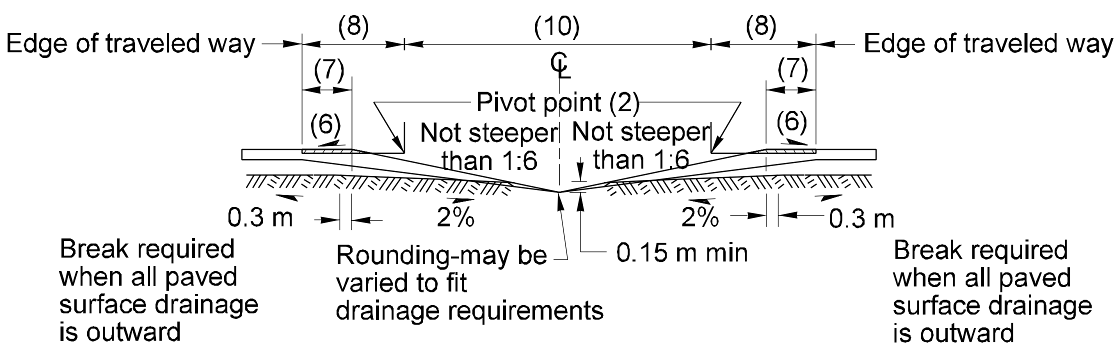
Alternate Design 2
Dual Pivot Points (2)

For notes, see Figure 640-15c

Divided Highway Median Sections
Figure 640-15a



Design C Minimum Nonpaved Median for 4 or More Lanes (2)

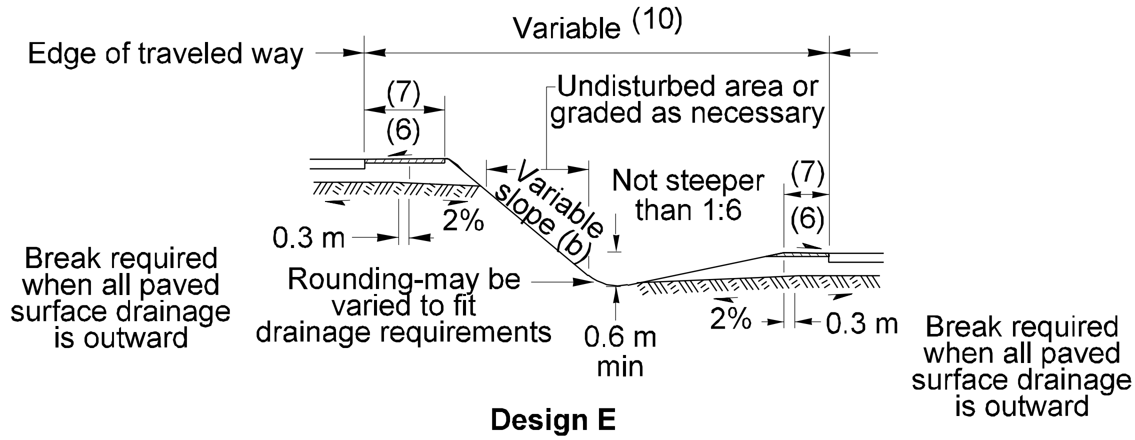


Design D Minimum for 4 or More Lanes with Future Lanes in Median

For notes, see Figure 640-15c

Divided Highway Median Sections

Figure 640-15b



Design E

Minimum for 4 or more lanes with independent alignment

(1) Designs A and B including Alternate Designs 1 and 2 are urban median designs, see Chapter 440 for minimum urban median width.

(2) Locate the pivot point to best suit the requirements of vertical clearances, drainage, and aesthetics.

(3) Pavement slopes generally shall be in a direction away from the median. A crowned roadway section may be used in conjunction with the depressed median where conditions warrant. See Figure 640-3 for additional crown information.

(4) Design B may be used uniformly on both tangents and horizontal curves. Use alternate designs 1 or 2 when the “roll over” between the shoulder and the inside lane on the high side of a superelevated curve exceeds 8%. Provide suitable transitions at each end of the curve for the various conditions encountered in applying the alternate to the basic median design.

(5) Method of drainage pickup to be determined by the designer.

(6) Median shoulders normally slope in the same direction and rate as the adjacent through lane. When median shoulders are over 1.8 m wide or cement concrete pavement is used, median shoulders may slope toward the median. However, the “roll over” algebraic difference in rate of cross slope shall not exceed 8%. See figures 640-10a and 10b for additional shoulder details.

(7) See Chapter 440 for minimum shoulder width.

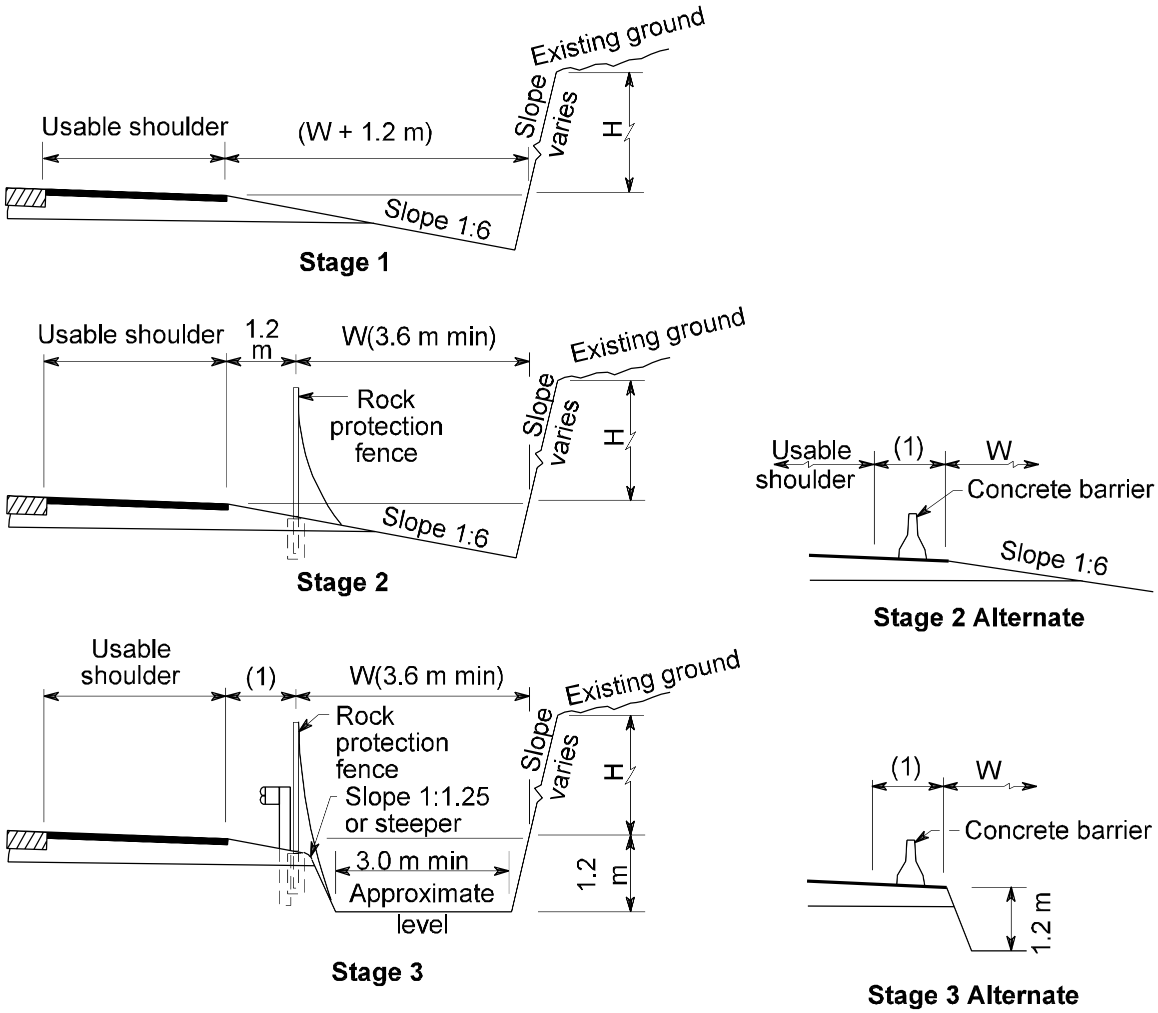
(8) Future lane, see Chapter 440 for minimum width.

(9) Widen and round foreslopes steeper than 1:4 as shown on Figure 640-10b.

(10) Designs C, D, and E are rural median desings, see Chapter 440 for minimum rural median widths. Rural median designs may be used in urban areas when minimum rural median widths can be achieved.

Divided Highway Median Sections

Figure 640-15c



Rock Slope	H(m)	W(m)
Near Vertical	6-9	3.6
	9-18	4.5
	>18	6.0
1:0.25 or 1:0.30	6-9	3.6
	9-18	4.5
	18-30	6.0
	>30	7.5

Notes:

Cut heights less than 6.0 m shall be treated as a normal roadway unless otherwise determined by the Region Materials Engineer.

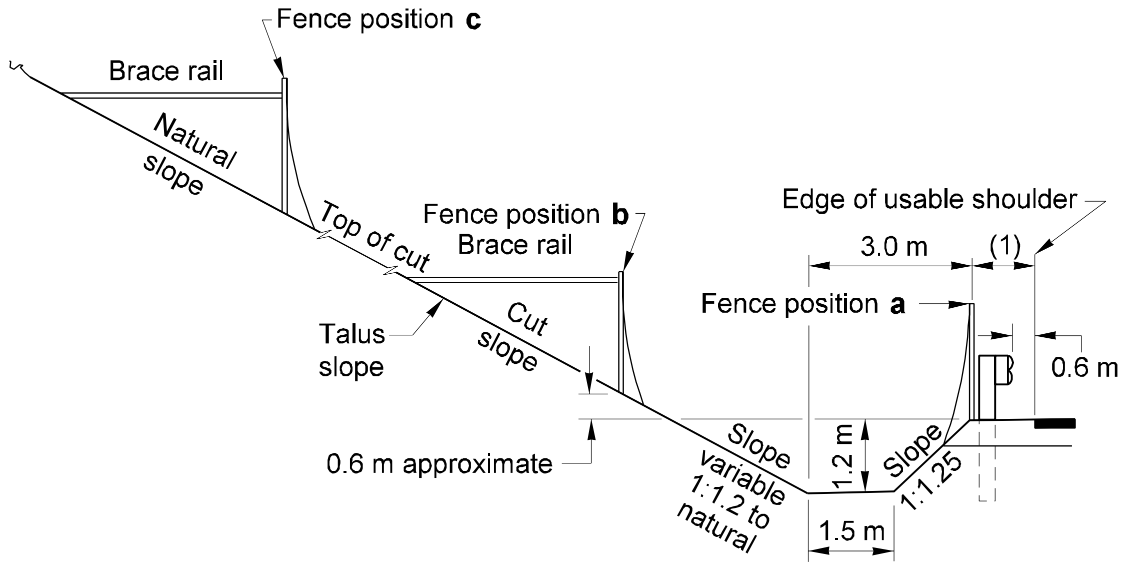
Stage 2 and 3 Alternates may be used when site conditions dictate.

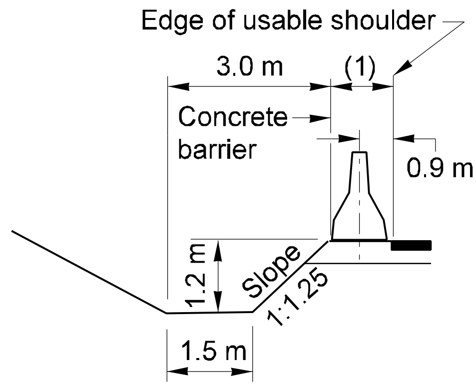
Fence may be used in conjunction with the Stage 3 Alternate. See Chapter 700 for clear zone requirements.

(1) See Chapter 710 for required widening for guardrail and concrete barrier.

Roadway Sections in Rock Cuts, Design A

Figure 640-16a





Shoulder Barrier Alternate

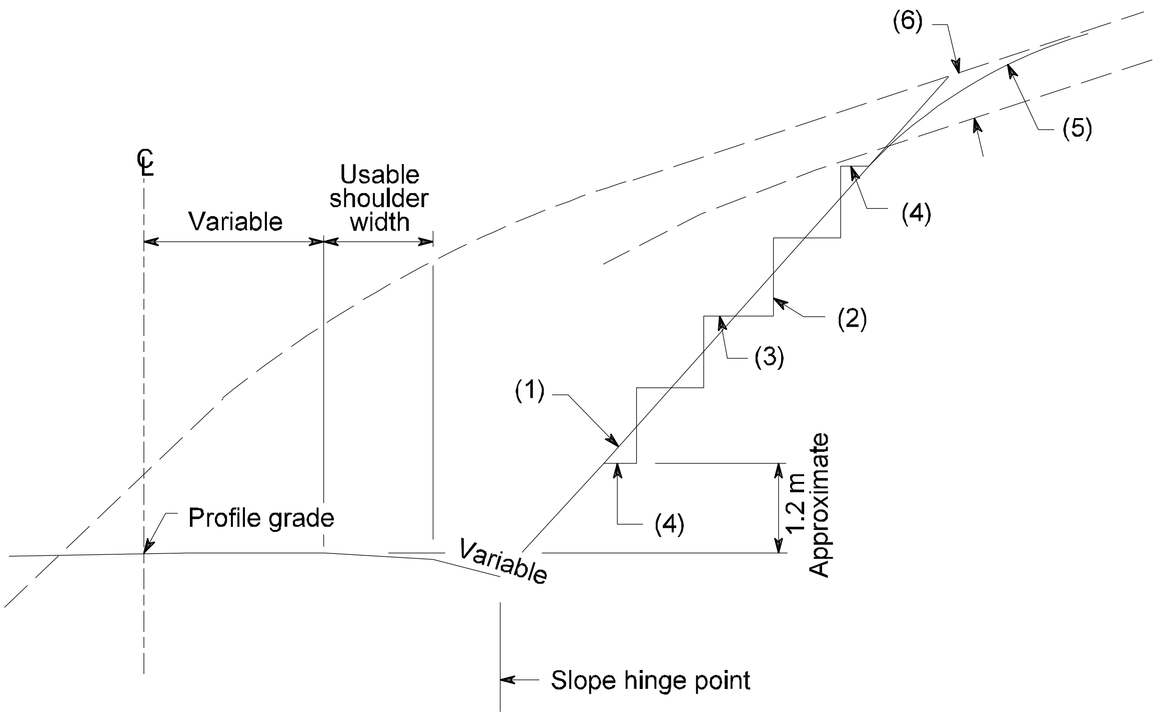
Notes

Ordinarily, place fence within a zone of 30 m to 60 m maximum from base of cliff measured along slope.

Rock protection fence may be used in conjunction with the Shoulder Barrier Alternate when site conditions dictate.

(1): See Chapter 710 for required widening for guardrail and concrete barrier.

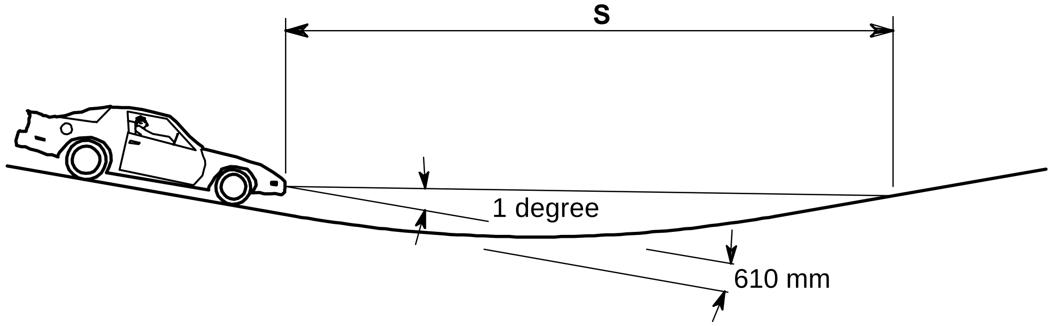
Roadway Sections in Rock Cuts, Design B
Figure 640-16b



Notes:

(1) Staked slope line - Maximum slope 1:1.
(2) Step rise - height variable 0.3 to 0.6 m
(3) Step tread - width = staked slope ratio x step rise.
(4) Step termini - width = 1/2 step tread width.
(5) Slope rounding.
(6) Overburden area - variable slope ratio.

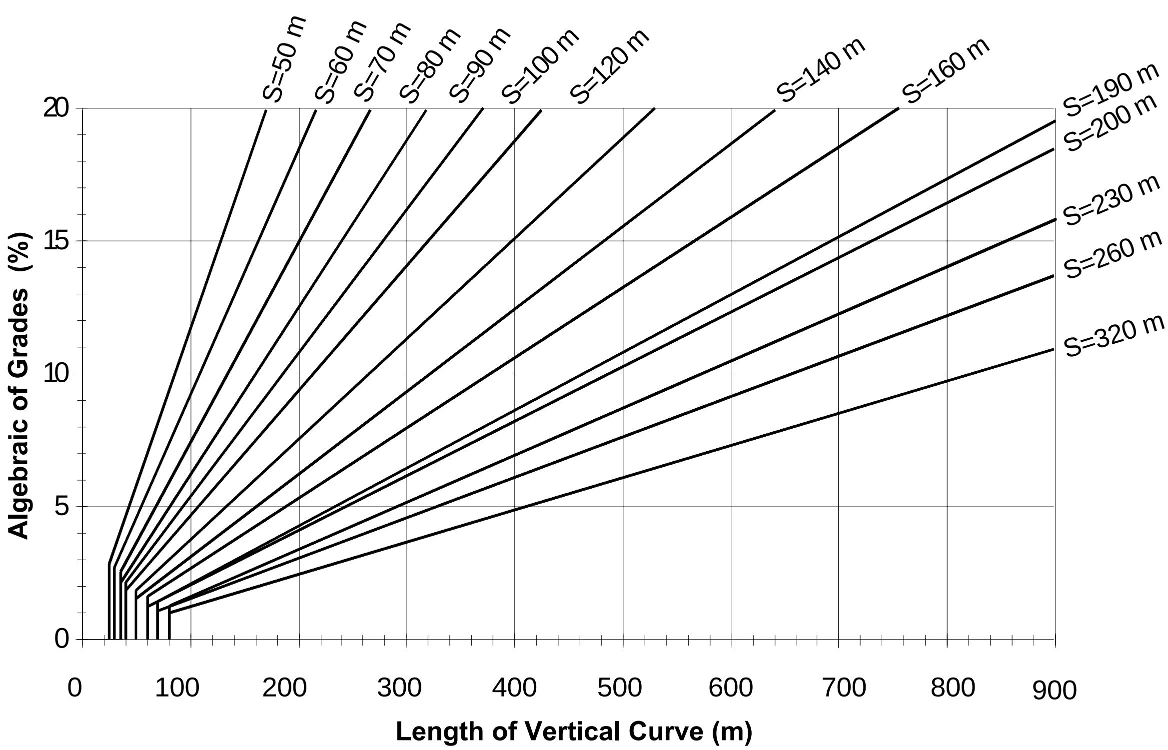
Roadway Sections With Stepped Slopes
Figure 640-17



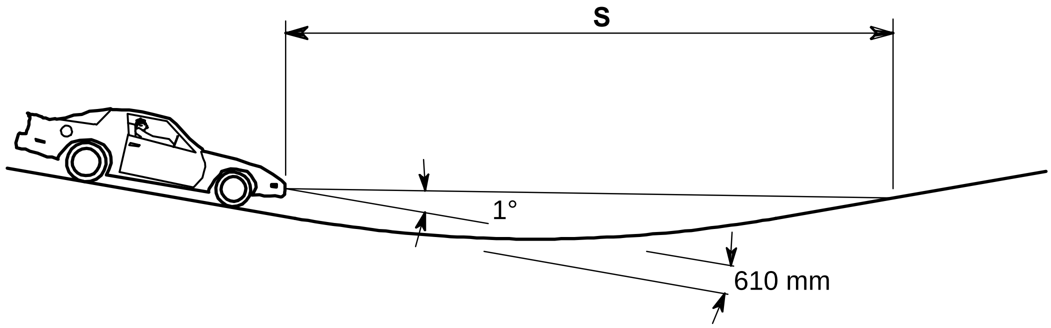
When S > L	When S < L*
$L = 2S - \frac{122 + 3.5S}{A}$	$L = \frac{AS^2}{122 + 3.5S}$

L = Curve length (meters)
A = Algebraic grade difference (percent)
S = Sight distance (meters)

*shown in figure above

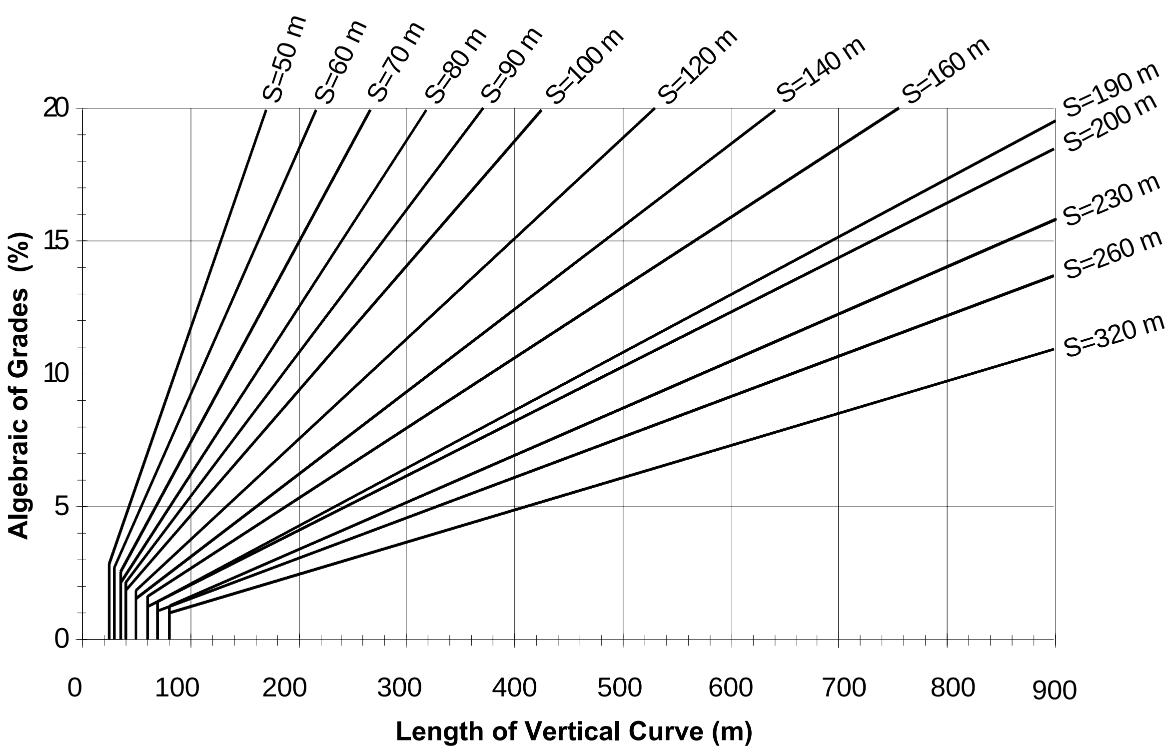


Stopping Sight Distance for Sag Vertical Curves
Figure 650-8



When S > L	When S < L*
$L = 2S - \frac{122 + 3.5S}{A}$	$L = \frac{AS^2}{122 + 3.5S}$
L = Curve length (meters) A = Algebraic grade difference (percent) S = Sight distance (meters)	

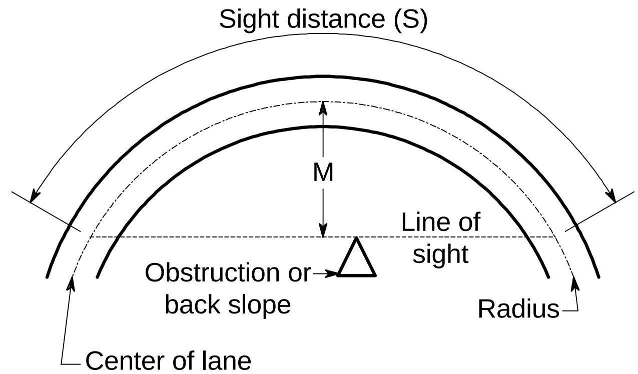
*shown in figure above



Stopping Sight Distance for Sag Vertical Curves

Figure 650-8

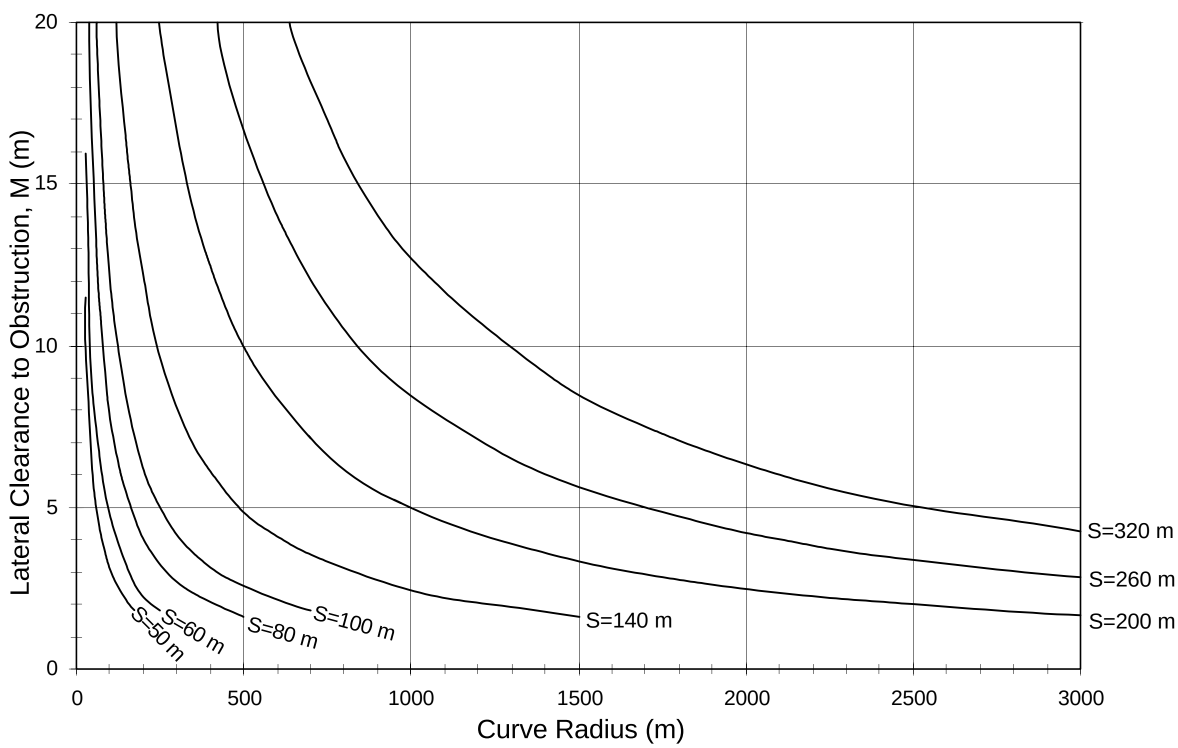
Height of eye: 1070 mm
Height of object: 150 mm
Line of sight is normally 610 mm above center line of inside lane at point of construction provided no vertical curve is present in horizontal curve.



$$M = R\left(1 - \cos\frac{28.65\,S}{R}\right)$$

$$S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R-M}{R}\right)\right]$$

S ≤ Length of curve
Angle is expressed in degrees



Horizontal Stopping Sight Distance
Figure 650-9

710.01 General

Traffic barriers are used to reduce the severity of accidents that occur when an errant vehicle leaves the traveled way. However, traffic barriers are obstacles that the vehicle will encounter and must only be used when justified by accident history or the criteria in Chapter 700.

710.02 References

Standard Plans for Road, Bridge, and Municipal Construction (*Standard Plans*), M 21-01, WSDOT

Roadside Design Guide, AASHTO

Bridge Design Manual, M 23-50, WSDOT

Traffic Manual, M 51-02, WSDOT

710.03 Definitions

barrier terminal A crashworthy end treatment for longitudinal barriers that is designed to reduce the potential for spearing, vaulting, rolling, or excessive deceleration of impacting vehicles from either direction of travel. Beam guardrail terminals include anchorage.

controlled releasing terminal (CRT) post A standard length guardrail post that has two holes drilled through it so that it will break away when struck.

crashworthy A feature that has been proven acceptable for use under specified conditions either through crash testing or in-service performance.

guardrail transition A section of barrier used to produce a gradual stiffening of a flexible or semirigid barrier as it connects to a more rigid barrier or fixed object.

impact attenuator system A device that acts primarily to bring an errant vehicle to a stop at a deceleration rate tolerable to the vehicle occupants or to redirect the vehicle away from a hazard.

length of need The length of a traffic barrier needed to shield a hazard.

longitudinal barrier Traffic barrier oriented parallel or nearly parallel to the roadway. The purpose is to contain or redirect errant vehicles. Beam guardrail, cable barrier, bridge rail, and concrete barrier are longitudinal barriers. Longitudinal barriers are categorized as rigid, unrestrained rigid, semirigid, or flexible and can be installed as roadside or median barriers.

shy distance The distance from the edge of the traveled way beyond which a roadside object will not be perceived as an immediate hazard by the typical driver to the extent that the driver will change the vehicle's placement or speed.

traffic barrier A longitudinal barrier, including bridge rail, or an impact attenuator used to redirect vehicles from hazards located within an established Design Clear Zone, to prevent median crossovers, to prevent errant vehicles from going over the side of a bridge structure, or (occasionally) to protect workers, pedestrians, or bicyclists from vehicular traffic.

710.04 Project Requirements

This section identifies the barrier elements that must be addressed according to the Design Matrices in Chapter 325. Remove any barrier that is not needed (based on the criteria in Chapter 700) and poses a more severe hazard than the hazard it is shielding.

(1) Barrier Terminals and Transitions

(a) **Basic Design Level (B).** When the basic design level (B) is indicated in the Terminal and Transition Section column of a Design Matrix, install, replace, or upgrade transitions as discussed in 710.06(3), Beam Guardrail Transitions.

Replace guardrail ends that do not have a crashworthy design with a crashworthy guardrail terminal. See 710.06(2), Beam Guardrail Terminals.

Common features of noncrashworthy designs are as follows:

- No cable anchor.
- A cable anchored into concrete in front of the first post.
- Second post not breakaway (CRT).
- Design A end section (Design C end sections may be left in place).
- Beam guardrail on both sides of the posts (two sided).

One terminal that was used extensively on Washington's highways was the Breakaway Cable Terminal (BCT). This system used a parabolic flare similar to the SRT and a Type 1 anchor. Type 1 anchor posts are wood set in a steel tube or a concrete foundation.

BCTs that have at least a 1 m offset may remain in place when the basic design level applies unless the guardrail run or anchor is being reconstructed or reset. (Raising the rail element is not considered reconstruction or resetting.) Replace all BCTs that have less than a 1 m offset.

Replace existing buried guardrail terminals that slope down such that the guardrail height is reduced to less than 600 mm.

Concrete barrier terminals must meet the requirements found in 710.08(2).

Impact attenuators must meet the requirements found in Chapter 720, Impact Attenuators.

For preservation projects, this work may be programmed under a separate project as described in Chapter 410.

(b) **Full Design Level (F).** When the full design level (F) is indicated, the requirements for the basic design level apply except that all BCT's must be replaced.

(2) Standard Run of Barrier

(a) **Basic Design Level (B).** When the basic design level (B) is indicated in the Standard Run column of a Design Matrix and the height of W-beam guardrail is or would be reduced to less than 610 mm from the ground to the top of the rail element, adjust the height to the standard height as shown in the *Standard Plans*. If Type 1 Alternate W-beam guardrail is present, raise the rail element after each overlay.

Overlays in front of safety shaped concrete barriers can extend to the top of the lower, near-vertical face of the barrier before adjustment is required.

(b) **Full Design Level (F).** When the full design level (F) is indicated, <u>in addition to the requirements for the basic design level</u>, the barrier must meet the requirements found in the following:

710.05(1)	Shy Distance
710.05(2)	Barrier Deflection
710.05(3)	Barrier Flare Rate
710.05(4)	Length of Need
710.06	Beam Guardrail
710.07	Cable Barrier
710.08	Concrete Barrier

Examples of nonstandard barriers include:

- W-beam guardrail with 3.81 m post spacing and no blockouts.
- W-beam guardrail on concrete posts.
- Cable barrier on wood or concrete posts.
- Half-moon or C shape rail element.

In all cases where nonstandard barrier is to be left in place, the terminals and transitions must be upgraded.

(4) Bridge Rail

When the Bridge Rail column of a matrix applies to the project, the bridge rails must meet the following requirements:

Use an approved, crash tested concrete bridge rail on new bridges or bridges to be widened. The *Bridge Design Manual* provides examples of typical bridge rails. Consult the Bridge and Structures Office regarding bridge rail selection and design and for design of the connection to an existing bridge.

An existing bridge rail on a highway with a posted speed of 30 mph or less may remain in place if it is not located on a bridge over a National Highway System highway. All other bridge rails must be evaluated for strength and geometrics. (See 710.11 for guidance on retrofit techniques.)

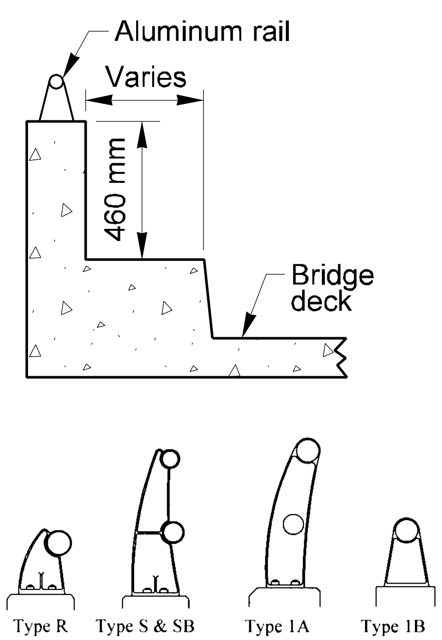
The Type 7 bridge rail is common. Type 7 bridge rails have a curb, a vertical-face parapet, and an aluminum top rail. The curb width and the type of aluminum top rail dictate the adequacy of the Type 7 bridge rail as shown on Figure 710-1. Consult the Bridge and Structures Office for assistance in evaluating other bridge rails.

710.05 Barrier Design

When selecting a barrier, consider the flexibility, cost, and maintainability of the system. It is generally desirable to use the most flexible system possible to minimize damage to the impacting vehicle. However, since nonrigid systems sustain more damage during an impact, the exposure of maintenance crews to traffic might be increased.

Concrete barrier maintenance costs are lower than for other barrier types. Deterioration due to weather and vehicle impacts is limited. Unanchored precast concrete barrier can usually be realigned or repaired when moved from its alignment. However, heavy equipment may be required to reposition or replace barrier segments. Therefore, in medians, consider the shoulder width and the traffic volume when determining the acceptability of unanchored precast concrete barrier versus a rigid concrete barrier.

Drainage alignment and drifting snow or sand are considerations that may influence selection of barrier type. Beam guardrail and concrete barrier can cause snow drifts. Consider long-term maintenance costs associated with snow removal at locations prone to snow drifting. Slope flattening is highly recommended, even at additional cost, to eliminate the need for the barrier. Cable barrier is not an obstruction to drifting snow and can be used if slope flattening is not practical.



Aluminum Rail Type	Curb Width: 230 mm or less	Curb Width: Greater than 230 mm*
Type R, S, or SB	Bridge rail adequate	Bridge rail adequate
Type 1B or 1A	Bridge rail adequate	Upgrade bridge rail
Other	Consult the Bridge and Structures Office	

*When the curb width is greater than 230 mm, the aluminum rail must be able to withstand a 22.2 kN load.

Type 7 Bridge Rail Upgrade Criteria
Figure 710-1

When designing a barrier for use on a Scenic Byway or Heritage Tour Route (formerly Scenic and Recreational Highway), consider barriers that are consistent with the recommendations in the associated Corridor Management Plan (if one is available). Contact the region's Landscape Architect or Heritage Corridors Program manager to determine if the project is on a designated route. Low cost options, such as using weathering steel beam guardrail (see 710.06) or cable barrier (see 710.07) may be feasible on most projects. Higher cost options, such as steel backed timber rail and stone guardwalls (see 710.09) might require a partnering effort to fund the additional costs. Grants might be available and attainable for this purpose if the need is identified early in the project definition phase. (See Chapter 120.)

(1) Shy Distance

Provide an additional 0.6 m of widening for shy distance when a barrier is to be installed in areas where the roadway is to be widened and the shoulder width will be less than 2.4 m. This shy distance is not required when the section of roadway is not being widened or the shoulders are at least 2.4 m wide.

(2) Barrier Deflections

All barriers except rigid barriers (concrete bridge rails for example) will deflect when hit by an errant vehicle. The amount of deflection depends on the stiffness of the system. For flexible and semirigid roadside barriers, the deflection distance is designed to prevent the impacting vehicle from striking the object being shielded. For unrestrained rigid systems (unanchored precast concrete barrier), the deflection distance is designed to prevent the barrier from being knocked over the side of a drop-off or steep fill slope (1V:2H or steeper).

In median installations, the deflected system must not become a hazard to oncoming traffic. In addition, narrow medians provide little space for maintenance crews to repair or reposition the barrier. Avoid installing deflecting barriers in medians that provide less than 2.4 m from the edge of the traveled way to the face of the barrier.

Use a rigid system where deflection cannot be tolerated such as in narrow medians or at the edge of a bridge deck (vertical drop-off). Runs of rigid concrete barrier can be cast-in-place, extruded with appropriate footings, or precast concrete barrier that is bolted or bracketed to the underlying material.

See Figure 710-2 for barrier deflection design values to be used when selecting a longitudinal barrier. The deflection distances for cable and beam guardrail are the minimum measurements from the face of the barrier to the hazard. The deflection distance for unanchored concrete barrier is the minimum measurement from the back edge of the barrier to the drop-off or slope break.

Barrier Type	System Type	Deflection
Cable barrier	Flexible	3.5 m
Beam guardrail Types 1, 1a, 2, and 10	Semirigid	1.0 m
Two-sided W-beam guardrail Types 3 and 4	Semirigid	0.6 m
Permanent concrete barrier, unanchored	Unrestrained Rigid	1.0 m (1)
Temporary concrete barrier, unanchored	Unrestrained Rigid	0.6 m (2)
Concrete barrier, anchored	Rigid	no deflection

(1) When placed in front of a fill slope that is 1V:2H or flatter, the deflection distance can be reduced to 0.6 m.

(2) When used as temporary bridge rail, anchor all barrier that is within 1.0 m of a drop-off

Longitudinal Barrier Deflection
Figure 710-2

(3) Flare Rate

Flare the ends of longitudinal barriers where possible. There are four functions of the flare:

- To locate the barrier and its terminal as far from the traveled way as is feasible.

- To reduce the length of need.
- To redirect an errant vehicle without serious injuries to its occupants.
- To minimize a driver's reaction to the introduction of an object near the traveled way.

Keeping flare rates as flat as practical preserves the barrier's redirectional performance and minimizes the angle of impact. But, it has been shown that an object (or barrier) close to the traveled way may cause a driver to shift laterally, slow down, or both. The flare reduces this reaction by gradually introducing the barrier so that the driver does not perceive the barrier as a hazard. The flare rates in Figure 710-3 satisfy all four functions listed above. More gradual flares may be used.

Posted Speed mph	Rigid System	Unrestrained Rigid System	Semirigid System
70	20:1	18:1	15:1
60	18:1	16:1	14:1
55	16:1	14:1	12:1
50	14:1	12:1	11:1
45	12:1	11:1	10:1
40	11:1	10:1	9:1
or below			

Longitudinal Barrier Flare Rates
Figure 710-3

(4) Length of Need

The length of traffic barrier required to shield a hazard (length of need) is dependent on the location and geometrics of the hazard, direction(s) of traffic, posted speed, traffic volume, and type and location of traffic barrier. When designing a barrier for a fill slope as recommended in Chapter 700, the length of need begins at the point where barrier is recommended. For fixed objects and water hazards, Figures 710-11a and b show design parameters for determining the necessary length of a barrier for both adjacent and opposing traffic on relatively straight sections of highway. When the barrier is to be installed on the outside of a horizontal curve, the length of need can be determined graphically as shown on Figure 710-11c. For installations on the inside of a curve, determine the length of need as though it was straight. Consider the flare rate, barrier deflection, and barrier end treatment to be used when determining the length of need.

Before the actual length of need is determined, establish the lateral distance between the proposed barrier installation and the item shielded. This distance must be greater than or equal to the anticipated deflection of the longitudinal barrier. (See Figure 710-2 for barrier deflections.) Place the barrier as far from the edge of the traveled way as possible while maintaining the deflection distance.

If the end of the length of need is near an adequate cut slope, extend the barrier and embed it in the slope. Avoid gaps of 100 m or less. Short gaps are acceptable when the barriers are terminated in a cut slope. If the end of the length of need is near the end of an existing barrier, it is recommended that the barriers be connected to form a continuous barrier. Consider maintenance access when determining whether to connect barriers.

710.06 Beam Guardrail

(1) Beam Guardrails

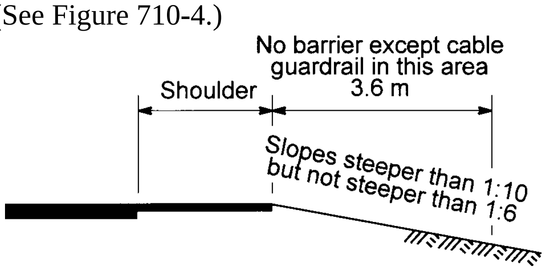
Standard beam guardrail systems are shown in the *Standard Plans*.

Strong post W-beam guardrail (Types 1 through 4) and thrie beam guardrail (Type 10) are semirigid barriers used predominately on roadsides. They also have limited application as median barrier. Strong post beam guardrail that has been installed incorrectly can cause vehicle snagging or spearing. This can be avoided by lapping the rail splices in the direction of traffic as shown in the *Standard Plans*, by using crashworthy end treatments, and by blocking the rail away from the strong posts. In no case will more than two 200 mm blockouts be permitted at any location.

On asphalt concrete pavements (where overlays are anticipated), the Type 1 Alternate guardrail can be used to allow raising of the guardrail without having to adjust the posts.

Weak post W-beam guardrail (Type 20) and thrie beam guardrail (Type 21) are flexible barrier systems that can be used where there is adequate deflection distance. These systems use weak steel posts. The primary purpose of these posts is to position the guardrail vertically and they are designed to bend over when struck. These more flexible systems will result in less damage to the impacting vehicle. Since the weak posts will not result in snagging, blockouts are not necessary.

Keep the slope of the area between the edge of shoulder and the face of the guardrail as flat as possible. The preferred slope is 1V:10H or flatter. Do not place beam guardrail on a fill slope steeper than 1V:6H. On fill slopes between 1V:6H and 1V:10H, beam guardrail must not be placed within 3.6 m of the break point. (See Figure 710-4.)



Guardrail Locations on Slopes
Figure 710-4

On the high side of superelevated sections, place beam guardrail at the edge of shoulder.

Generally, 0.6 m of shoulder widening behind the barrier is provided from the back of the post to the beginning of a fill slope. If the slope is 1V:2H or flatter, this distance can be measured from the face of the guardrail rather than the back of the post. (See Figure 710-12, Cases 1 and 2.)

On projects where no roadway widening is proposed and the minimum 0.6 m shoulder widening behind the barrier is not practical, long post installations are available as shown on Figure 710-12, Cases 3, 4, 5, and 6. When guardrail is to be installed in areas where the roadway is to be widened, the use of Cases 4, 5, or 6 requires a design deviation.

The use of rail washers on beam guardrail is not standard. In areas where heavy snow accumulations are expected to cause the bolts to pull out, specify snow load post and rail washers in the contract documents. (Snow load post washers are used to prevent the bolts from pulling through the posts and snow load rail washers are used to prevent the bolt head from pulling through the rail.) Rail washers are never to be used within the limits of a guardrail terminal except at the end post where they are required for anchorage of the rail.

It is preferred that no curbs be installed in conjunction with beam guardrail. However, if a curb is necessary, the 75 mm high curb is preferred. The 100 mm high curb can only be used at locations where the 75 mm curb will not be adequate. Do not use 150 mm high curb in conjunction with beam guardrails. This policy applies to new installations. Existing 150 mm high curb is allowed to remain in place. If work requires replacement of an existing 150 mm curb, it must be replaced with a 75 mm or 100 mm curb, whichever is appropriate.

The preferred location of a curb, when used in conjunction with beam guardrail, is behind the face of the beam as shown in the *Standard Plans*.

Beam guardrail is usually galvanized and has a silver color. It can also be provided in a weathering steel that has a brown or rust color. Weathering steel guardrail may be desirable on Scenic Byways or Heritage Tour Routes. (See 710.05.)

(2) Terminals and Anchors

A guardrail anchor is required at the ends of a run of guardrail to develop its tensile strength throughout its length. In addition, when the end of the guardrail is subject to head-on impacts, a crashworthy guardrail terminal is required. (See the *Standard Plans*.)

(a) **Buried Terminals.** The buried terminal (BT) is designed to terminate the guardrail by burying the end in a backslope. The standard BT is the preferred terminal because it eliminates the exposed end of the guardrail.

The BT uses a Type 2 anchor to develop the tensile strength in the guardrail. The entire BT can be used within the length of need.

The backslope required to install a BT must be 1V:3H or steeper and at least 1.2 m in height above the roadway. Flare the guardrail into the backslope using a flare rate that meets the criteria in 710.05(3). Provide a 1V:10H or flatter foreslope into the face of the guardrail and maintain the full guardrail height to the foreslope/backslope intersection. This may require filling ditches and installing culverts in front of the guardrail face.

(b) **Flared Terminal.** If a BT cannot be installed as described above, consider a flared terminal. (See Figure 710-13.) There are currently 2 acceptable sole source proprietary designs; the Slotted Rail Terminal (SRT) and the Flared Energy Absorbing Terminal (FLEAT).

Both of these designs include an anchor for developing the tensile strength of the guardrail. The length of need begins at the third post for both flared terminals.

1. The SRT uses W-beam guardrail with slots cut into the corrugations and wood breakaway and controlled release terminal (CRT) posts that are designed to break away when hit. The end of the SRT is offset from the tangent guardrail run by the use of a parabolic flare. When struck head on, the first 2 posts are designed to break away and the parabolic flare gives the rail a natural tendency to buckle, minimizing the possibility of the guardrail end entering the vehicle. The buckling is facilitated by the slots in the rail. The CRT posts provide strength to the system for redirection and deceleration without snagging the vehicle.

   The SRT has a 1.220 m offset of the first post.

2. The FLEAT uses W-beam guardrail with a special end piece that fits over the end of the guardrail and wood breakaway and CRT posts. The end of the FLEAT is offset from the tangent guardrail run by the use of a straight flare. When struck head on, the end piece is forced over the rail, bending the rail and forcing it away from the impacting vehicle.

   The FLEAT is available in 2 designs based on the posted speed of the highway. For high speed highways (posted speed of 45 mph or greater) use a FLEAT 350 that has a 1.220 m offset at the first post. For lower speed highways (posted speed of 40 mph or less), use a FLEAT TL-2 that has a 510 mm offset at the first post.

When a flared terminal is specified, it is critical that embankment also be specified so that the area around the terminal can be flattened as shown on the *Standard Plans*. For every meter of height of the embankment, 30 cubic meters of “Embankment in Place” must be specified.

No snow load rail washers are allowed within the limits of this terminal.

The FHWA has granted approval to use these sole source proprietary terminals without justification on a project by project basis.

(c) **Nonflared Terminal.** Where widening to provide the offset for a flared terminal is not practical, consider a nonflared terminal. (See Figure 710-13.) There are currently 2 acceptable sole source proprietary designs; the ET 2000 - PLUS and the Sequential Kinking Terminal (SKT). Both of these systems use W-beam guardrail with a special end piece that fits over the end of the guardrail and wood breakaway and CRT posts. When hit head-on, the end piece is forced over the rail and either flattens or bends the rail and then forces the rail away from the impacting vehicle.

Both of these terminals include an anchor for developing the tensile strength of the guardrail. The length of need begins at the third post for both terminals.

Both of these terminals are available in two designs based on the posted speed of the hghway The primary difference in these designs is the length of the terminal. For high speed highways (posted speed of 45 mph or greater), use the ET

2000 - PLUS (TL3) or SKT 350 whch are 15.24 m long. For lower speed highways (posted speed of 40 mph or less), use the ET 2000 - PLUS (TL2) or SKT-TL2 which are 7.62 m long.

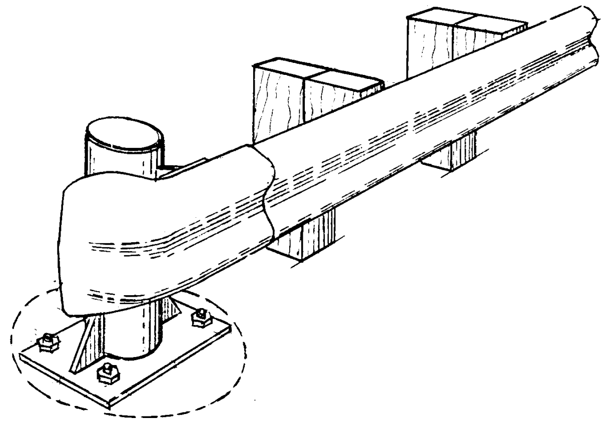
While these terminals do not require an offset at the end, a flare is recommended so that the end piece does not protrude into the shoulder. These terminals may have a 300 mm offset of the first post. One meter of widening is required at the end 2 posts to ensure that the system is properly anchored. For every meter of height of embankment, 8 cubic meters of "Embankment in Place" must be specified.

No snow load rail washers are allowed within the limits of these terminals.

The FHWA has granted approval to use these sole source proprietary terminals without justification on a project by project basis.

(d) **Other Anchor Applications.** On the trailing end of guardrail runs along one-way highways, use the Type 4 anchor to develop the tensile strength of the guardrail. Use the Type 5 anchor with the Weak Post Intersection Design. (See 710.06(4) Cases 12 and 13.) The Type 7 anchor is used to develop tensile strength in the middle of a guardrail run when the guardrail curves and weak posts are used. (See 710.06(4) cases 9, 12, and 13.)

The old Type 3 anchor was primarily used at bridge ends. (See Figure 710-5.) This anchor consisted of a steel pipe mounted vertically in a concrete foundation. Bridge approach guardrail was then mounted on the steel pipe. On one-way highways, these anchors were usually positioned so that neither the anchor nor the bridge rail posed a snagging hazard. In these cases, the anchor may remain in place if a stiffened transition section is provided at the connection to the post. On two-way highways the anchor may present a snagging hazard. In these cases, install a connection from the anchor to the bridge rail if the offset from the bridge rail to the face of the guardrail is 460 mm or less. If the offset is greater than 460 mm, remove the anchor and install a new transition and connection.



Old Type 3 Anchor
Figure 710-5

Locations where crossroads and driveways cause gaps in the guardrail require special consideration. Elimination of the need for the barrier is the preferred solution. Otherwise, a barrier flare may be required to provide sight distance. If the slope is 1V:2H or flatter and there are no hazards on or at the bottom of the slope, a terminal can be used to end the rail. Place the anchor of this installation as close as possible to the road approach radius PC. If there is a hazard at or near the bottom of the slope that cannot be mitigated, then the Weak Post Intersection Design (see 710.04(4) and the *Standard Plans*) can be used. This system can also be used at locations where a crossroad or road approach is near the end of a bridge and installing a standard bridge approach guardrail placement (guardrail transition and terminal) is not possible.

(3) Transitions and Connections

When there is an abrupt change from one barrier type to a more rigid barrier type, a vehicle hitting the more flexible barrier is likely to be caught in the deflected barrier pocket and directed into the more rigid barrier. This is commonly referred to as pocketing. A transition stiffens the more flexible barrier by decreasing the post spacing, increasing the post size, and using stiffer beam elements to eliminate the possibility of pocketing.

When connecting beam guardrail to a more rigid barrier or a structure, or when a rigid object is within the deflection distance of the barrier, use the transitions and connections that are shown on Figures 710-6 and 7 and detailed in the *Standard Plans*. The transition pay item includes the connection.

	Connection
Untapered safety shaped bridge rails or barriers(1)	B
Bridge rails with curbs 230 mm or less in width	B
Bridge rails with curbs up to 450 mm in width	C
Vertical walls or tapered safety shape barrier	D

(1)New safety shaped bridge rails are designed with the toe of the barrier tapered so that it does not project past the face of the approach guardrail.

Guardrail Connections
Figure 710-6

(4) Guardrail Placement Cases

The *Standard Plans* contain placement cases that show all of the beam guardrail elements required for typical situations. The following is a description of each.

Case 1 is used only where there is one-way traffic. It uses a crashworthy terminal on the approach end and a Type 4 anchor on the trailing end.

Case 2 is used where there is two-way traffic. A crashworthy terminal is used on both ends. When flared terminals are used on both ends, a minimum of 7.62 m of guardrail is required between the terminal limits.

Case 3 is used at railroad signal supports on one-way or two-way roadways. A terminal is used on the approach end but usually cannot be used on the trailing end because of its proximity to the railroad tracks. For one-way roadways, a Type 4 anchor is used on the trailing end. On two-way roadways a Type 1 anchor is used on the trailing end. If there is a history of crossover accidents, consider additional protection, such as an impact attenuator.

Case 4 is used where guardrail on the approach to a bridge is to be shifted laterally to connect with the bridge rail. A terminal is used on the approach end and a transition is required at the bridge end. A curve in the guardrail is shown to shift it to the bridge rail. However, the length of the curve is not critical and the only requirement is to provide a smooth curve that is not more abrupt than the allowable flare rate. (See Figure 710-3.)

Case 5 is a typical bridge approach where a terminal and a transition are required.

Case 6 is used on bridge approaches where opposing traffic is separated by a median that is 10.8 m or wider. This case was designed so that the end of the guardrail would be outside of the clear zone for the opposing traffic.

Cases 7 and 8 are used with beam guardrail median barrier when median hazards such as bridge piers are encountered. A transition is required on the approach end for each direction and the flare rate must not be more abrupt than allowed. (See Figure 710-3.)

Case 9 is used on bridge approaches where opposing traffic is separated by a median less than 10.8 m wide. This design, called a “Bull Nose Attenuator,” treats both bridge ends and the opening between the bridges. The “nose” is designed to collapse when struck head-on and the ribbon strength of the rail brings the vehicle to a controlled stop. Type 7 anchors are installed on each side of the nose to develop the ribbon strength.

Since an impacting vehicle will penetrate into the system, it is critical that no fixed object be located within the first 9 m of the system. Table 1 on this standard plan gives the dimensions needed for a range of median widths.

Case 10 (A, B, and C) is used at roadside hazards (such as bridge piers) when 1.0 m or more is available from the face of the guardrail to the hazard. The approach end is the same for one-way or two-way traffic. Case 10A is used with

Connecting W-beam guardrail to:			Transition	Connection
Bridge Rail	New		1[1]	D
	Existing concrete	Concrete parapet > 500 mm	1[1]	Figure 710-6
		Concrete Parapet < 500 mm	2	Figure 710-6
		Existing W-Beam Transition	2[2]	[3]
	Thrie Beam installed at face of curb[5]	Approach end	10	na
		Trailing end, two way trafffic only	11, 12	na
	Thrie Beam installed at bridge rail (curb exposed)[5]	Approach end	13	na
		Trailing end, two way traffic only	14, 15	na
	All if:	Weak Post Intersection Design (see 710.06(4) cases 12 and 13)	5	Figure 710-6
Concrete Barrier	Rigid/ Restrained		1	Figure 710-6
	Unrestrained		3	A
	Temporary		4	A
Weak Post barrier systems (Type 20 and 21)			6	na
Rigid structures such as bridge piers		New installation (see Case 11)	16, 17, 18	na
		Existing W-Beam Transition	(4)	na

(1) A Type 1a transition can be used where there is a problem placing a post within 740 mm from the end of the bridge in which case a B or E connection is required. When the E connection is to be used, a special detail for the end of the bridge is required. Contact the Bridge and Structures Office.

(2) If work requires reconstruction or resetting of the transition, upgrade as shown above. Raising the guardrail is not considered reconstruction.

(3) See 710.06(2)(d) for guidance when Type 3 anchors are encountered. If the transition is not being reconstructed, the existing connection may remain in place.

(4) For new/reconstruction, use Case 11 (thrie beam). For existing Case 11 with W-beam, add a second W-beam rail element.

(5) For Service Level 1 bridge rail see 710.06(4), case 14.

Transitions and Connections

Figure 710-7

two-way traffic and, therefore, a terminal is required on the trailing end. Case 10B is used for one-way traffic when there is no need to extend guardrail past the bridge pier and a Type 4 anchor is used to end the guardrail. Case 10C is used for one-way traffic when the guardrail will extend for a distance past the bridge pier.

Case 11 (A, B, and C) is used at roadside hazards (such as bridge piers) when the guardrail is to be placed within 1 m of the hazard. Since there is no room for deflection, the rail in front of the hazard must be considered a rigid system and a transition is necessary. The trailing end cases are the same as described for Placement Case 10.

Cases 12 and 13 are called “Weak Post Intersection Designs.” They are used where an intersection requires a gap in the guardrail or there is not adequate space for a standard bridge approach installation. These placements are designed to collapse when hit at the nose, and the ribbon strength of the rail brings the vehicle to a stop. A Type 7 anchor is used to develop the ribbon strength. These designs include a Type 5 transition for connection with bridge rail and a Type 5 anchor at the other end of the rail. The Type 5 anchor is not a breakaway anchor and, therefore, can only be used on low speed side roads and driveways.

Since an impacting vehicle will penetrate into the system, it is critical that no fixed objects be located within the clear area shown on the standard plan. The 7.62 m along the side road is critical for the operation of this system.

These designs were developed for intersections that are approximately perpendicular. Evaluate installation on skewed intersections on a case-by-case basis. Use the Case 22 placement if it is not feasible to install this design according to the standard plan.

Case 14 shows the approach rail layout for a Service Level 1 bridge rail system. Type 20 guardrail is used on the approach and no transition is required between the Type 20 guardrail and the Service Level 1 bridge rail since they are both weak post systems. A Type 6 transition is used when connecting the Type 20 to a strong post guardrail or a terminal.

Case 15 is used to carry guardrail across a box culvert where there is insufficient depth to install standard posts for more than 5.4 m. This design uses steel posts anchored to the box culvert to support the rail. Newer designs, Cases 19, 20 and 21, have replaced this design for shorter spans.

Cases 16 and 17 are similar to Cases 1 and 2, except that they flare the rail and terminal as far from the road as possible and reduce the length of need.

Case 18 is used on the trailing end of bridge rail on a one-way roadway. No transition is necessary.

Cases 19 and 20 are used where it is not possible to install a post at the 1.905 m spacing. These designs omit one post (which allows a span of 3.5 m) and use nested W-beam to stiffen the rail. The cases differ by the location of the splice. No cutting of the rail or offsetting of the splices is necessary or desirable.

Case 21 is similar to Cases 19 and 20, except that it allows for two posts to be omitted which allows a span of 5.4 m.

Case 22 is the Strong Post Intersection Design that provides a stiff barrier. This design is only to be used as a last resort at crossroads or road approaches where a barrier is necessary and there isn’t a clear area behind the nose or minimum distances for a “Weak Post Intersection Design.”

710.07 Cable Barrier

Cable barrier is a flexible barrier system that can be used on a roadside or as a median barrier.

This system consists of three steel cables mounted to steel posts (weak posts). The maximum spacing for the steel posts is 5 m on tangent sections and curves of 210 m radius or greater. A deflection of 3.5 m is anticipated with this post spacing. A smaller spacing is required on radii less than 210 m. For tangent sections and large radius curves, the deflection can be reduced to 2.1 m by reducing the post spacing to 1.2 m.

At each end of the barrier run, the cable is turned down and anchored to concrete blocks. A coil spring and turnbuckle are required on each cable to maintain tension on the system.

Cable barrier can be installed in front of side slopes as steep as 1V:2H. This barrier is the only barrier that can be placed on a side slope steeper than 1V:10H within the 3.6 m area immediately beyond the breakpoint. Do not place this barrier on a side slope steeper than 1V:6H. Figure 710-14 shows the placement of cable barrier.

When cable barrier is to be connected to a more rigid barrier, a transition section is required. Contact the Olympia Service Center (OSC) Design Office for details.

The primary advantage of cable barrier is that it provides effective vehicle containment and redirection while imposing the lowest deceleration forces on the vehicle's occupants. It also has advantages in heavy snowfall areas and it does not present a visual barrier which may make it desirable on Scenic Byways. (See 710.05.)

Maintenance is a consideration because routine maintenance is necessary to keep tension in the cables and a comparatively long run of cable barrier will have to be repaired after an impact. However, the effort (time and materials) required to maintain and repair cable barrier is much less than the effort required for a W-beam system.

710.08 Concrete Barrier

Concrete barriers are rigid or unrestrained, rigid systems that are primarily used as median barriers. They are also used as shoulder barriers. These systems are stiffer than beam or cable barrier and impacts with these barriers will tend to be more severe.

Light standards mounted on top of concrete median barrier must not have breakaway features. See the *Standard Plans* for the concrete barrier light standard section.

Where drainage may be a problem, contact the OSC Hydraulics Branch for guidance.

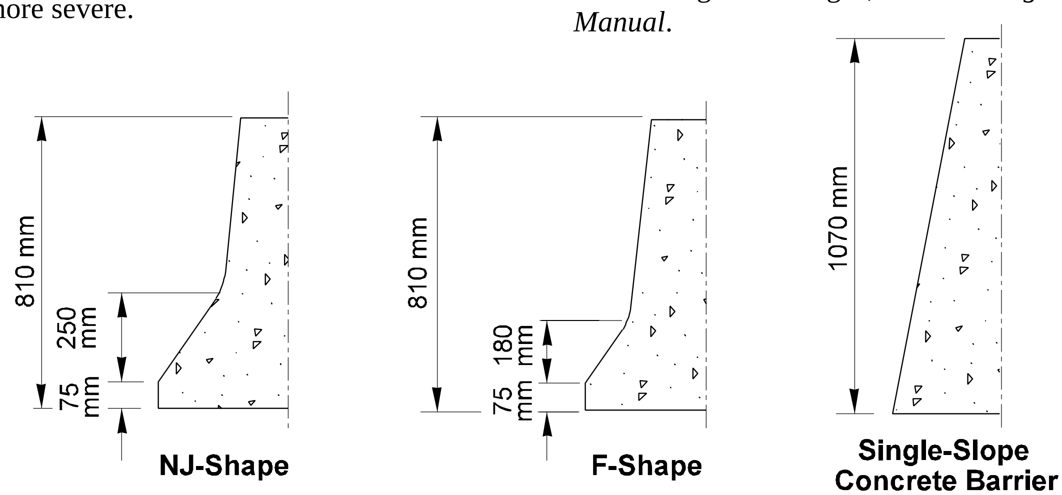
(1) Concrete Barrier Shapes

Concrete barriers use a safety shaped (New Jersey shape and, on bridges, the F-Shape) or single-sloped face to redirect vehicles while minimizing vehicle vaulting, rolling, and snagging. A comparison of these barrier shapes is shown on Figure 710-8.

The New Jersey shaped face is used on precast concrete barrier.

The single-slope barrier face is recommended when separating roadways with different elevations (stepped medians). The single-slope barrier face can be used for bridge rails (median or outside) when it is to be used on any approach to the bridge and an existing bridge rail is to be replaced.

The F-Shape face is used on all other bridge rails and on cast-in-place barrier where the New Jersey and single-slope face are not appropriate. When the F-Shape face is used and precast barrier is to be used on the approaches, a cast-in-place transition section is required so that no vertical edges of the barriers are exposed to oncoming traffic. For details on the F-Shape barrier or any of the bridge rail designs, see the *Bridge Design Manual*.



Concrete Barrier Shapes
Figure 710-8

For aesthetic reasons, avoid changes in the shape of the barrier face within a project or corridor. However, the cost of precast Type 2 barrier is significantly less than the cost of the cast-in-place barriers. Therefore, consider the length of the barrier run to determine whether transitioning to precast Type 2 barrier is desirable. If precast Type 2 barrier is used for the majority of a project, use the New Jersey face for small sections that require cast-in-place barrier.

(a) **New Jersey Shape Barrier.** The New Jersey shaped face is primarily used on precast concrete barrier.

Concrete barrier Type 2 (see the *Standard Plans*) is a precast barrier that has the New Jersey shape on two sides and can be used for both median and shoulder installations. This barrier is 810 mm in height, which includes 75 mm for future pavement overlay.

Concrete barrier Type 5 is a precast barrier that has a single New Jersey face and is intended for use at bridge ends where the flat side is highly visible. Both designs are freestanding, unanchored units connected with steel pins through wire rope loops. For permanent installation, this barrier is placed on a paved surface and a 0.6 m wide paved surface is provided beyond the barrier for its displacement during impact. (See Chapter 640.)

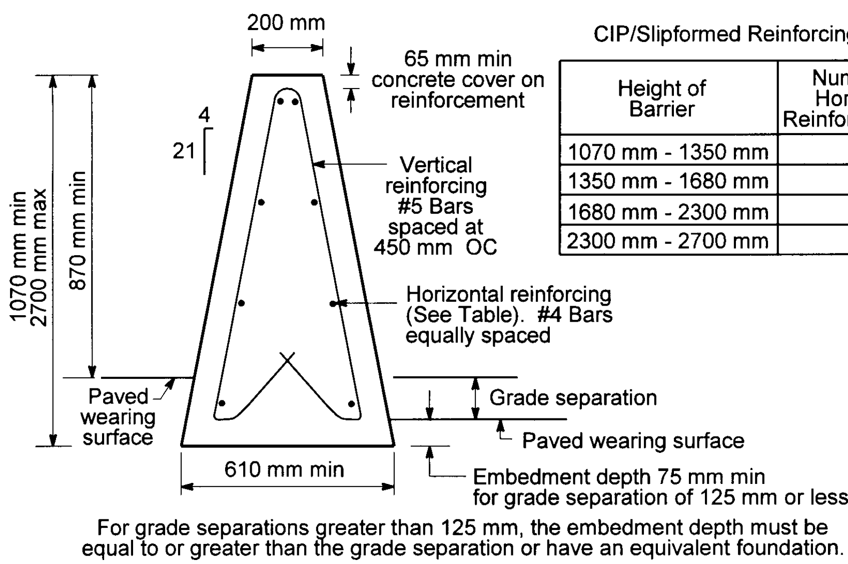
Concrete barrier Type 4 is also a precast, single-faced New Jersey shaped barrier. These units are not freestanding and must be placed against a rigid structure or anchored to the pavement. If Type 4 barriers are used back to back, consider filling any gap between them to prevent tipping.

Precast barrier can be anchored where a more rigid barrier is desired. Anchoring methods are shown in the *Standard Plans*. The Type 1 and 2 anchors are for temporary installations on a rigid pavement. Type 3 anchors can be used in temporary or permanent installations on an asphalt pavement. Consult the Bridge and Structures Office for details when anchoring permanent precast concrete barrier to a rigid pavement.

Precast barrier used on the approach to bridge rail must be connected to the bridge rail by installing wire rope loops embedded 380 mm into the bridge rail with epoxy resin.

For unrestrained (unanchored) precast concrete barrier, the preferred foundation slope is 5 percent or flatter with a maximum of 8 percent. The slope of the area between the edge of the shoulder and the face of the traffic barrier should be kept as flat as possible. The maximum slope is 1V:10H.

(b) **Single Slope Barrier.** The single slope concrete barrier (see Figure 710-9) can be cast-in-place, slipformed, or precast. The most common



CIP/Slipformed Reinforcing Steel

Height of Barrier	Number of Horizontal Reinforcing Bars
1070 mm - 1350 mm	8
1350 mm - 1680 mm	10
1680 mm - 2300 mm	12
2300 mm - 2700 mm	14

Single Slope Concrete Barrier
Figure 710-9

construction technique for this barrier has been slipforming but some precast single slope barrier has been installed. The primary benefit of using precast barrier is that it can be used as temporary barrier during construction and then reset into a permanent location.

This barrier is considered a rigid system regardless of the construction method used. For new installations, the minimum height of the barrier above the roadway is 870 mm which allows 50 mm for future overlays. The minimum total height of the barrier section is 1070 mm with a minimum of 75 mm embedded in the roadway wearing surface. This allows for use of the barrier between roadways with grade separations of up to 125 mm. For greater grade separations, the barrier must have a depth of embedment equal to or greater than the grade separation or have an equivalent structural foundation.

For details of the single slope barrier, contact the OSC Design Office.

(2) Concrete Barrier Terminals

Whenever possible, bury the end of the concrete barrier in the backslope. The backslope required to bury the end must be 1V:3H or steeper and at least 1.2 m in height above the roadway. Flare the concrete barrier into the backslope using a flare rate that meets the criteria in 710.05(3). Provide a 1V:10H or flatter foreslope into the face of the barrier and maintain the full barrier height to the foreslope/backslope intersection. This might require filling ditches and installing culverts in front of the barrier face.

A precast or cast-in-place terminal section having a minimum length of 15 m and a maximum length of 25 m is another end treatment. It can only be used for posted speeds of 35 mph or less. Contact the OSC Design Office for details on this end treatment.

The 2.1 m long precast concrete terminal end section for Concrete Barrier Type 2 may be used:

- Outside the Design Clear Zone.
- On the trailing end of the barrier when it is outside the Design Clear Zone for opposing traffic.
- On the trailing end of one-way traffic.
- Where the posted speed is 25 mph or less.

When the Barrier Terminals and Transitions column of a design matrix applies to a project, existing sloped down concrete terminals that are within the Design Clear Zone must be replaced when they do not meet the criteria above.

When the end of a concrete barrier cannot be buried in a backslope or terminated as described above, terminate the barrier using a guardrail terminal and transition or an impact attenuator. (See Chapter 720.)

710.09 Special Use Barriers

The following barriers may be used on designated Scenic Byway and Heritage Corridor routes if funding can be arranged. (See 710.05 and Chapter 120.)

(1) Steel Backed Timber Guardrail

Steel backed timber guardrails consist of a timber rail with a steel plate attached to the back to increase it's tensile strength. There are several variations of this system that have passed crash tests. The nonproprietary systems use a beam with a rectangular cross section that is supported by either wood or steel posts. A proprietary (patented) system called the Ironwood guardrail is also available. This system uses a beam with a round cross section and is supported by steel posts with a wood covering to give the appearance of an all-wood system from the roadway. The Ironwood guardrail can be allowed as an alternate to the nonproprietary system. However, specifying this system exclusively requires the approval, from the Assistant State Design Engineer, of a public interest finding for the use of a sole source proprietary item.

The most desirable method of terminating the steel backed timber guardrail is to bury the end in a back slope as described in 710.06(2)(a). When this type of terminal is not possible, the use of the barrier is limited to highways with speeds of 45 mph or less. On these highways, the barrier can be flared away from the traveled way and terminated in a berm.

For details of these systems, contact the OSC Design Office.

(2) Stone Guardwalls

Stone guardwalls function like rigid concrete barriers but have an appearance of natural stone. These walls can be constructed of stone masonry over a reinforced concrete core wall or of simulated stone concrete. These types of barriers are designed to have a limited projection of the stones that will not affect the redirectional characteristics of the barrier. Installation of stone guardwalls is limited to highways with a posted speed of 55 mph or less when the end can be buried in a backslope as described in 710.08(2). When this type of terminal is not possible, the use of the barrier is limited to highways with speeds of 45 mph or less. On these highways, the barrier can be flared away from the traveled way and terminated in a berm.

For details of these systems, contact the OSC Design Office.

710.10 Redirectional Land Forms

Redirectional land forms, also referred to as earth berms, redirect an errant vehicle. They are used to mitigate hazards located in depressed medians and may be used at roadside hazards when the slope, length, and height requirements can be met.

The *Standard Plans* shows a typical redirectional land form and identifies basic design features. Earth berm heights and slope rates are not fixed. Slopes adjacent to the hazard should be in the range of 1V:2H to 1V:3H. Flatter slopes may be used in the transition areas preceding the hazard. Berm heights over 3 m are not recommended.

Redirectional land forms are constructed of readily available materials that will provide support for the traversing vehicle without special compaction. Aesthetic compatibility is a significant consideration in selecting the earth berm surface material. Contact the region's Landscape Architecture Office for additional guidance on the surface material and vegetation requirements for redirectional land forms.

Redirectional land forms can add to the foundation loads or affect the seismic performance of a structure. Identify proposed locations in the planning stage of the design of a new structure. Investigate locations of proposed berms for possible foundation overloading or seismic concerns at existing structures.

Items required to drain the roadway shoulder and median ditch areas, such as grate inlets or slotted drains, should not interrupt the smooth contours of the land form or shoulder.

710.11 Bridge Rails

Bridge rails are traffic barriers that redirect errant vehicles and prevent them from going over the side of the structure. See the *Bridge Design Manual* for information on bridge rail on new bridges and replacement bridge rail on existing bridges.

For most new bridge rail installations, use an 810 mm high safety shape (F Shape) bridge rail. The single slope bridge rail that is 870 mm high can be used to be consistent with the heights of connecting single slope barrier (710.08(1)(b)).

Use taller, 1070 mm, safety shape or single slope bridge rails on Interstate or freeway routes where accident history suggests a need or where roadway geometrics increase the possibility of a larger trucks hitting the barrier at a high angle (such as on ramps for freeway to freeway connections with sharp curvature in the alignment).

For bridges where high volumes of pedestrian traffic are anticipated, see Chapter 1020 for further guidance.

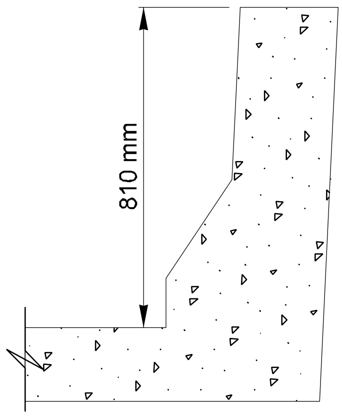
Approach barriers, transitions, and connections are usually required on all four corners of bridges carrying two-way traffic and on both corners of the approach end for one-way traffic. See 710.06(3) for guidance on transitions.

If the bridge rail system does not meet the criteria for strength and geometrics, modifications to improve its redirectional characteristics and its strength may be required. The modifications can be made using one of the retrofit methods described below.

(1) Concrete Safety Shape

Retrofitting with a new concrete bridge rail (see Figure 710-10) is costly and requires justification when no widening is proposed. Consult the

Bridge and Structures Office for design details and to determine if the existing bridge deck and other superstructure elements are of sufficient strength to accommodate this bridge rail system.



Safety Shaped Concrete Bridge Rail Retrofit
Figure 710-10

(2) Thrie Beam Retrofit

Retrofitting with thrie beam is an economical way to improve the strength and redirectional performance of bridge rails. The thrie beam can be mounted to steel posts or the existing bridge rail, depending on the structural adequacy of the bridge deck, the existing bridge rail type, the width of curb (if any), and the curb-to-curb roadway width carried across the structure.

The existing bridge deck must have adequate strength to withstand an impact without causing significant damage to the deck. Contact the Bridge and Structures office to determine if the deck has adequate strength.

Consider the Service Level 1 (SL-1) system on bridges with wooden decks and for bridges with concrete decks that do not have adequate strength to accommodate the standard thrie beam system. Contact the Bridge and Structures Office for information required for the design of the SL-1 system.

Figure 710-15 shows typical installation criteria.

710.12 Other Barriers

(1) Water Filled Barriers

Water filled barriers are longitudinal barrier systems that use light weight modules pinned together and filled with water to form a barrier. They may be used only in work zones as an improvement over cones or plastic drums. See the *Traffic Manual* for further guidance.

Two different water filled barrier systems (Triton and Guardian) have been crash tested with the vehicle hitting the system at a 25 degree angle at 45 mph and 60 mph. The systems were deflected up to 3.9 m at 45 mph and up to 7 m at 60 mph. At lesser speeds and angles this deflection will be less. However, with this amount of deflection, use of water filled barrier will generally not be practical when a crashworthy barrier is required. Therefore, they cannot be considered a substitute for concrete barrier.

The minimum length of water filled barrier is 30 m. For 45 mph, the end 10 m do not contribute to the length-of-need. For 60 mph, the end 20 m do not contribute to the length of need. One of the water filled systems, the Triton Barrier, can act as its own end treatment if the end module is left empty and the retaining pin is left out of the exposed end. The other system, the Guardian, requires a crashworthy end treatment or a TMA on the approach end.

(2) Dragnet

The Dragnet Vehicle Arresting Barrier consists of chain link or fiber net that is attached to energy absorbing units. When a vehicle hits the system, the Dragnet brings the vehicle to a controlled stop with a minimum of damage. Possible uses for this device are as follows:

- Reversible lane entrances and exits.
- Railroad crossings.
- Truck escape ramps (instead of arrester beds).
- T-intersections.
- Work zones.

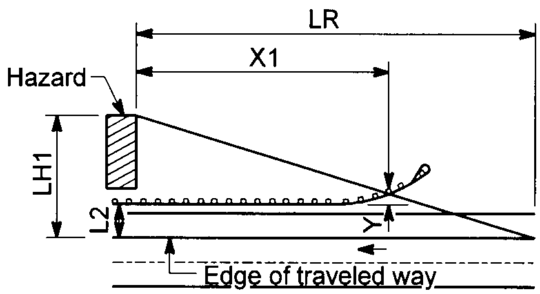
For permanent installations, this system can be installed between towers that lower the unit into position when needed and lift it out of the way when it is no longer needed. For work zone applications, it is critical to provide deflection space for stopping the vehicle between the system and the work zone. For additional information on the Dragnet, contact the OSC Design Office.

710.13 Documentation

The following documents are to be preserved in the project file. See Chapter 330.

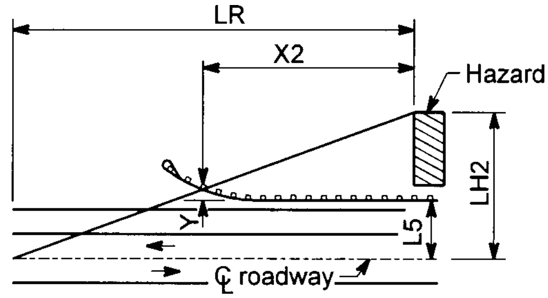
- Barrier selection.
- Shy distance requirements.
- Barrier length of need calculation.
- Long guardrail post justification or approved deviation.
- Barrier terminal and transition selection.
- Bridge rail evaluation and upgrade method.

P65:DP/DMM



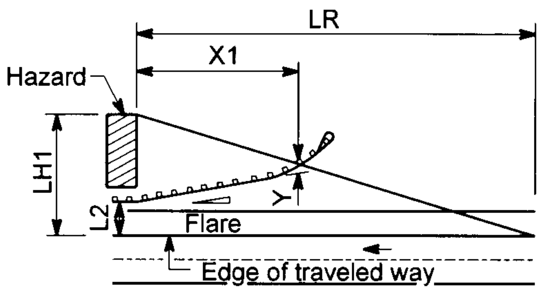
$$X1 = \frac{LH1 - (L2+Y)}{(LH1/LR)}$$

Adjacent-Side Hazard
Barrier Parallel to Roadway



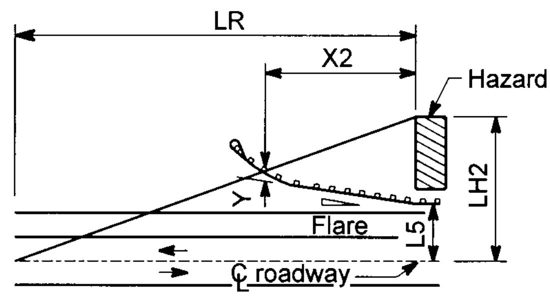
$$X2 = \frac{LH2 - (L5+Y)}{(LH2/LR)}$$

Opposite-Side Hazard
Barrier Parallel to Roadway



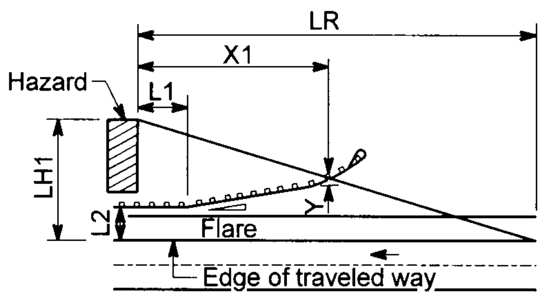
$$X1 = \frac{LH1 - (L2+Y)}{(1/F) + (LH1/LR)}$$

Adjacent-Side Hazard
Barrier Flare Begins at Hazard



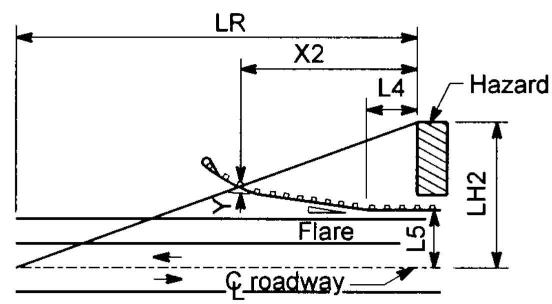
$$X2 = \frac{LH2 - (L5+Y)}{(1/F) + (LH2/LR)}$$

Opposite-Side Hazard
Barrier Flare Begins at Hazard



$$X1 = \frac{(LH1 + L1/F) - (L2+Y)}{(1/F) + (LH1/LR)}$$

Adjacent-Side Hazard
Barrier Flare Begins Before Hazard



$$X2 = \frac{(LH2 + L4/F) - (L5+Y)}{(1/F) + (LH2/LR)}$$

Opposite-Side Hazard
Barrier Flare Begins Before Hazard

Barrier Length of Need
Figure 710-11a

L1 = Length of barrier parallel to roadway from adjacent-side hazard to beginning of barrier flare. This is used if a portion of the barrier cannot be flared (such as a bridge rail and the transition)

L2 = Distance from adjacent edge of traveled way to portion of barrier parallel to roadway.

L4 = Length of barrier parallel to roadway from opposite-side hazard to beginning of barrier flare.

L5 = Distance from center line of roadway to portion of barrier parallel to roadway. Note: if the hazard is outside of the Design Clear Zone when measured from the center line, it may only be necessary to provide a crashworthy end treatment for the barrier.

LH1 = Distance from outside edge of traveled way to back side of adjacent-side hazard. Note: if a hazard extends past the Design Clear Zone, the Design Clear Zone can be used as LH1.

LH2 = Distance from center line of roadway to back side of opposite-side hazard. Note: if a hazard extends past the Design Clear Zone, the Design Clear Zone can be used as LH1.

LR = Runout length (measured parallel to roadway).

X1 = Length of need for barrier to shield an adjacent-side hazard.

X2 = Length of need for barrier to shield an opposite-side hazard.

F = Flare rate value.

Y = Offset distance required at the beginning of the length of need.

Different end treatments require different offsets.

For the SRT 350 and FLEAT 350, use Y = 0.55 m.

For evaluating existing BCT's, use Y = 0.55 m.

For the FLEAT TL-2, use Y = 0.25 m.

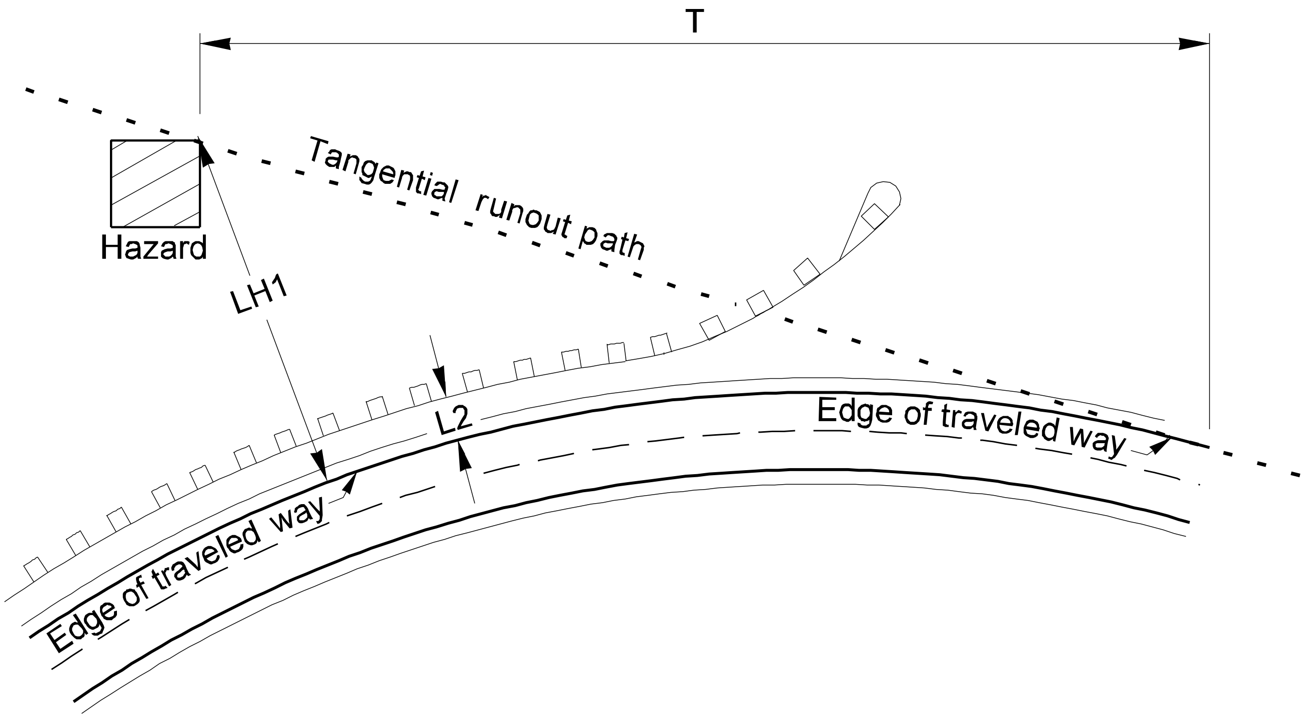
No offset is required for the nonflared terminals, or impact attenuator systems. Use Y = 0.

Buried terminal end treatments are used with barrier flares and have no offset. Use Y = 0.

Design Parameters							
	ADT						
Posted Speed	Over 10,000	5,000 to 10,000	1,000 to 4,999	Under 1,000	Rigid Barrier	Unrestrained Barrier	Semirigid Barrier
(mph)	LR	LR	LR	LR	F	F	F
70	140 m	120 m	105 m	90 m	20	18	15
60	110 m	90 m	80 m	70 m	18	16	14
55	95 m	80 m	70 m	60 m	16	14	12
50	80 m	65 m	55 m	50 m	14	12	11
45	75 m	60 m	50 m	45 m	12	11	10
40	65 m	55 m	45 m	40 m	11	10	9

Barrier Length of Need

Figure 710-11b



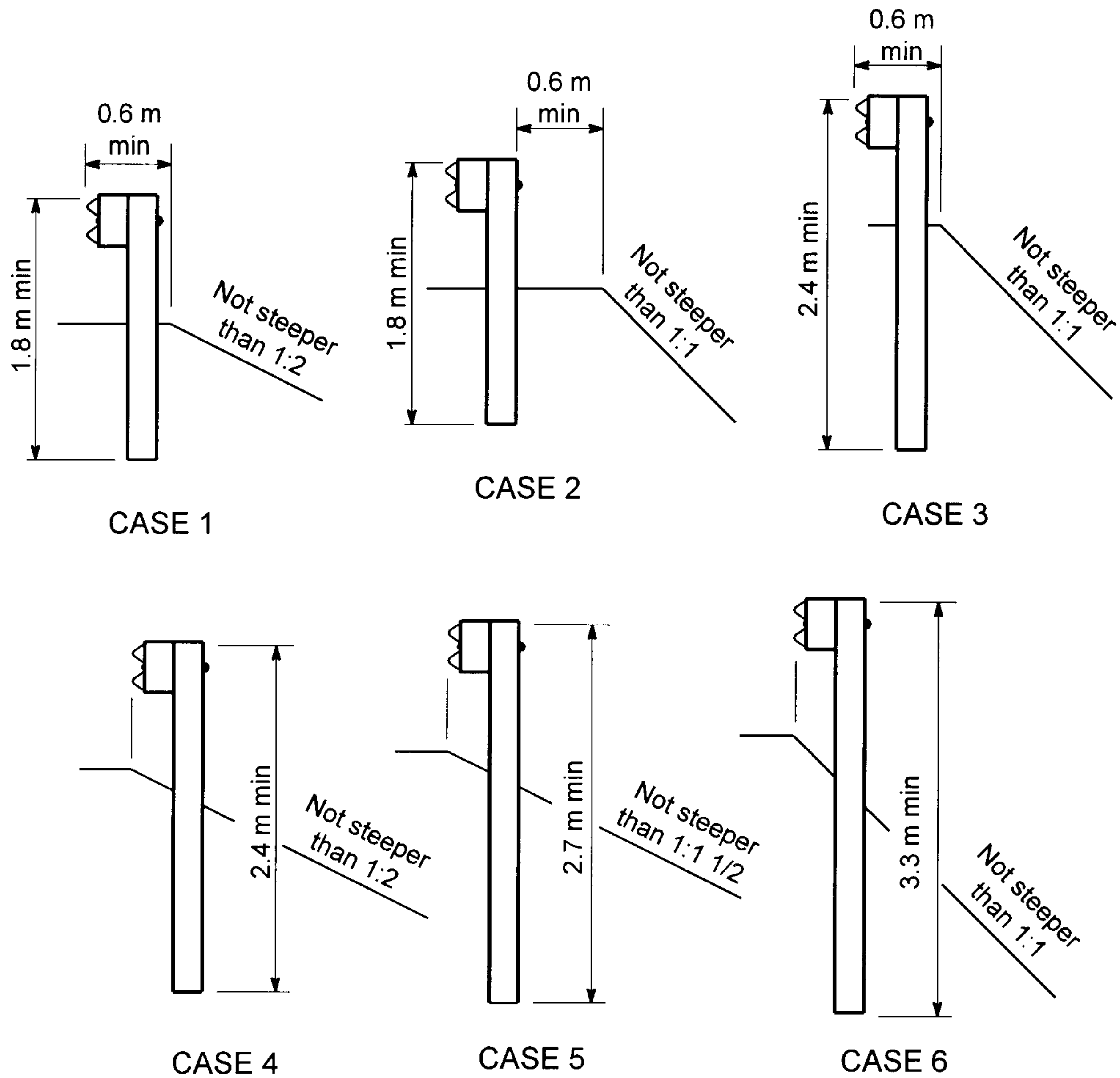
Note:

This is a graphical method for determining the length of need for barrier on the outside of a curve. On a scale drawing, draw a tangent from the curve to the back of the hazard. Compare T to LR from Figure 710-11b and use the shorter value.

If using LR, follow Figures 710-11a and b.

If using T, draw the intersecting barrier run to scale and measure the length of need.

Barrier Length of Need on Curves
Figure 710-11c

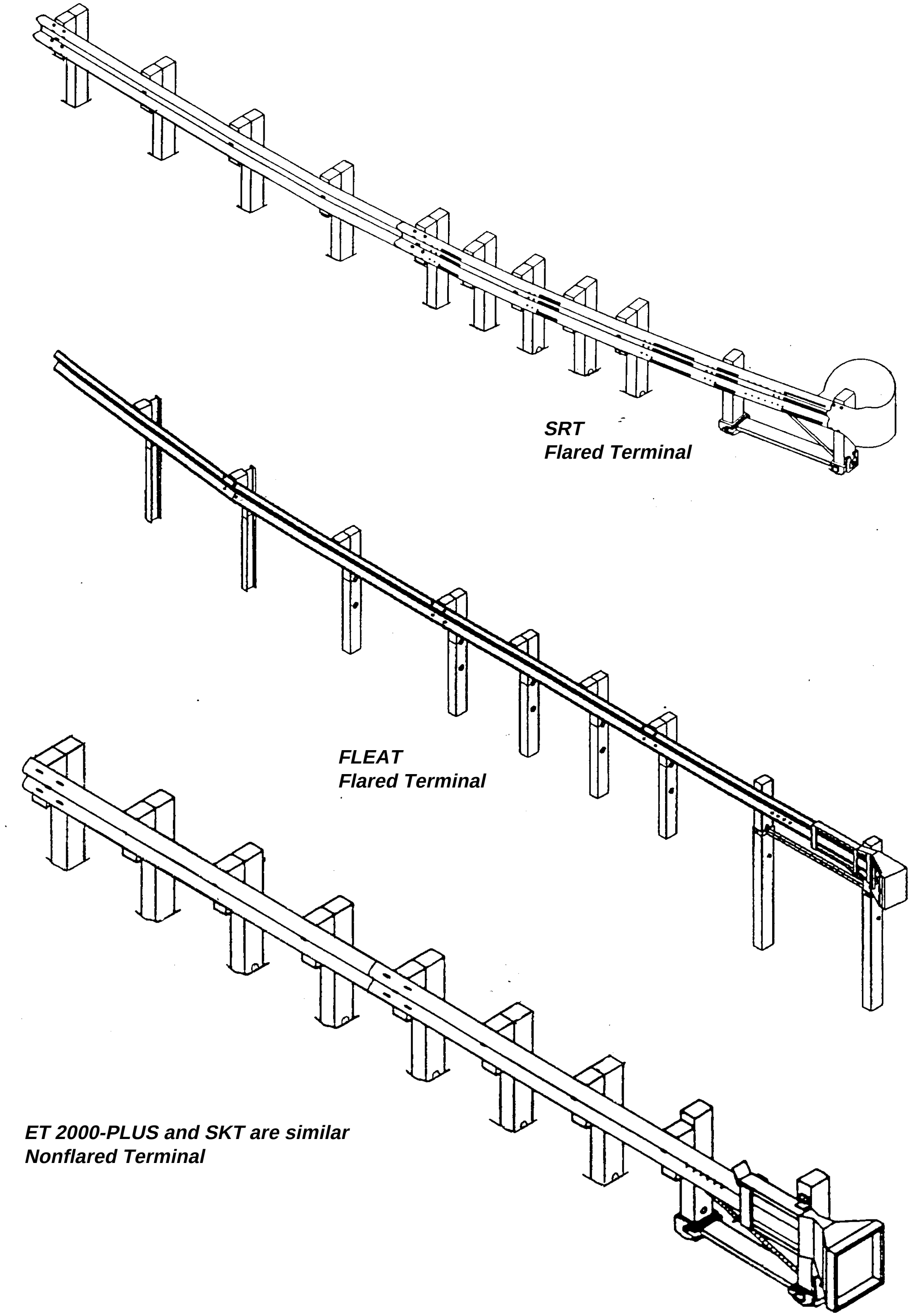


Notes:

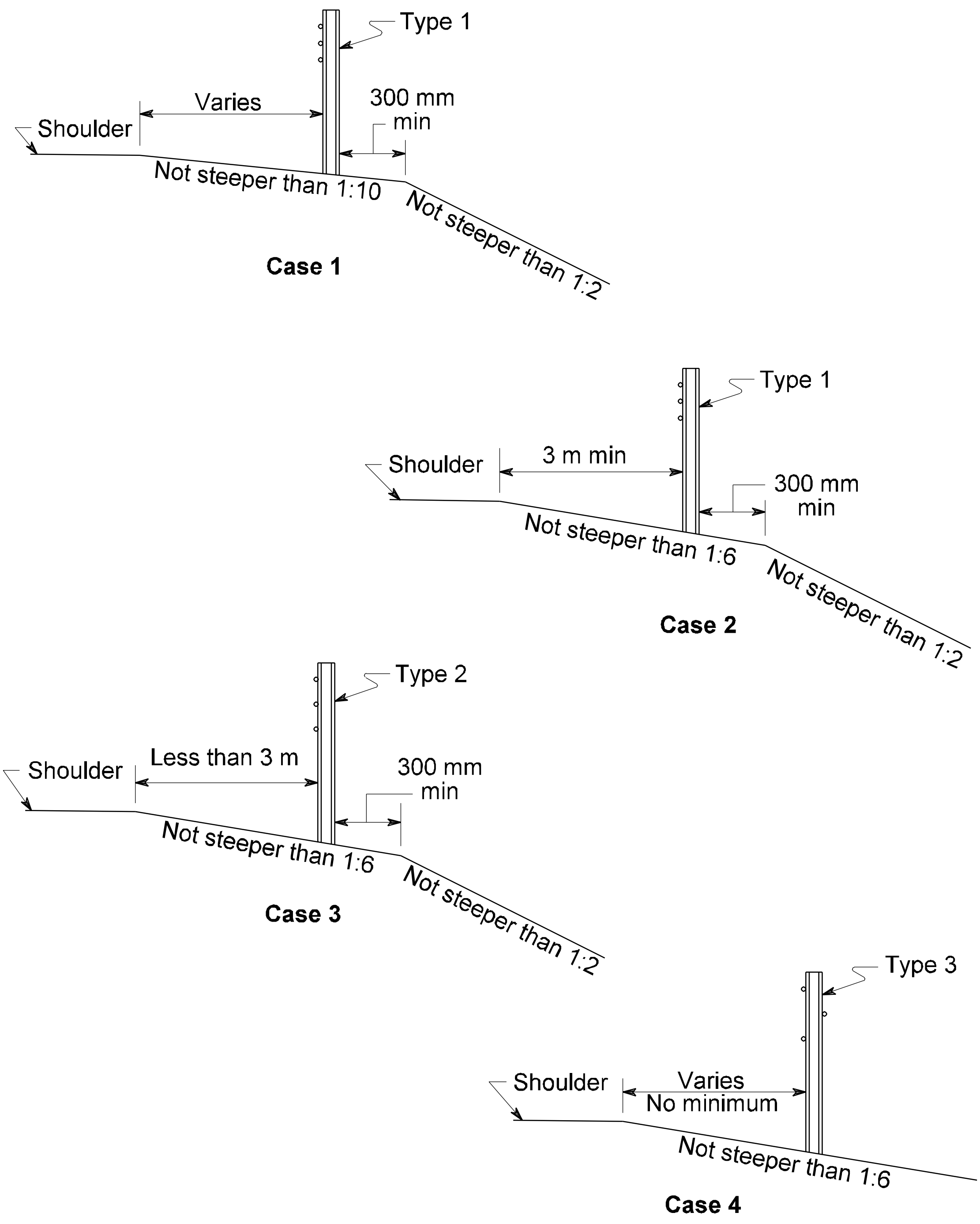
Use cases 1, 2, and 3 when there is 0.6 m or greater shoulder widening from face of guardrail to the breakpoint.

Use cases 4, 5, and 6 when there is less than 0.6 m shoulder widening from face of guardrail to the breakpoint.

Beam Guardrail Post Installation
Figure 710-12



Beam Guardrail Terminals
Figure 710-13

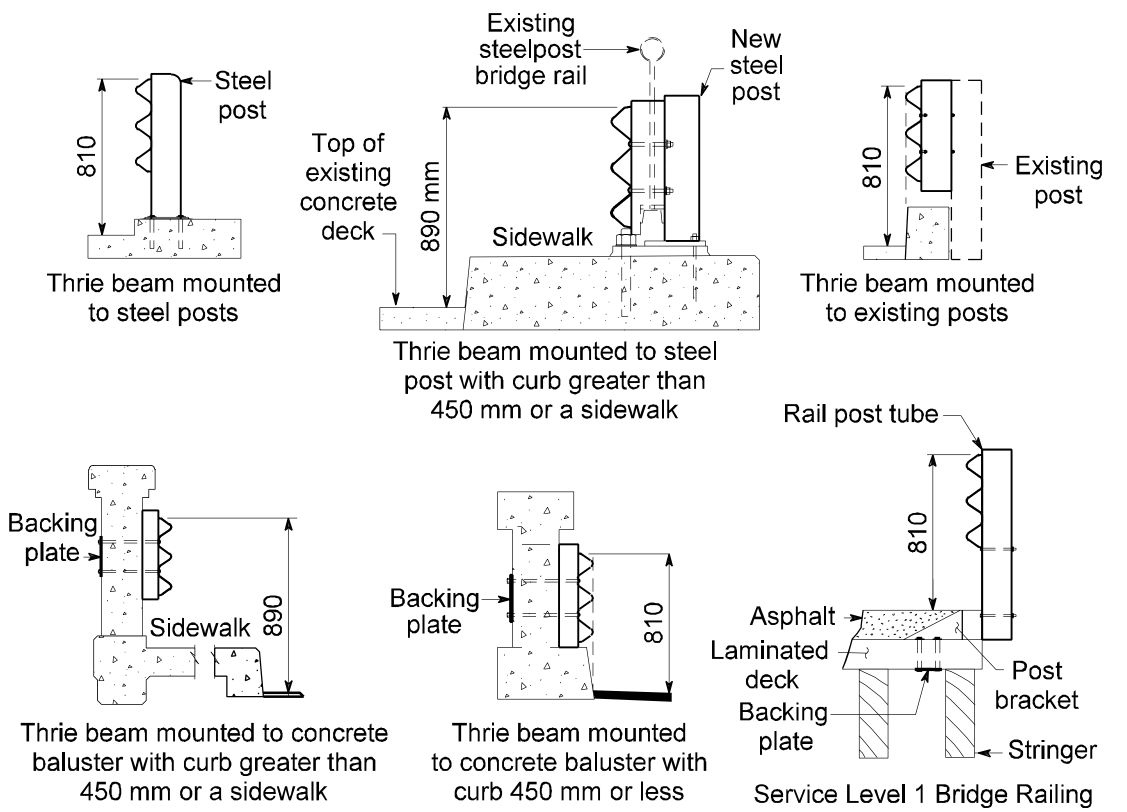


Cable Barrier Locations on Slopes
Figure 710-14

		Concrete Bridge Deck		Wood bridge deck or Low Strength Concrete Deck
Curb Width		Concrete Bridge Rail (existing)	Steel or Wood Post Bridge Rail (existing)	
450 mm or less		Thrie beam mounted to existing bridge rail and blocked out to the face of curb Height = 810 mm	Thrie beam mounted to steel posts[2] at the face of curb Height = 810 mm	Service Level 1 Bridge Rail[2]
Greater than 450 mm	Bridge width more than 8.4 m (curb-to-curb)	Thrie beam mounted to steel posts[2] at the face of curb[1] Height = 810 mm		Height = 810 mm
	Bridge width 8.4 m (curb-to-curb) or less	Thrie beam mounted to existing bridge rail Height = 890 mm	Thrie beam mounted to steel posts[2] in line with existing rail Height = 890 mm	Curb or wheel guard must be removed

[1]Thrie beam may be mounted to the bridge rail to accommodate pedestrians (height = 890 mm).

[2]Contact the Bridge and Structures Office for the post connection details and to determine if the existing bridge deck and other superstructure elements are of sufficient strength.



Thrie Beam Bridge Rail Retrofit Criteria

Figure 710-15

830 Delineation

830.01 General

The primary function of delineation is to provide the visual information needed by the driver to operate a vehicle safely in a variety of situations. Delineation can be the marking of highways with painted or more durable pavement marking lines and symbols, guide posts, and other devices. These devices use retroreflectance, reflecting light from a vehicle's headlights back to the driver, to enhance their visibility at nighttime. WSDOT uses the latest edition of FHWA's *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) as a guide for design, location, and application of delineation.

Delineation is a required safety item of work and is addressed on all projects. A decision to omit delineation work can only be justified if the existing delineation is unaffected by construction and an evaluation of accident rates clearly shows that delineation is not a contributing factor.

830.02 References

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, Washington, DC, 1988, including the *Washington State Modifications to the MUTCD*, M 24-01, WSDOT, 1996

Roadway Delineation Practices Handbook, FHWA report, Washington, DC, 1994

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

Sign Fabrication Manual, M 55-05, WSDOT

830.03 Pavement Markings

(1) Pavement Marking Types

Pavement markings have specific functions. They guide the movement of traffic and promote safety on the highway. In some cases, they are used to supplement the messages of other traffic control devices. In other cases, markings are the only way to convey a message without distracting the driver. Pavement markings are installed and maintained to provide adequate performance year round. Adequate performance is defined as meaning the marking meets or exceeds standards of both daytime and nighttime visibility. Pavement markings are classified as either longitudinal or transverse. Centerlines, lane lines, where applicable, and edge lines, except as noted, are required on all paved State highways unless an exception is granted by the State Traffic Engineer with justification. Guidelines for the application of various pavement markings are provided in Chapter 910 for intersections and channelization, Chapter 940 for interchanges, and the Standard Plans.

(a) Longitudinal pavement markings define the boundary between opposing traffic flows. They also define the edges of traveled way, multiple traffic lanes, turn lanes, and special use lanes. Longitudinal pavement markings are:

skip center line. A broken yellow line used to separate lanes of traffic moving in opposite directions, where passing in the opposing lane is allowed.

double yellow center line. Two parallel solid yellow lines used to separate lanes of traffic moving in opposite directions where passing in the opposing lane is prohibited.

edge line. A solid white line used to define the outer edge of the traveled way. Edge lines are not required where curbs or sidewalks are 1.2 m or less from the traveled way.

dotted extension line. A broken white line that is an extension of an edge line used at exit ramps, intersections on horizontal curves, and other locations where the direction of travel for through traffic is unclear.

wide line. A wide solid white line used to separate lanes of traffic moving in the same direction at ramp connections, storage lanes at intersections, and high occupancy vehicle lanes.

wide dotted line. A wide broken white line used to designate a portion of a high occupancy vehicle lane located on an arterial highway where general purpose vehicles may enter to make a turn at an intersection.

wide skip line. A wide broken white line used to designate a portion of a high occupancy vehicle lane located on a divided highway where general purpose vehicles may enter to make an exit.

lane line. A broken white line used to separate lanes of traffic moving in the same direction.

drop lane line. A wide broken white line used in advance of a wide line to delineate a lane that ends at an off ramp or intersection.

no-pass line. A solid yellow line used in conjunction with a skip center line where passing in the opposing lane is prohibited.

reversible lane line. Two broken yellow lines used to delineate a lane where traffic direction is periodically reversed.

two way left turn line. Two yellow lines, one solid and one broken, used to delineate each side of a two way left turn lane.

barrier line. A very wide solid yellow line used to separate opposing traffic movements where all movements over the line are prohibited. Barrier line locations require the approval of the region's Traffic Engineer.

(b) Transverse pavement markings define pedestrian crossings and vehicle stopping points at intersections. They are also used to warn the motorist of approaching conditions, required vehicular maneuvers, or lane usage. Typical transverse pavement markings are:

crosswalk line. A series of parallel solid white lines used to define a pedestrian crossing.

stop bar. A solid white line used to indicate the stopping point at an intersection or railroad crossing.

traffic arrow. A white marking used in storage lanes and two way left turn lanes to denote the direction of turning movement. Arrows are also used at ramp terminals and intersections on divided highways to discourage wrong way movements.

traffic letters. White markings forming word messages, such as "ONLY", used in conjunction with a traffic arrow at drop lane situations. Traffic letters are not required for left and right turn storage lanes where the intended use of the lane is obvious.

handicapped parking stall symbol. A white marking used to designate parking stalls provided for motorists with disabilities.

HOV symbol. A white diamond marking used for high occupancy vehicle lanes. Typical spacing is 150 m for divided highways and 90 m for arterial highways.

railroad crossing symbol. A white marking used in advance of a railroad crossing where grade crossing signals or gates are located or where the posted speed of the highway is 40 mph or higher.

bicycle lane symbol. A white marking consisting of a symbol of a bicyclist and an arrow used in a marked bike lane. Typical spacing is between 50 and 75 m.

drainage marking. A white line used to denote the location of a catch basin, grate inlet or other drainage feature in the shoulder of a roadway.

aerial surveillance marker. White markings used at 1.6 km and 0.8 km intervals on sections of highways where the State Patrol uses airplanes to enforce speed limits.

(2) Pavement Marking Materials

Pavement markings are available in various materials. These materials are divided into two categories, paint and plastic. When selecting the pavement marking material to use in a project, consider the initial cost of the material, its service life, location, traffic conditions, the snow and ice removal practices of the particular maintenance area, and the region's ability to maintain the markings. Only consider plastic marking material if the pavement is in good condition and will not require major reconstruction for at least the service life of the material. See Figure 830-1 for the recommended pavement marking materials for different highway types and snow removal practices.

Paint is the most common pavement marking material. It is relatively easy to apply and dries quickly (30 - 90 seconds), after application. This allows the application to be a moving operation which minimizes traffic control costs and delay to the roadway users. Paint is applied on construction contracts with two coats; the first coat is 250 micrometers thick, followed by a second coat 380 micrometers thick. The disadvantage of painted pavement markings is its short service life. Only on very low volume roadways subjected to little sanding or snow removal activity will paint provide adequate performance for a year.

Plastic markings have a higher installation cost than paint. They can, however, be a more cost effective measure than paint because of their longer service life. Plastic marking materials currently listed in the Qualified Products List include the following:

- **Thermoplastic.** Thermoplastic material consists of resins and filler materials in solid form at room temperature. The material is heated to a semiliquid, molten state (200 degrees Celsius) and is then applied to the roadway by spray or extrusion methods. This material can be used for both transverse and long line applications. Special equipment is required for both the initial application and subsequent maintenance renewal. Sprayed material can be applied at a thickness of 760 micrometers and dries in 30 to 60 seconds. The service life of material applied in this manner is slightly longer than that of paint. Extruded material is applied at a thickness of 3 mm and has a drying time of 15 minutes. This material can be applied as a flat line or it can be applied with ridges or bumps that enhance wet night visibility These bumps produce a rumble effect similar to rumble strips when a vehicle crosses over the marking. The service life of extruded material is about 3 years. Thermoplastic pavement markings costs about three times more than paint. Failure is usually a result of delamination, rather than wear and abrasion. The material has a different coefficient of expansion than pavement material. Changes in temperature cause the thermoplastic material to crack. This allows the intrusion of moisture between the thermoplastic material and the pavement surface and eventually causes the delamination.
- **Preformed Tape.** Preformed tapes are composed of thermoplastic or other materials that are fabricated under factory conditions. After curing, the material is cut to size and shipped to the work site in rolls or in flat pieces. The material is then applied to the roadway with an adhesive or with heat to activate a preapplied bonding agent. Preformed tapes are available in a thickness of either 1.5 mm, 2.3 mm, or 3.2 mm. Preformed tape will last between 3 and 4 years in a rubber bit snow plow removal area. Preformed tape is about 5 times more expensive than paint. The most durable application of preformed tapes is achieved when the tape is rolled into hot asphalt and the top of the tape is flush with the surface of the pavement. Preformed tapes can have acceptable service lives in ice chisel snow removal areas when the tape is installed in a groove ground into the pavement.
- **Methyl Methacrylate (MMA).** Methyl methacrylate application can be either by spraying or extrusion. Sprayed applications are typically two coats, 1.15 mm thick. Extruded applications are 2.3 mm thick for dense asphalt or PCC pavement or 3 mm thick for open graded asphalt pavement.

The aterial is not heated and can be applied within a temperature range of 4 to 40 degrees Celsius, provided the pavement surface is dry. The material can be used for both transverse and longitudinal applications. The material can also be applied with bumps that enhance wet night visibility. The bumps also produce the rumble effect. MMA can have acceptable service life in ice chisel snow removal areas if the material is installed in a 6.35 mm deep groove ground into the pavement. MMA has a service life of between 4 and 8 years. MMA, depending on the application, can cost between 5 and 10 times more than paint.

- **Raised Pavement Markers (RPMs).** RPMs are installed as positioning guides with long line pavement markings. They can also be installed as a complete substitution for certain long line markings.. RPMs have a service life of two years. RPMs provide good wet night visibility and a rumble effect. RPMs cost 2 to 3 times more than paint when used in substitution applications. RPMs are made from plastic materials and are available in three different types.

  Type 1 markers are 100 mm diameter, 13 mm high, and nonreflectorized.

  Type 2 markers are 100 mm wide, 60 mm to 100 mm long, 13 mm high, and reflectorized.

  Type 3 markers are 100 mm wide, 150 mm to 300 mm long, 13 mm high, and reflectorized.

  Type 2 RPMs are not used as a substitute for right edge lines. They can only be used to supplement the right edge line markings; at lane reductions, at sections with reduced lane widths such as narrow structures, and at the gore of exit ramps. All other applications supplementing right edge line markings require approval of the region’s Traffic Engineer. Type 3 RPMs are used in locations where additional emphasis is desired. These locations include vehicle separations and islands. Approval of the region’s Traffic Engineer is required for all installations of Type 3 RPMs.

  Reflectorized RPMs are not required for center and lane line applications in continuously illuminated sections of highway. However, if reflectorized RPMs are used at an intersection within an illuminated section, they are also provided throughout that section.

830.04 Guide Posts

(1) General

Guide posts are retroreflective devices mounted at the side of the roadway to indicate alignment. They are considered to be guidance devices rather than warning devices. They are used as an aid to nighttime driving primarily on horizontal curves; all multilane divided highways; ramps; tangent sections where they can be justified due to snow, fog, or other reduced visibility conditions; and at intersections without illumination.

The types of guide posts and their application are as follows:

(a) **Type W.** Guide posts with silver-white reflective sheeting, facing traffic, used on the right side of divided highways, ramps, right-hand acceleration and deceleration lanes, intersections, and ramp terminals.

(b) **Type WW.** Guide posts with silver-white reflective sheeting, on both sides, used on the outside of horizontal curves on two-way, undivided highways.

(c) **Type Y.** Guide posts with yellow reflective sheeting, facing traffic, used on the left side of ramps, left-hand acceleration and deceleration lanes, ramp terminals, intersections on divided highways, median crossovers, and horizontal curves on divided highways.

(2) Placement and Spacing

Guide posts are placed not less than 0.6 m or more than 2.4 m outside the outer edge of the shoulder. Place guide posts at a constant distance from the edge of the roadway. When an obstruction intrudes into this space, position the guide posts to smoothly transition to the inside of the obstruction. Guide posts are not required along continuously illuminated divided or undivided highways. See Figure 830-2 for guide post placement requirements.

830.05 Barrier Delineation

Traffic barriers are delineated where guide posts are required, such as bridge approaches, ramps, and other locations on unilluminated roadways. See Figure 830-2. At these locations, the barrier delineation has the same spacing as that of guide posts. Barrier delineation is also required when the traffic barrier is 1.2 m or less from the traveled way. Use a delineator spacing of no more than 12 m at these locations.

Beam guardrail is delineated by either mounting standard length flexible guide posts behind the rail or by attaching shorter flexible guide posts to the wood guardrail posts.

Concrete barrier is delineated by placing retroreflective devices on the face of the barrier about 150 mm down from the top. Consider mounting these devices on the top of the barrier at locations where mud or snow accumulates against the face of the barrier.

The terminal ends of impact attenuators are delineated with modified Type 3 Object Markers. These are the impact attenuator markers in the *Sign Fabrication Manual*. When the impact attenuator is used in a roadside condition, the marker with diagonal stripes pointing downward toward the roadway is used. When the attenuator is used in a gore where traffic will pass on either side, the marker with chevron stripes is used.

830.06 Wildlife Warning Reflectors

(1) Reflector System

Collisions between automobiles and wildlife (predominately deer) produce a substantial economic cost through damage to vehicles, human injuries, fatalities, and loss of the wildlife resources.

A wildlife warning reflector system has been developed to reduce this accident potential. This system consists of a series of reflectors mounted adjacent to the roadway. During the hours of low natural light (dusk, dawn, and night), light from the headlights of an approaching vehicle is reflected to the adjacent roadside by the reflectors. This reflected light creates an "optical fence" causing deer to remain motionless until the vehicle has passed.

The Olympia Service Center (OSC) Environmental Affairs Office biologist maintains a history of vehicle-deer collisions on state highways and can furnish the region with prospective "optical fence" locations. The biologist is available to assist with a benefit/cost analysis of proposed reflector installations. Consider wildlife reflectors where the deerkill for any 1.5 kilometer section exceeds five kills per year. Also, consider wildlife reflectors for special circumstances such as at a high use deer crossing where a short section of this reflector system might be appropriate. After-installation maintenance costs can be a prohibitive factor when considering a wildlife reflector system. To remain effective, dirty reflectors must be cleaned periodically and reflector posts damaged by snow plowing or errant vehicles must be replaced.

(2) Reflector Placement

Spacing of the wildlife reflectors along the shoulder edges is dependent upon the geometric configuration of the highway and upon the roadside conditions. Reflectors are placed along both sides of the roadway in a staggered arrangement with the longitudinal spacing roughly equal to the combined transverse width of the roadway and reflector offset. See Figures 830-3 and 830-4 for examples of wildlife reflector placements. More detailed information for reflector placement in different locations is available from the manufacturer. Contact the OSC Environmental Affairs office biologist or the OSC Traffic Office.

830.07 Documentation

Preserve the following documents in the project file: See Chapter 300.

- ☐ All decisions to not provide basic delineation
- ☐ All correspondence when considering wildlife reflectors
- ☐ Approval of the use of Type 2 RPMs to delineate a right edge line

P65:DP/DMM

Ice Chisel Snow Removal Areas					
Roadway Classification	Marking Type				
	Center Lines	Lane Lines	Edge Lines	Wide Lines	Special Markings
Interstate	N.A.	Plastic Insets	Paint	Paint	Paint
Major Arterial	Paint and RRPMs	Paint	Paint	Paint	Paint
Minor Arterial	Paint	Paint	Paint	Paint	Paint
Collector	Paint	Paint	Paint	Paint	Paint

Steel Blade Snow Removal Areas					
Roadway Classification	Marking Type				
	Center Lines	Lane Lines	Edge Lines	Wide Lines	Special Markings
Interstate-Urban	N.A.	Plastic	Paint or Plastic	Paint or Plastic	Paint or Plastic
Interstate-Rural	N.A.	Paint	Paint or Plastic	Paint or Plastic	Paint or Plastic
Major Arterial	Paint and RRPMs or Plastic	Paint	Paint or Plastic	Paint or Plastic	Paint or Plastic
Minor Arterial	Paint	Paint	Paint	Paint or Plastic	Paint or Plastic
Collector	Paint	Paint	Paint	Paint or Plastic	Paint or Plastic

Rubber Blade Snow Removal Areas					
Roadway Classification	Marking Type				
	Center Lines	Lane Lines	Edge Lines	Wide Lines	Special Markings
Interstate-Urban	N.A.	RPMs only or Plastic and RPMs	Paint or Plastic	Plastic	Plastic
Interstate-Rural	N.A.	RPMs only or Plastic and RPMs	Paint	Plastic	Plastic
Major Arterial	Paint and RPMs or Plastic and RPMs	Paint and RPMs	Paint	Plastic	Plastic
Minor Arterial	Paint and RPMs	Paint and RPMs	Paint	Plastic	Plastic
Collector	Paint and RPMs	Paint	Paint	Plastic	Plastic

Notes

1. Insets are grooves ground into the pavement and filled with material, usually methyl methacrylate.
2. Plastic refers to methyl methacrylate, thermoplastic, or preformed tape.
3. See Standard Plan H-5d for RPM substitute applications.
4. See Standard Plan H-3 and H-3a for RPM applications with paint or plastic.
5. Special Markings include arrows, symbols, letters, channelizing lines, and transverse markings.
6. RRPMs refers to RPMs installed in a groove ground into the pavement.
7. Type 2 RPMs are not required with painted or plastic center or lane line in continuously illuminated sections. See Section 830.03(2).

Pavement Marking Material Guide

Figure 830-1

Highway Type	Guide Posts on Tangents (See Note 1)	Guide Posts on Horizontal Curves (See Note 1)
Divided Highways with Continuous Illumination		
Main Line	None	None
Bridge Approaches	None	None
Intersections	None	None
Lane Reductions	Standard Plan H-1d	Standard Plan H-1d
Median Crossovers	None	None
Ramps	Standard Plan H-1b	Standard Plan H-1b
Divided Highways without Continuous Illumination		
Main Line with RPMs	None	Standard Plan H-1c
Main Line without RPMs	Right Side Only (160m spacing)	Standard Plan H-1c
Bridge Approaches	Standard Plan H-1e	Standard Plan H-1e
Intersections	Standard Plan H-1a	Standard Plan H-1a
Lane Reductions	Standard Plan H-1d	Standard Plan H-1d
Median Crossovers	Standard Plan H-1d	Standard Plan H-1d
Ramps	Standard Plan H-1b	Standard Plan H-1b
Undivided Highways with Continuous Illumination		
Main Line	None	None
Bridge Approaches	None	None
Intersections	None	None
Lane Reductions	Standard Plan H-1d	Standard Plan H-1d
Undivided Highways without Continuous Illumination		
Main Line	See Note 2	Standard Plan H-1c (See Note 2)
Bridge Approaches	Standard Plan H-1e	Standard Plan H-1e
Intersections with Illumination	None	None
Intersections without Illumination	Standard Plan H-1d	Standard Plan H-1d
Lane Reductions	Standard Plan H-1d	Standard Plan H-1d

Note 1: See Standard Plan H-1 for lateral placement of guide posts.
Note 2: Installation of guide posts on tangents and on the inside of horizontal curves is allowed at locations approved by the region's Traffic Engineer.

Guide Post Placement
Figure 830-2

Wildlife Reflectors on a Tangent Section
Figure 830-3

Wildlife Reflectors on the Outside of a Curve
Figure 830-4

840.01 General

Illumination is provided along highways, in parking lots, and at other facilities to enhance visual perception of conditions or features that require additional driver, cyclist, or pedestrian alertness during the hours of darkness.

The design matrices identify the design levels for illumination on all preservation and improvement projects. (See Chapter 325.) These levels, basic or full, are indicated in the columns. At the basic design level for minor safety or preservation work, providing breakaway features on existing light standards (when required), replacing deficient electrical components, and other minor work would be the extent of consideration. Providing additional lighting or relocating light standards on preservation projects may be considered as a spot safety enhancement.

A full design level notation in a design matrix column indicates that the required illumination (see 840.04 Required Illumination) specified in this chapter is necessary. When the illumination column has an EU (evaluate upgrade to full design level), consider providing illumination if it would be beneficial to the specific project.

A deviation to not provide the illumination required for full design level on a National Highway System (NHS) highway requires Olympia Service Center (OSC) approval. Submit the necessary information, justifying the deviation, to the Assistant State Design Engineer. Design deviations on Non-NHS highways are approved by the Regional Administrators or their designees. Proposals to provide less than or more than the required illumination are considered a deviation and require justification and the same approval process.

840.02 References

Revised Code of Washington (RCW) 47.24.020, "Jurisdiction, control."

Washington Administrative Code (WAC) 468-18-040, "Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings"

Directive D 22-21, "Truck Weigh Stations and Vehicle Inspection Facilities on State Highways"

Roadway Lighting Handbook, USDOT, Washington, DC 1978

Roadway Lighting Handbook Addendum to Chapter Six, USDOT, Washington, DC 1983

An Informational Guide for Roadway Lighting, AASHTO, Washington, DC 1984

American National Standard Practice for Roadway Lighting, IES RP-8-1983, New York, NY 1983

Recommended Practice for Tunnel Lighting, IESNA RP-22-96, New York, NY 1996

National Electrical Code, NFPA, Quincy, MA

City Streets as a Part of the State Highway - Final Report, WSDOT 1997

840.03 Definitions

candela A unit of luminous intensity equal to one lumen per steridian.

lamp lumens The total light output from a lamp in lumens. (A lumen being a unit of luminous flux.)

luminous flux The time rate of flow of light.

lux The illumination of a surface one square meter in area on which there is uniformly distributed a flux of one lumen, or the illuminance produced on a surface, all points of which are at a distance of one meter from a uniform point source, of one candela.

minimum light level The minimum light intensity of illumination at any point within the design area measured just prior to relamping the system.

minimum average light level The average of all light intensities within the design area measured just prior to relamping the system.

mounting height The vertical distance between the surface of the design area and the center of the light source of the luminaire. This is the distance used to compute the light level of the design area.

pole height (H1) The vertical distance from the light source to the pole base. This distance is specified in contracts and used by the pole manufacturers to fabricate the light standard. In curb and sidewalk areas, the H1 distance is assumed to equal the mounting height. Typically, the mounting height in fill sections is less than the H1 distance while the mounting height in cut sections is equal to or greater than the H1 distance.

security lighting A minimal amount of lighting used to illuminate areas for public safety or theft reduction. Security lighting for walkways is the lighting of angle points and shadow areas.

spacing The distance in meters measured on center line between adjacent luminaires. Spacing is equal to the lamp lumens times the coefficient of utilization times the light loss factor divided by the width and the design lux value.

uniformity ratio The ratio of the minimum average light level on the design area to the minimum light level of the same area.

veiling luminance The stray light produced within the eye by the light source that alters the apparent brightness of an object within the visual field and the background against which it is viewed.

840.04 Required Illumination

(1) General

The Washington State Department of Transportation (WSDOT) is responsible for illumination on state highways with partial, modified, or full limited access control regardless of the location and on state highways located outside the corporate limits of cities. Cities are responsible for illumination of state highways without WSDOT established access control located within their corporate limits. Figures 840-1 through 840-5 show examples of illumination for highway applications. Illumination in these examples and the locations listed below are required on state highways.

(2) Freeway Off Ramps and On Ramps

Provide the necessary number of light standards to illuminate the design area of all freeway off ramp gore areas and on ramp acceleration tapers. See 840.06(2).

(3) Freeway Ramp Terminals

A single light standard is required at the intersection of a ramp terminal with a two lane roadway. At the intersection of a ramp terminal with a multilane roadway, additional lighting is required to illuminate the intersection design area. See Figure 840-5. Additional illumination is also required if the intersection has left turn channelization or a traffic signal.

(4) Intersections With Left Turn Channelization

Illumination of the intersection area and the left turn storage is required for intersections with painted or other low profile pavement markings such as raised pavement markings. When the channelization is delineated with curbs, raised medians or islands, illuminate the raised channelization from the beginning of the left turn taper. Illumination of the secondary road intersecting the state highway can be beneficial to the motoring public. Funding and design, however, are the local agency's responsibility. Contact that agency to see if they are interested in participating.

(5) Intersections With Traffic Signals

All traffic signals on state highways are illuminated. The extent of illumination is the same as for intersections with left turn channelization. Illumination of the crossroad is beneficial and participation of the local agency is desirable. In cities with a population under 22,500, the state may assume responsibility for illumination installed on signal standards.

(6) Railroad Crossings With Gates or Signals

Railroad crossings with automated gates or signals on state highways are illuminated if there is nighttime train traffic. Within the corporate limits of a city, illumination is the responsibility of that agency.

(7) Transit Flyer Stops

Illuminate the loading area of a transit flyer stop located within the limited access boundaries. Normally, this illumination consists of one light standard at the point where passengers enter the bus.

(8) Major Parking Lots

All parking lots with usage exceeding 50 vehicles during the nighttime peak hour are considered major parking lots. Provide an illumination design that will produce the light levels shown in Figure 840-6 for the parking area and bus loading zone. During periods of low usage at night, only security lighting is required. Provide an electrical circuitry design that allows the illumination system to be reduced to approximately 25% of the required light level.

(9) Minor Parking Lots

Minor parking lots have a nighttime peak hour usage of 50 or less vehicles. Provide security level lighting for those lots owned and maintained by the state. Security lighting consists of lighting the entrance and exit to the lot.

(10) Truck Weigh Sites

Provide illumination of the scale platforms, parking areas, and inspection areas of weigh sites.

(11) Midblock Pedestrian Crossings

Illuminate the entire midblock pedestrian crossing, including the crosswalks, the refuge area in the roadway, and the sidewalks or shoulders adjacent to the crosswalk. When a raised median pedestrian refuge design is used, illuminate this raised channelization.

(12) Long Tunnels

Long tunnels have a portal to portal length greater than the wet pavement stopping sight distance. Provide both nighttime and daytime illumination for long tunnels.

840.05 Additional Illumination

(1) General

At certain locations, additional illumination is desirable to provide better definition of nighttime driving conditions or to provide consistency with local agency goals and enhancement projects. Funding, design, and maintenance of illumination along state highways within the corporate limits of a city is the responsibility of the municipality unless the state has acquired modified, partial, or full limited access control. Contact the local agencies to determine if they desire to participate in the installation of illumination for roadways under their jurisdiction as a part of the project. For improvement projects, consider additional illumination on state highways where there is a diminished level of service or an accident frequency during the hours of darkness.

Diminished Level of Service is a mobility condition where the nighttime peak hour level of service is D or lower. When volumes are used to determine the level of service, use traffic counts taken during the evening peak hour. Peaking characteristics in urban areas are related to the time of day. Traffic counts taken in the summer between 4:30 p.m. and 7:30 a.m. may be used as nighttime volumes if adjustment factors for differences in seasonal traffic volumes are applied for November, December, and January.

Accident Frequency condition is when the number of nighttime accidents equals or exceeds the number of daytime accidents. An engineering study that indicates that illumination will result in a reduction in nighttime accidents is required to demonstrate justification. Consider the seasonal variations in lighting conditions when reviewing reported accidents. Accident reporting forms, using a specific time period to distinguish between “day” and “night,” might not indicate the actual lighting conditions at the time of an accident. Consider the time of year when determining if an accident occurred at nighttime. An accident occurring at 5:00 p.m. in July would be a daytime accident, but an accident occurring at the same time in December would be during the hours of darkness.

The mitigation of high nighttime, pedestrian accident locations requires different lighting strategies than vehicular accident locations. Provide light levels to emphasize crosswalks and adjacent sidewalks. Multiple lane highways with two way left turn lanes, in urban build up areas, are typically high speed facilities with numerous road approaches. These roadways allow numerous vehicle entry and exit points and provide few crossing opportunities for pedestrians. Additional illumination may be justified for this condition.

(2) Highways With Full Limited Access Control

On the main line, consider full illumination if a diminished level of service exists and any two of the following conditions are satisfied:

- There are three or more successive interchanges with an average spacing of 2.4 km or less.
- The segment is in an urban area.
- The accident frequency condition exists.

At ramps, consider additional illumination when a diminished level of service exists and any of the following conditions are present:

- The ramp alignment and grade are complex.
- There are routine queues of five or more vehicles per lane at the ramp terminal due to traffic control features.
- The nighttime accident frequency condition exists.

At crossroads, consider additional illumination when a diminished level of service exists and the nighttime accident frequency exists. Also, consider additional illumination for tunnels, undercrossings, or lids on the crossroad.

(3) Highways With Partial or Modified Limited Access Control or With Managed Access Control

Consider additional illumination if this segment of highway is in a commercial area and either a diminished level of service exists or the nighttime accident frequency exists and an engineering study indicates that nighttime driving conditions will be improved.

(4) Intersections Without Channelization

Illumination of intersections without channelization is justified in urban areas and other locations if a nighttime accident frequency requirement is satisfied or the traffic volumes and movements would be improved with the installation of left turn channelization.

(5) Tunnels, Underpasses, or Lids

Illumination is justified if portal conditions result in a brightness in the tunnel that is less than the measured daytime brightness of the approach roadway divided by 15 and the length to vertical clearance ratio is 10:1 or greater.

(6) Construction Zones and Detours

Illumination may be justified if construction activities take place on the roadway at night. Illumination may also be justified for detours where the alignment and grade are unusual and require additional driver, cyclist, or pedestrian alertness.

(7) Transit Stops

Transit stops with shelters are indicative of higher passenger usage and illumination is justified. This lighting consists of a single light standard positioned to illuminate both the transit pull-out area and the loading area. Additional illumination to highlight the loading area at transit stops with significant, nighttime usage may be considered, if the transit company will provide the necessary funding for construction and maintenance.

(8) Bridges

Justification for illuminating bridges is the same as that for highways with or without full limited access control, as applicable.

(9) Railroad Crossing Without Gates or Signals

Illumination of these facilities is justified if there is a potential for nighttime accidents. Consider the extent of nighttime train activity in making this determination. Also, consider illumination if there is a probability that railroad cars will be stopped on the crossing during the nighttime.

(10) Walkways and Bicycle Trails

Illumination of pedestrian walkways is justified if the walkway is a connection between two highway facilities. This might be between parking areas and rest room buildings at rest areas, between drop-off or pick-up points and bus loading areas at flyer stops, or between parking areas and bus loading areas or ferry loading zones, for example. Consider illuminating existing walkways and bicycle trails if security problems have been reported. Also, consider illumination if security problems are anticipated. In these conditions the walkways and bicycle trails are illuminated to security levels. Illumination to the level shown in Figure 840-6 is allowed only when approved by the Regional Administrator.

(11) Rest Areas

Provide illumination at the roadway diverge and merge sections within rest areas and the parking areas as for a major parking lot.

840.06 Design Criteria

(1) Light Levels

Light levels vary with the class of highway, development of the adjacent area, and the level of nighttime activity. Light level requirements for highways and other facilities are shown in Figure 840-6. These levels are the minimum average light levels required for a design area at the end of rated lamp life for applications requiring a spacing calculation. Light level requirements are not applicable for single light standard or security lighting installations. See Chapters 430 and 440 for design classes of highways.

The types of activity areas, shown below, are related to the number of pedestrian crossings. These crossings need not occur within a single crosswalk and can be at several locations along the roadway in an area with pedestrian generators. Land use and activity classifications are as follows:

- **High Activity.** Areas with over 100 pedestrian crossings during the nighttime peak pedestrian hour usage. Examples are: downtown retail areas, near stage theaters, concert halls, stadiums, and transit terminals; and parking areas adjacent to these facilities.
- **Medium Activity.** Areas with pedestrian crossings that number between 11 and 100 during the nighttime peak pedestrian hour usage. Examples are: downtown office areas, blocks with libraries, movie theaters, apartments, neighborhood shopping, industrial buildings, and older city areas; and streets with transit lines.
- **Low Activity.** Areas with pedestrian crossings that number less than 11 during the nighttime peak pedestrian hour usage. Examples are suburban single family areas, low density residential developments, and rural or semirural areas.

(2) Design Areas

The design area is that portion of the roadway, parking lot, or other facility that is subject to the minimum light level, minimum average light level, and uniformity ratio design requirements. This encompasses the area between the edges of the traveled way along the roadway; the outer edges of the stopping points at intersections; and, when present, a bike lane adjacent to the traveled way. When the roadway has adjacent sidewalks with high or medium activity classifications, the design area includes these features.

Design area requirements for various applications are shown in Figures 840-1 through 840-5 and the following:

- One lane off-ramp. Two main line through lanes and the ramp lane, including gore area, from the gore point to a point 60 m (minimum) down stream of the gore point. A 30 m longitudinal tolerance either way from the gore point is allowed.
- Two lane off-ramp. Two main line through lanes and both ramp lanes, including gore area, from a point 60 m upstream of the gore point to a point 60 m downstream from the gore point. A 30 m longitudinal tolerance either way from the gore point is allowed.
- One lane on-ramp. Two main line through lanes and the ramp lane, from a point where the ramp lane is 3 m wide to a point 60 m upstream. A 30 m longitudinal tolerance either way is allowed.
- Two lane on-ramp. Two main line through lanes and the ramp lanes from a point where the ramp lanes are 6.7 m wide to a point 60 m upstream. A 30 m longitudinal tolerance either way is allowed.
- Intersections channelized with pavement markings. The design area has two components, the intersection area and the approach areas. The intersection area is the area between the stopping points on both the main road and the minor road, including marked or unmarked crosswalks. The approach areas are the areas on the main roadway between the stopping point and where the left turn lane is full width.
- Intersections with raised channelization. The design area has two components, the intersection area and the approach areas. The intersection area is the area between the stopping points on both the main road and the minor road, including marked or unmarked crosswalks. The approach areas are the areas on the main roadway between the stopping point and where the left turn taper begins.
- Unchannelized intersection. The area between the stopping points on both the main road and the minor road, including marked or unmarked crosswalks.
- Railroad crossings. The roadway width from a point 15 m either side of the track (the approach side only for one way roadways).
- Transit loading areas. The lane width and length designated for loading.
- Major parking lots. The entire area designated for parking including internal access lanes.
- Scale Platforms at weigh sites. The approach width from the beginning of the scale platform to the end of the platform.
- Inspection areas at weigh sites. The area dedicated to inspection as agreed upon with the Washington State Patrol.

(3) Light Levels for Tunnels and Underpasses

Short tunnels and underpasses, with a length to vertical clearance ratio of 10:1 or less, normally do not have daytime illumination. Short tunnels with length to vertical clearance ratios greater than 10:1 are treated the same as an entrance zone on a long tunnel to establish daytime light levels. Nighttime light level requirements for short tunnels on continuously illuminated roadways are the same as the light level required on the roadway outside the tunnel.

Long tunnels are divided into zones for the determination of daytime light levels. Each zone is equal in length to the wet pavement stopping sight distance. The entrance zone beginning point is a point outside the portal where the motorist’s view is confined to the predominance of the darkened tunnel structure.

The daytime entrance zone light level is dependent upon the brightness of the features within the motorist’s view on the portal approach. The brightness level is defined as the average brightness measured over a 20 degree cone at a point 150 m in advance of the portal. The entrance zone light level produced within the tunnel must be sufficient to provide a brightness level of approximately 5% of the measured portal brightness, after adjustment for the reflectivity of the roadway, walls, and ceiling. Design successive zones for a daytime light level of 5% of the previous zone light level to a minimum value of 50 lux. Requirements for nighttime light levels for long tunnels on continuously illuminated roadways are the same as the light level required on a roadway outside the tunnel. Provide adequate illumination of fire protection equipment, alarm pull boxes, phones, and emergency exits in long tunnels to minimize the risk associated with catastrophic accidents.

(4) Light Standards

(a) **Light Standards.** Light standards are the most common supports used to provide illumination for highway facilities. The 12.2 m and 15.2 m high light standards with breakaway bases and Type 1 mast arms are used predominately on state highways. The angular Type 2 mast arms are allowed only to match existing systems. Use Type 1 mast arms on all new systems. Cities and counties may elect to use different mounting heights to address factors unique to their environments. On state highways, alternate light standards may be use if requested by the city or county, provided they agree to pay any additional costs associated with this change.

The typical location for a light standard is on the right shoulder. When considering designs that propose light standards mounted on concrete barrier in the median, consider the total life cycle cost of the system, including the user costs resulting from lane closures required for relamping and repair operations. Light standards located in the vicinity of overhead power lines require a 3 m clearance from the power line to any portion of the light standard or luminaire. Consult the Bridge and Structures Office when mounting lights on structures such as retaining walls and bridge railings.

It is preferable to locate a light standard as far from the traveled way as possible to reduce the potential of impacts from errant vehicles. The length of the mast arm can vary from 1.8 m to 4.9 m to allow for this placement. The preferred position for the luminaire is over the edge line. However, some flexibility is acceptable with the luminaire position to allow for placement of the light standard. When necessary, the luminaire can be positioned up to 1.2 m outside of the edge line. See Figure 840-7.

When light standards are located within the Design Clear Zone, breakaway features are used to reduce the severity of a potential impact. To allow these breakaway features to function as intended, it is preferred that they be installed on slopes that are 1V:6H or flatter (cut or fill slope). On fill slopes where flattening of the slope to achieve a 1V:6H slope is not practical, consider locating the light standard at least 3.6 m beyond the slope break. If this is not possible, locate the light standard at the slope break. Do not place the light standard on a fill slope that is 1V:3H or steeper unless it is behind a traffic barrier.

When placing the light standard on a cut slope, that is 1V:3H or flatter (such as the backslope of a ditch), the preferred location is outside of the Design Clear Zone. If this is not practical, the light standard may be installed with a modified foundation that matches the slope's surface. In this case, it is critical that the light standard be positioned at least 1.2 m beyond the bottom of the ditch. Locate light standards on slopes steeper than 1V:3H outside of the Design Clear Zone. Even when located beyond the Design Clear Zone, it is desirable to use a breakaway base if there is a possibility it could be struck by an errant vehicle.

In curb and sidewalk sections, locate the light standard behind the sidewalk.

Breakaway bases on light standards are a safety requirement for higher speed roadways. They are not always desirable at other locations. Locations where fixed bases are installed are:

- Parking lots.
- Medians where the light standard is mounted on median barrier.
- Behind traffic barrier, beyond the barrier's deflection design value (See Chapter 710).

- Along highways with posted speeds of 35 mph or less where there is medium or high pedestrian activity.
- Pedestrian walkways, bike paths, and shared use paths.

(b) **Light Standard Heights.** Non-standard pole heights require longer fabrication time and are not recommended. Use standard pole heights of 12.2 m and 15.2 m for roadway illumination. Standard pole heights will result in variable mounting heights for the luminaires. Use the actual mounting height at each location when calculating light standard spacing. High mast light supports may be considered for complex interchanges where continuous lighting is justified. Initial construction costs, long term maintenance, clear zone mitigation, spill-over light on to adjacent properties, and negative visual impacts are important factors when considering high mast illumination. Shorter light standards of 9.2 m or less may be used for minor parking lots, trails, pedestrian walkways, and locations with restricted vertical clearance.

(c) **Standard Luminaire.** The cobra head style, high pressure sodium vapor luminaire with Type III, cut-off light distribution is the standard light source used for state highway lighting. A Type III distribution has an oval pattern, and a Type V distribution has a circular pattern. Post top mounted luminaires and other decorative light fixtures with Type V patterns are more effective for area lighting in parking lots and other locations where more symmetrical light distribution patterns are preferred. Recommended mounting heights and initial lumens for various luminaire wattages are shown in Figure 840-8.

(5) Electrical Design

(a) **Circuit Layout.** Circuit layout is usually determined by line loss, control requirements, and maintenance considerations. Illumination systems normally operate on either 240 or 480 volts, single phase. Standard service cabinet installations provide two lighting circuits for Type B Services and five circuits for Type D or E Services. Although the electrical load can usually be carried with one or two circuits, consider using multiple circuits for the lighting system. Multiple circuits are easier to install, maintain, and allow quicker location of circuitry failures. Consider providing separate circuits for each approach at intersections and at each ramp and the crossroad at interchanges. At major parking lots, consider providing at least two circuits for full illumination and another for security level lighting. Providing separate circuits for the inspection area, scales, and parking area at weigh sites allows more flexibility in controlling light levels.

(b) **Circuit Isolation.** Power feed conductors, from the power source to the service, are isolated from other circuits by using a separate conduit. Junction boxes in this conduit run are not allowed. Provide separate conduits for illumination circuits to isolate them from communication and traffic signal circuits on new construction. Illumination circuits may share a junction box with other circuits, including traffic signal detection and display circuits, provided that all circuits in the junction box are energized from the same service. When modifying an existing traffic signal, the installation of separate illumination conduits might be impracticable. In these situations, the illumination circuit conductors may be installed in the signal circuit conduit. When considering this, verify that all conductors in the conduit have an insulation rating equal to or exceeding the maximum circuit voltage applied to any conductor within that raceway. Ratings for various types of insulation are contained in the *National Electrical Code*.

(c) **Conductors.** Copper conductors are required for all permanent underground illumination circuits. Aluminum conductors may be used for temporary overhead illumination circuits. The conductor type installed between the utility power source and the service cabinet is specified by the utility company and is normally aluminum. The minimum conductor size for illumination circuits is a #8 AWG (American Wire Gage). Diameters, areas, ampacities, and resistance factors for various conductor sizes are shown in Figure 840-8.

(d) **Line Loss.** Line loss is the voltage drop between the electrical service and the electrical load. In illumination systems of four or five light standards that are located near the electrical service, line loss is not a factor. In more complex systems the voltage drop can be significant. The light standards farthest from the service might fail to energize if this loss is not compensated for by using larger electrical conductors or by splitting the system into two or more circuits. Some voltage drop is allowable. For design purposes, the allowable line loss for illumination circuits is 5% where the system might be expanded in the future. An 8% loss is acceptable when future expansion seems unlikely. A larger line loss of 10% is allowed for temporary illumination circuits on construction projects. Line loss is calculated by using the formula:

Voltage Drop = 2ALR.

Where: A = Current in amps
L = Length of conductors
R = Resistance of the conductor

An example of a line loss calculation is shown in Figures 840-9a and 840-9b.

(e) **Conduit.** The size of a conduit is dependent on the number and size of the conductors it contains. In new construction, size the conductors to occupy 26% of the cross-sectional area of the conduit. When modifying an existing system, the conductors can occupy up to 40% of the conduit's area. The table in Figure 840-8 lists the 26% and 40% cross-sectional fill areas of various conduit sizes. The minimum size conduit for illumination installations is 25 mm diameter. The minimum size conduit for installation under a roadway is 32 mm diameter.

Conduits are usually placed under existing pavement by jacking, drilling, directional boring, or by boring and casing.

- In jacking, the conduit is pushed under a roadway mechanically, usually with a hydraulic jack. A pointed tip is fitted to the leading end of the conduit to allow easier movement through the soil. Jacking is most effective when the underlying soil is free of rocks.
- In drilling, a small hole is first drilled under the roadway with an auger. Then either the conduit is attached to the auger and pulled back through the hole or the auger is retracted and the conduit is pushed through the hole.
- In directional boring, conduit is installed under the roadway using a surface launched steer-able high pressure fluid jet drilling tool. The drilling fluid maintains the stability of the tunnel, reduces drag on the conduit and provides backfill between the conduit and tunnel. A guidance system is used to measure the depth, lateral position and roll of the tool head while creating the pilot hole. Once the pilot hole is established, a reamer, a swivel and the conduit are attached to the end of the boring tool and the conduit is then pulled back into the tunnel. Multiple conduits may be pulled back into the pilot hole at the same time. Directional boring is used when: there are known objects under the roadway such as, fiber optical cable, sewer line, utility power cable, that must be avoided; the crossing distance is 9 m or greater; and open cut trenching is not allowed.
- In boring and casing, a combination of drilling and jacking is used. An auger located in the leading end of a large diameter steel casing drills through the soil as the casing is being jacked under the roadway. The auger is then removed and conduits are placed in the casing. This type of installation is used when more than three conduits are required.

Open trenching to install conduits is allowed on existing roadways where substantial obstacles under the roadway will be encountered or where there is insufficient room for jacking pits at the edges of the roadway.

(f) **Overcurrent Protection Devices.** These devices are main breakers, branch breakers, and contactors contained within the service cabinet. They protect electrical conductors and components. Breakers are available in different amperage sizes to carry electrical loads. Size the branch breakers to at least 140% of the computed illumination circuit load. The breaker size cannot exceed the ampacity of the smallest conductor it protects. The #10 pole and bracket cable is protected by fusing and is not a consideration in this sizing requirement. Size the main breakers to exceed 140% of all of the computed illumination loads and 125% of all other loads on the service. The minimum size main breaker is 60 amps.

Lighting contactors are used to switch the lighting circuits on and off. Contactors are used because the control equipment (photocell) operates on 120 volts and is not rated to carry the 240 or 480 volts of the lighting circuits. Size the lighting contactor to equal or exceed the branch breaker rating for the circuit it switches. Lighting contactors are available in 30, 60, and 100 amp ratings.

(g) **Control Equipment.** Photoelectric control devices and time clocks are used to control illumination circuits. The photoelectric control, with sunset turn-on and sunrise turn-off, is used for continuous nighttime operation. Continuous nighttime operation is used at the following locations:

- All required interchange illumination on highways with full limited access control.
- All additional illumination installed on highways with full limited access control.
- Illumination at intersections.
- Illumination at railroad crossings.
- Security lighting at bus loading zones at park and ride lots and at flyer stops.
- Security lighting in major parking lots.
- Security lighting for walkways at park and ride lots, flyer stops, ferry terminals, and rest areas.
- Illumination for parking areas and conflict points at rest areas.
- Detour illumination.
- Construction illumination.
- Illumination installed for accident frequency condition treatment on highways with managed access control.
- The single luminaire in the vicinity of the public telephone at weigh sites.

At certain locations, additional illumination is only required for short periods of time at night. The circuits for this illumination are controlled by a time clock or similar device. This device is designed to be overridden by the photoelectric control unit. This type of control is provided for illumination in excess of security levels in major parking lots, weigh sites, and bus loading areas in park and ride lots and flyer stops.

Other locations, such as tunnels with daytime lighting, require special controls. Controls are provided for circuits that energize certain fixtures throughout the day and night. Other controls energize additional fixtures to provide minimum daytime light levels, entrance zone light levels, and any subsequent zone lighting.

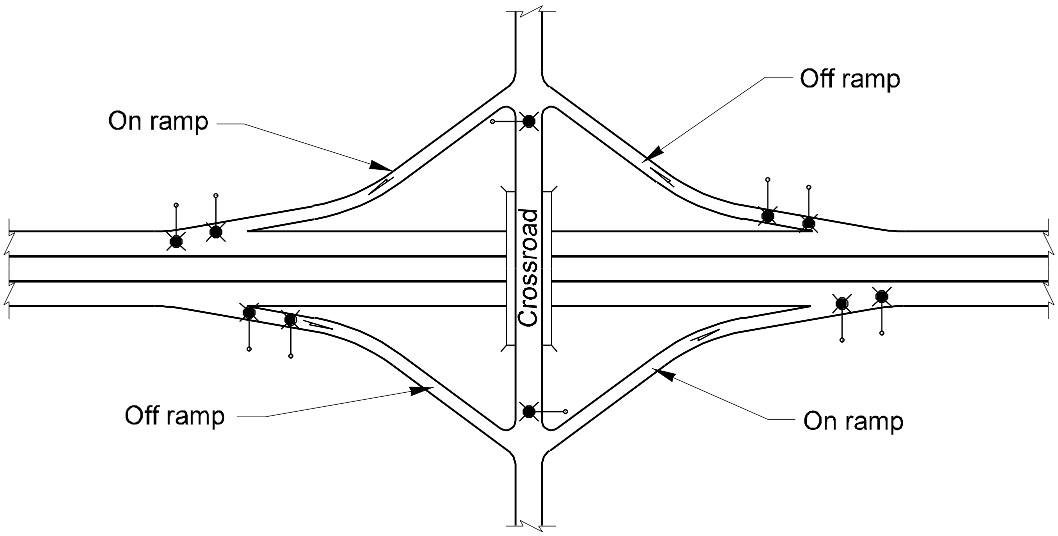
(h) **Light Level and Uniformity Calculations.** These calculations are used to determine the spacing of the luminaires to illuminate the design area. There are both manual methods and computer programs that can be used for these calculations. An example of the inputs and outputs of a computerized program are shown in Figures 840-10a through 840-10d.

840.07 Documentation

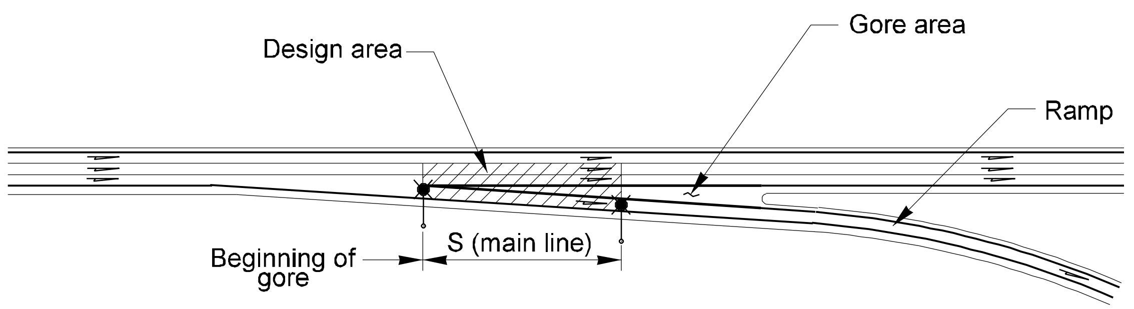
Preserve the following documents in the project file. See Chapter 330.

- ☐ A list of the facilities where the required illumination is provided.
- ☐ Justification and approval of proposals to install less than or more than the required illumination.
- ☐ Justification and approvals for any proposal to install additional illumination at other highway facilities.
- ☐ Justification for using nonstandard luminaires and light standards on state highways.

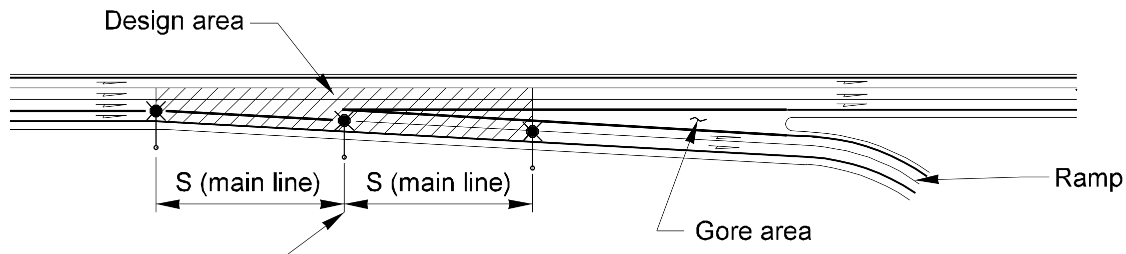
P65:DP/DMM



Required Illumination for a Typical Diamond Interchange
(Shown for single lane ramp connection and a two lane crossroad without channelization.)



Single Lane Off Connection
(Light standards can be shifted up to 30 m from the beginning of the gore.)



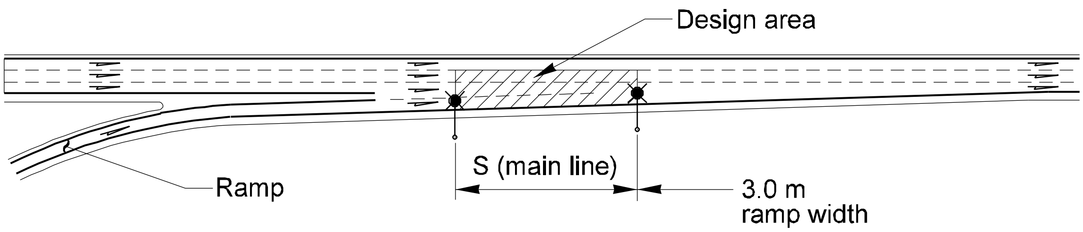
Two Lane Off Connection
(Light standards can be shifted up to 30 m from the beginning of the gore.)

Legend

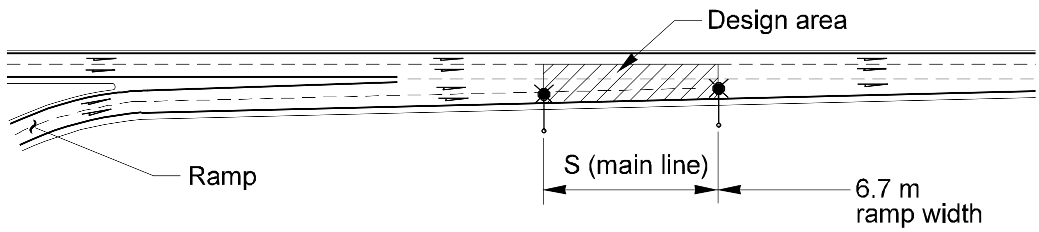
S Distance between light standards that will result in an average light level that exceeds the requirements of figure 840-6.

Light standards with mast arm mounted luminaire. (Locations are typical and not mandatory.)

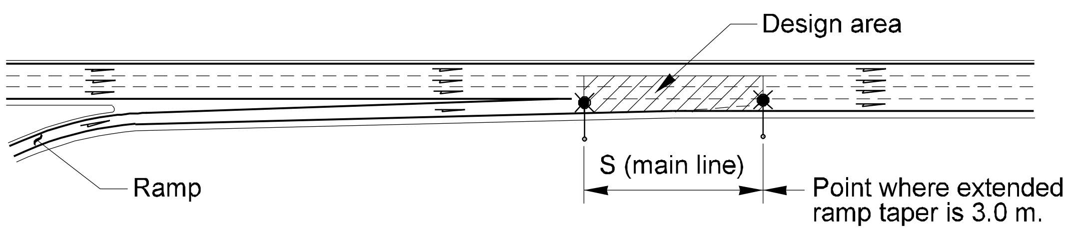
Freeway Lighting Applications
Figure 840-1



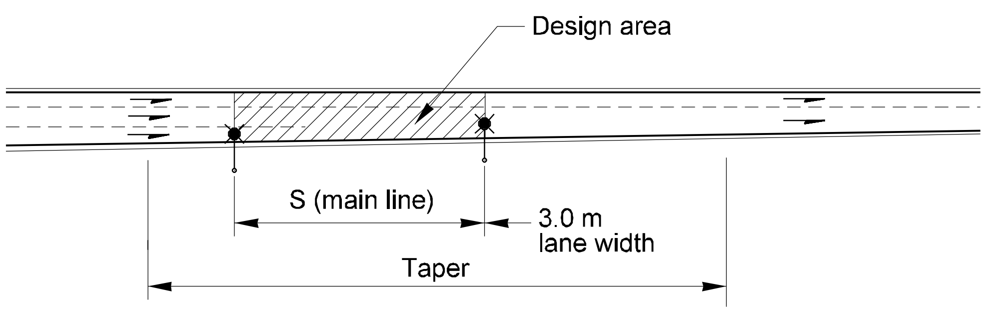
Single Lane On Connection



Two Lane On Connection



Auxiliary Lane at On Connection
(Required only if significant weaving problem exists.)



Lane Reduction

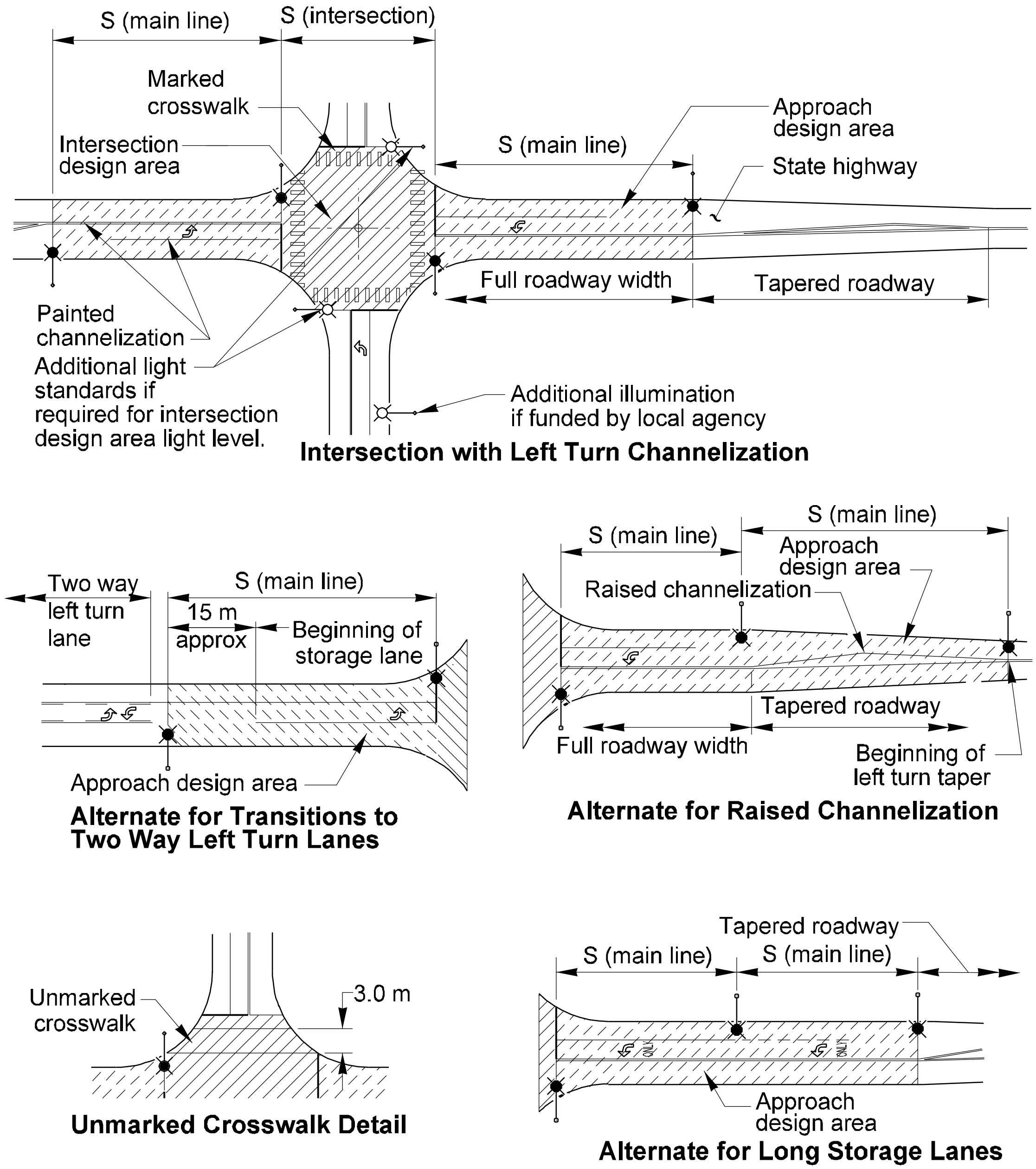
Legend

S Distance between light standards that will result in an average light level that exceeds the requirements of figure 840-6.

Light standards with mast arm mounted luminaire. (Locations are typical and not mandatory.)

Freeway Lighting Applications

Figure 840-2

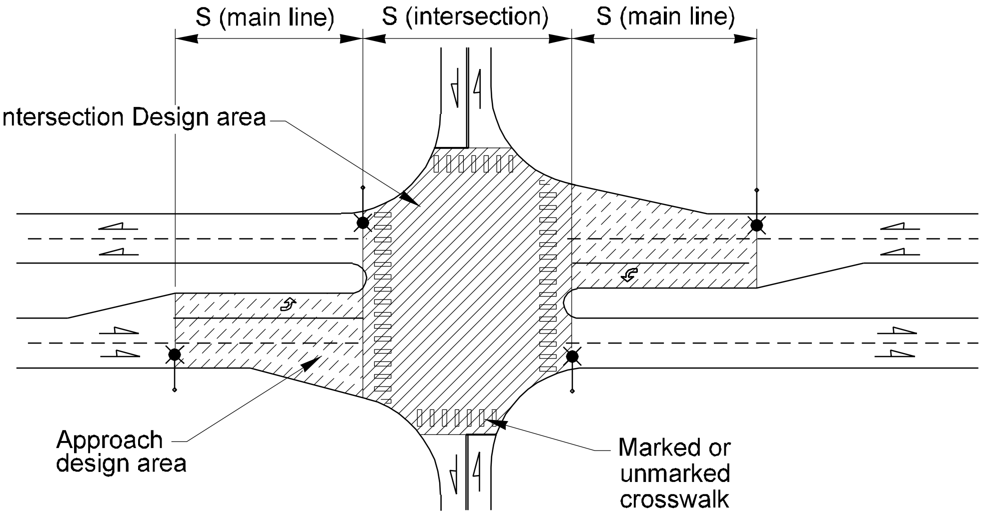


Legend

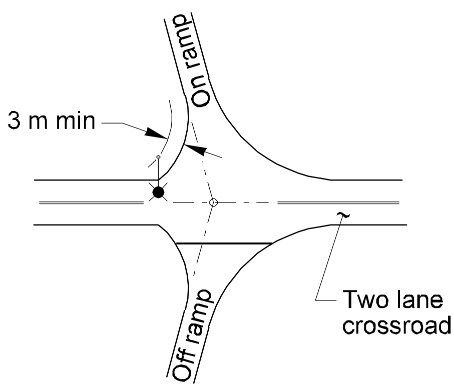
S Distance between light standards that will result in an average level that exceeds the requirements of Figure 840-6.

Light standard with mast arm mounted luminaire. (Locations are typical and not mandatory.)

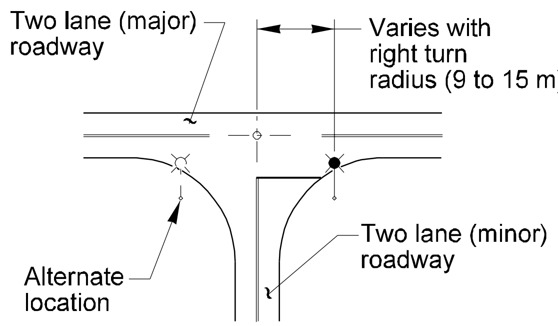
Roadway Lighting Applications
Figure 840-3



Divided Highway Intersection



Ramp Terminals



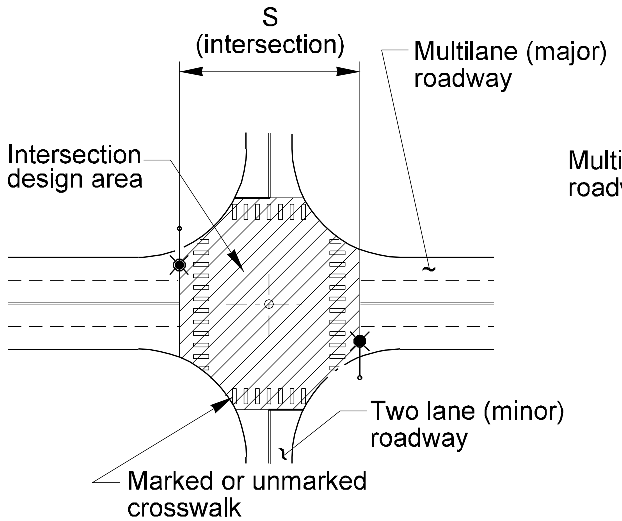
Tee Intersection Minor
(without left turn channelization)

Legend

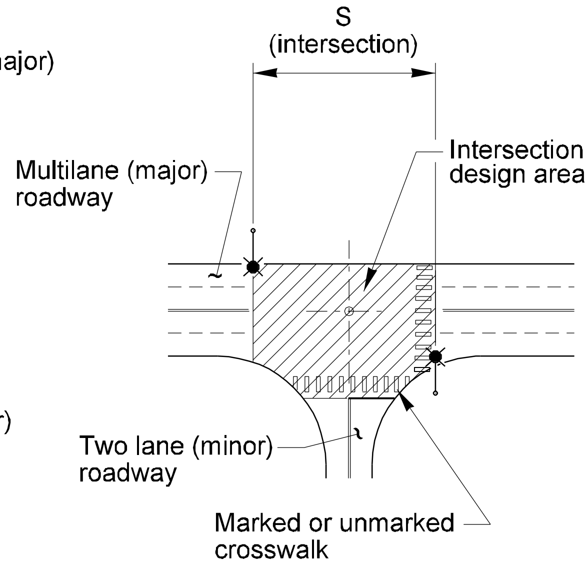
S Distance between light standards that will result in an average level that exceeds the requirements of Figure 840-6.

Light standard with mast arm mounted luminaire (Locations are typical and not mandatory.)

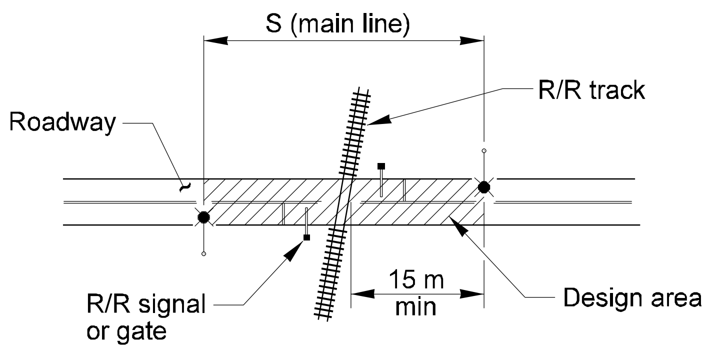
Roadway Lighting Applications
Figure 840-4



Four Way Intersection
(Without left turn channelization)



Tee Intersection Major
(Without left turn channelization)



Railroad Crossing

Legend

S Distance between light standards that will result in an average light level that exceeds the requirements of figure 840-6.

Light standard with mast arm mounted luminaire. (Locations are typical and not mandatory.)

Roadway Lighting Applications
Figure 840-5

Light Level and Uniformity Ratio Chart					
Highway Design Class	Average Maintained Horizontal Light Level			Maximum Uniformity Ratio(1) avg/min	Maximum Veiling Luminance Lmax/Lavg
	Pedestrian/Area Classification				
	High (lux)	Medium (lux)	Low (lux)		
Highways with Full Limited Access Control					
Main Line	6	6	6	4 : 1	0.3 : 1
Ramps	6	6	6	4 : 1	0.3 : 1
Crossroads	6	6	6	3 : 1	0.3 : 1
Ramp Intersections(2)	9	9	9	3 : 1	0.3 : 1
Principal Arterials(3)					
Main Line	17	13	6	3 : 1	0.3 : 1
Intersections	17	13	9	3 : 1	0.3 : 1
Minor Arterials					
Main Line	12	9	6	3 : 1	0.3 : 1
Intersections	9	9	9	3 : 1	0.3 : 1
Collectors					
Main Line	12	9	6	3 : 1	0.3 : 1
Intersections	9	9	9	3 : 1	0.3 : 1
Construction Lanes and Detours	10	10	10	3 : 1	0.3 : 1
Parking Lots	8	8	8	3 : 1	0.3 : 1
Vehicle Inspection Areas	20	20	20	3 : 1	0.3 : 1
Walkways	8	8	8	3 : 1	0.3 : 1
Weigh Scales	8	8	8	3 : 1	0.3 : 1
Bus Loading Zones(4)	20	20	20	NA	0.3 : 1

Notes

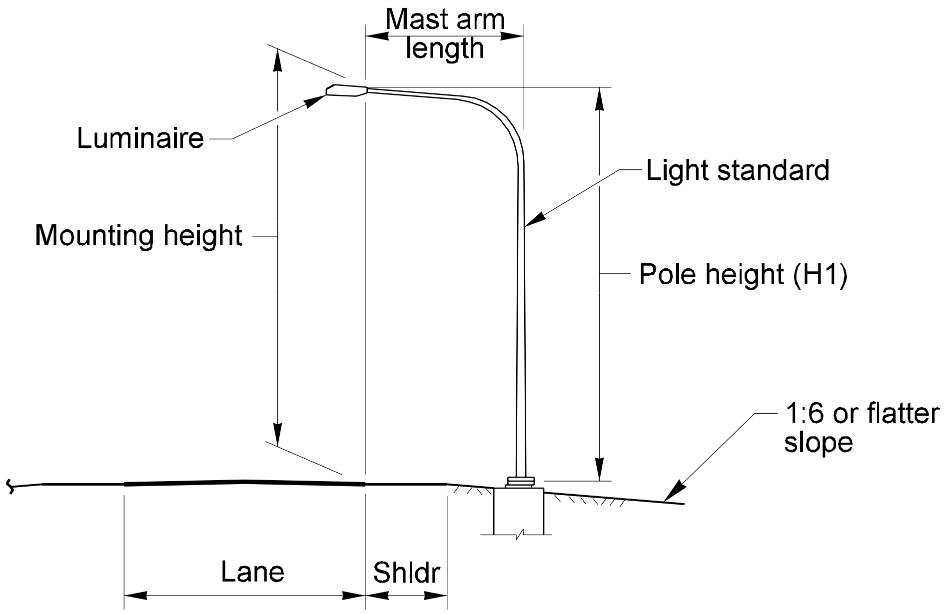
(1) The minimum light level is 2 lux for any application with an average light levels of 6lux. The minimum light levels for all other applications are controlled by the uniformity ratio.

(2) Light level and uniformity ratio apply only when installation of more than one light standard is justified.

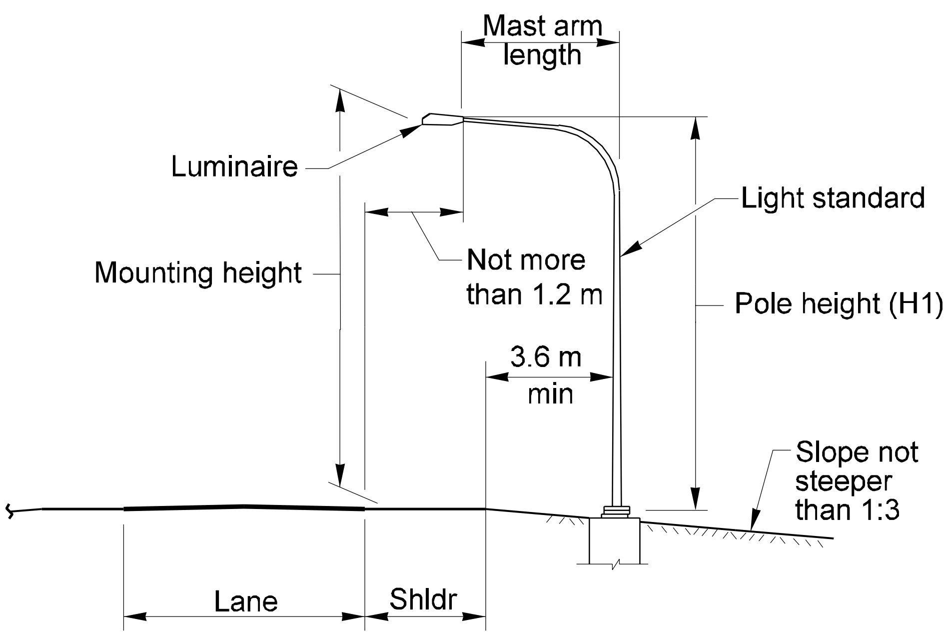
(3) Light levels shown also apply to modified and partial limited access control.

(4) Provide the light level at the location where the bus stops for riders.

Light Levels and Uniformity Ratios
Figure 840-6



Preferred Location
Embankment slope



Alternate Location

Light Standard Locations
Figure 840-7

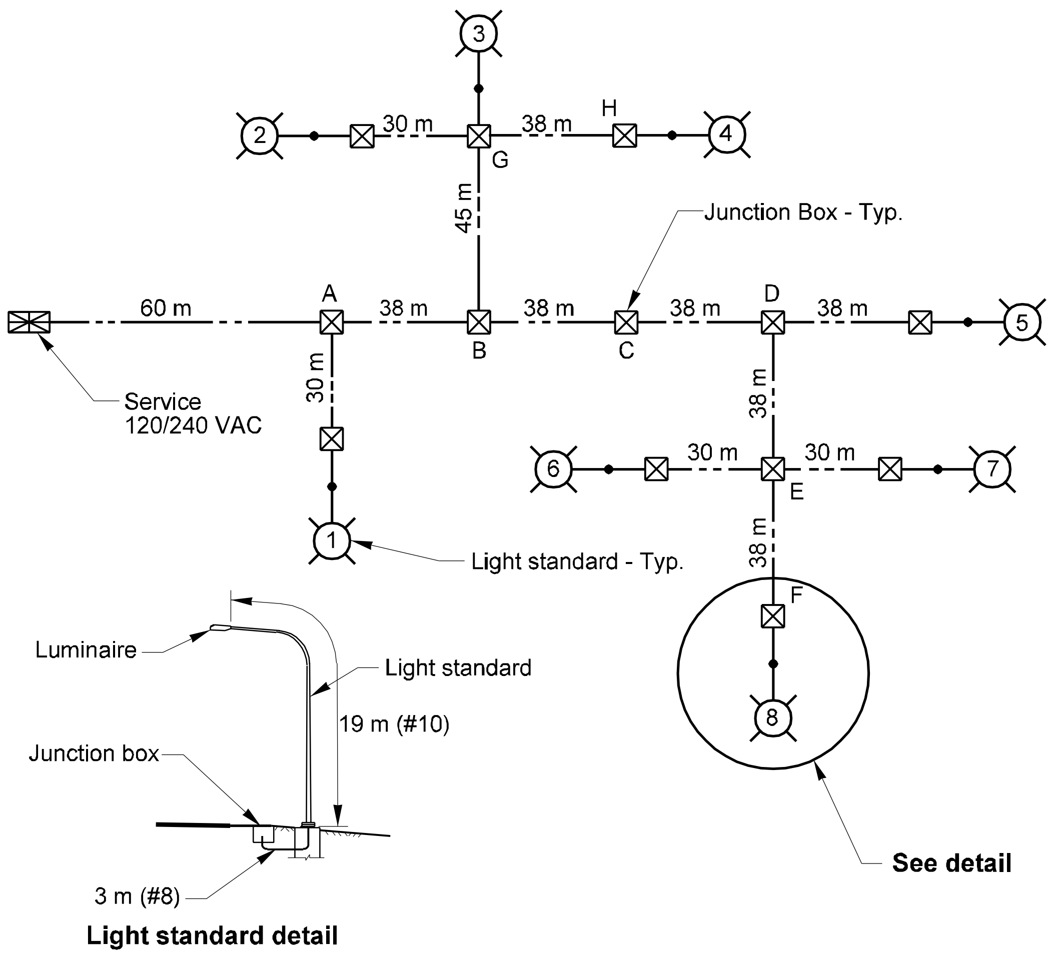
Light Standard Heights				
Luminaire Wattage	Initial Lumens*	H1	Recommended Mounting Height	
			Maximum	Minimum
200	22,000	9.1 m	9.8 m	8.5 m
250	28,000	10.7 m	11.6 m	9.8 m
310	37,000	12.2 m	13.4 m	11.0 m
400	50,000	12.2 m	13.4 m	11.0 m
400	50,000	15.2 m	16.5 m	14.0 m
1,000	140,000	30.5 m	33.5 m	27.4 m

*Note: Lumens are for high pressure sodium vapor luminaires

Conductor Properties Table				
Size (AWG)	Area (mm^2)	Ampacity (Amps)	Resistance Copper (ohms/meter)	Resistance Aluminum (ohms/meter)
# 14	14	15	0.01070	---
# 12	17	20	0.00673	---
# 10	22	30	0.00423	---
# 8	36	50	0.00265	0.00420
# 6	47	65	0.00167	0.00265
# 4	63	85	0.00105	0.00167
# 2	86	115	0.00066	---
# 1	123	130	0.00052	---
# 1/0	143	150	0.00042	---
#2/0	169	175	0.00033	

Illumination Conduit Sizing Table		
Trade Size (NEC)	Maximum Fill (mm^2)	
	26%	40%
27	149	232
35	258	394
41	348	535
53	574	877
63	819	1258
78	1258	1935
91	1677	2580

Light Standard Heights, Conductor, and Conduit Properties
Figure 840-8



Given: 400 watt HPS luminaires @ 240 VAC, on 15.24m light standards with 4.88 mast arms and 120/240 VAC service.
Unit load= 400 watts / 240 VAC = 1.67 amps.
Unit load x Load Factor (1.2 for HPS) = 1.67 x 1.2 =2 amps per unit.
Allowable Voltage Drop (5%) = 240 VAC x 5% = 12 volts

SOLUTION

Step 1. Calcuate voltage drop to load furthest from service (Luminaire 8)

Circuit Segment	Conductor Size	Load on Segment	A Sum of Loads	L Length (Meters)	R Resistance	2ALR Voltage Drop	Sum of Volt Drop
Service to A	#8	8 @ 2 amps	16	60	0.00265	5.09	5.09
A to B	#8	7 @ 2 amps	14	38	0.00265	2.82	7.91
B to C	#8	4 @ 2 amps	8	38	0.00265	1.61	9.52
C to D	#8	4 @ 2 amps	8	38	0.00265	1.61	11.13
D to E	#8	3 @ 2 amps	6	38	0.00265	1.21	12.34
E to F	#8	1 @ 2 amps	2	41	0.00265	0.43	12.77
F to 8	#10	1 @ 2 amps	2	19	0.00423	0.32	13.09

13.09 total voltage drop exceeds the allowed value of 12 volts

Line Loss Calculations

Figure 840-9a

Step 2. Change conductor size to # 6 from service to A and recalculate voltage drop

Circuit Segment	Conductor Size	Load on Segment	A Sum of Loads	L Length (Meters)	R Resistance	2ALR Voltage Drop	Sum of Volt Drop
Service to A	# 6	8 @ 2 amps	16	60	0.00167	3.21	3.21
A to B	# 8	7 @ 2 amps	14	38	0.00265	2.82	6.03
B to C	# 8	4 @ 2 amps	8	38	0.00265	1.61	7.64
C to D	# 8	4 @ 2 amps	8	38	0.00265	1.61	9.25
D to E	# 8	3 @ 2 amps	6	38	0.00265	1.21	10.46
E to F	# 8	1 @ 2 amps	2	41	0.00265	0.43	10.89
F to 8	# 10	1 @ 2 amps	2	19	0.00423	0.32	11.21

11.21 total voltage drop is less than the allowable value of 12 volts

Step 3. Calculate voltage drop to Luminaire 4, using conductor sizes from Step 2

Circuit Segment	Conductor Size	Load on Segment	A Sum of Loads	L Length (Meters)	R Resistance	2ALR Voltage Drop	Sum of Volt Drop
Service to A	# 6	8 @ 2 amps	16	60	0.00167	3.21	3.21
A to B	# 8	7 @ 2 amps	14	38	0.00265	2.82	6.03
B to G	# 8	5 @ 2 amps	10	45	0.00265	2.39	8.42
G to H	# 8	1 @ 2 amps	2	41	0.00265	0.43	8.85
H to 4	# 10	1 @ 2 amps	2	19	0.00423	0.32	9.17

9.17 total voltage drop is less than the allowable value of 12 volts

Branch Breaker Size = 140% of load (16 amps) = 22.4 amps. Use 30 amp branch breaker.
Circuit Ampacity = The smallest conductor in the circuit is # 8 with an ampacity of 50 amps.
Contactor Size = 30 amps, minimum size that exceeds the circuit load.

Service Breaker Calculations

Circuit	Load	Factor	A	N	B
Illumination - 240 VAC	16 amps	140%	22.4 amps		22.4 amps
Outlet - 120 VAC	15 amps	125%	18.75 amps		
Heat strip - 120 VAC	1 amp	125%	1.3 amps		
Total sized load			43 amps		22.4 amps

Use 60 amp main breaker (minimum allowed size)

Line Loss Calculations
Figure 840-9b

Problem:
Determine the light standard spacing and offset for the approach and intersection design areas for a channelized collector intersection at a location with a low pedestrian classification using the AGI 32 Lighting Design software.

Given:

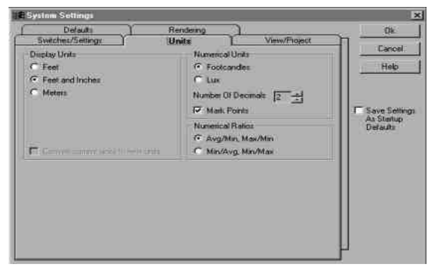
Geometric Design:
- Design speed = 50 mph
- Design vehicle = WB-15
- Lane Width = 3.6 m
- Shoulder width = 2.4 m
- Sidewalk width = 1.8 m
- Roadway cross slope = 2%
- Embankment section = 1:3 slopes
- Left turn storage length = 52.5 m
- Right turn radius = 17 m
- Right turn (T) = 6 m
- Right turn (F) = 5.8 m

Illumination Design:
- 15.2 m light standard height (H1)
- 4.9 m mast arm length
- 400 watt HPS luminaire
- Type III medium cutoff, light distribution
- 6 Lux Avg. light level for approaches
- 9 Lux Avg. light level for intersection
- 3:1maxium uniformity ratio for all design areas
- 0.3:1 maximum veiling luminance

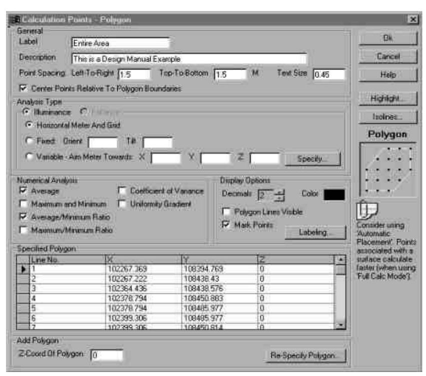
Step 1:
Determine the elevation of the top of the light standard slip base. Light standard is 4.9 m from the edge of traveled way. Assume elevation at edge of traveled way is 1.0 m.
Edge of shoulder elevation = 1.0 m - (2.4 x 0.02) = 0.95 m
Slip base elevation = 0.95 m - (2.4 ÷ 3) + 0.1 m = 0.25 m

Step 2:
Determine mounting height for 15.2 m light standard.
Luminaire elevation = 0.25 m + 15.2 m = 15.5 m
Edge of traveled way elevation = 1.0 m
Mounting height = 15.5 m - 1.0 m = 14.5 m

Step 3:
Setup calculation plane.
Note: Always use 2 decimal points.



Step 4:
Place the calculation grid so that it adequately covers the outside limits of the desired statistical area.



Note: Use a grid point spacing of 1.5 m in both X and Y directions.
Center the calculation grid between the grid boundaries.
The coordinates in the Specified Polygon Section above refer to the grid points at the corners of the calculation grid area. When the CADD drawing is imported, the coordinate locations of all the points and lines are equal to the original CADD file. If desired, the imported CADD drawing can be moved closer to the grid origin of (0,0)

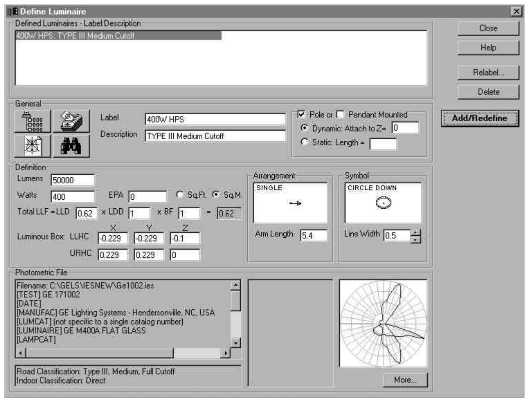
Step 5:
Place Statistical/Calculation Areas.
For the intersection, include all points within the back of shoulder and ahead of the stop bar.
For the approaches, include all points within the outside lane edge of each direction of traffic and the area between the stop bar and the end of full width in the left turn pocket.

Illumination Calculation Example

Figure 840-10a

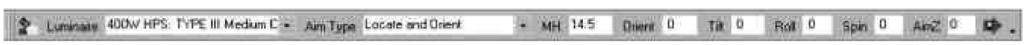
Step 6:
Define the luminaires and light standard.
Lumens for 400 watt HPS = 50,000
Tilt = 0
Light loss factor = 62%
Use photometrics file GE1002

Note: Arm length equals mast arm length plus the distance to the light source (4.9 m + 0.5 m = 5.4 m)



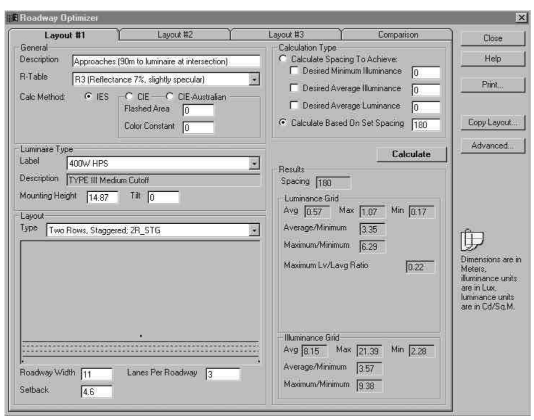
Step 7:
Place the luminaires. ht levels and uniformity values are obtained in their respective areas. This example uses a staggered pattern for light standard placement.

Note: The command line below describes the characteristics of the light standard and the luminaire being placed.



Step 8:
Calculate veiling luminance for the approaches and the intersection.
For these calculations, use the part of the program called the Roadway Optimizer.

Note: This step does not provide accurate outputs for high mast illumination.

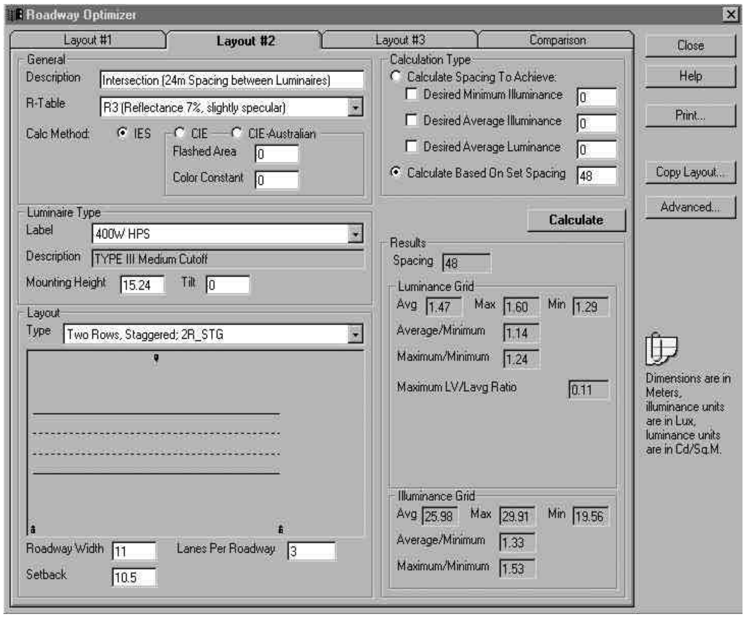


Intersection:
Spacing = 24 m
Roadway width = 11 m
Setback = 10.5 m
Pavement type = R2
Number of lanes = 3
Luminaire mounting height = 15.2 m

Illumination Calculation Example

Figure 840-10b

Step 8 (Continued):



Approaches:
Spacing = 24 m
Roadway width = 11 m
Setback = 10.5 m
Pavement type = R2
Number of lanes = 3
Luminaire mounting height = 15.2 m

Notes: The Roadway Optimizer cannot account for differences in mounting heights between the approach and intersection luminaires. To compensate for this, use an average mounting height. An average mounting height of 14.87 m was used in these examples.
The spacing of the luminaires is the distance shown in the examples. The spacing entered into the program is the distance to the next light standard on the same side of the roadway.

Program Outputs:

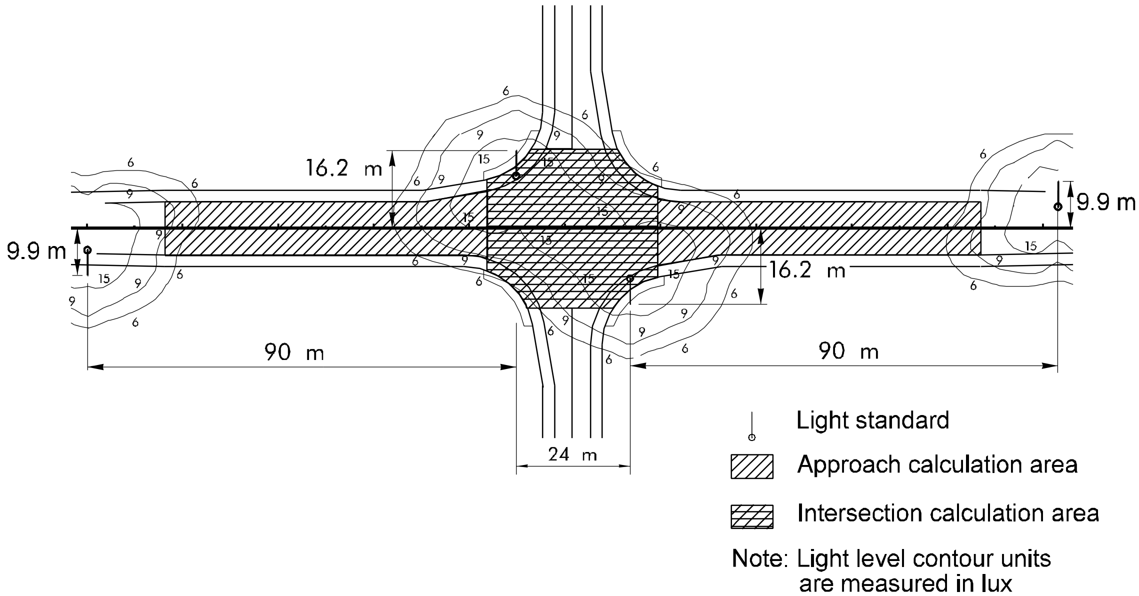
Statistical Area	Average lux	Minimum lux	Average\minimum	Veiling luminance
Intersection	16.35	5.66	2.89	0.11
Left Approach	6.4	2.46	2.6	0.22
Right Approach	6.4	2.46	2.6	0.22

Results:
Spacing on approaches = 90 m with approximately 9.9 m offsets from roadway centerline.
Spacing at intersections = 24 m with approximately 16.4 m offset from roadway centerline.

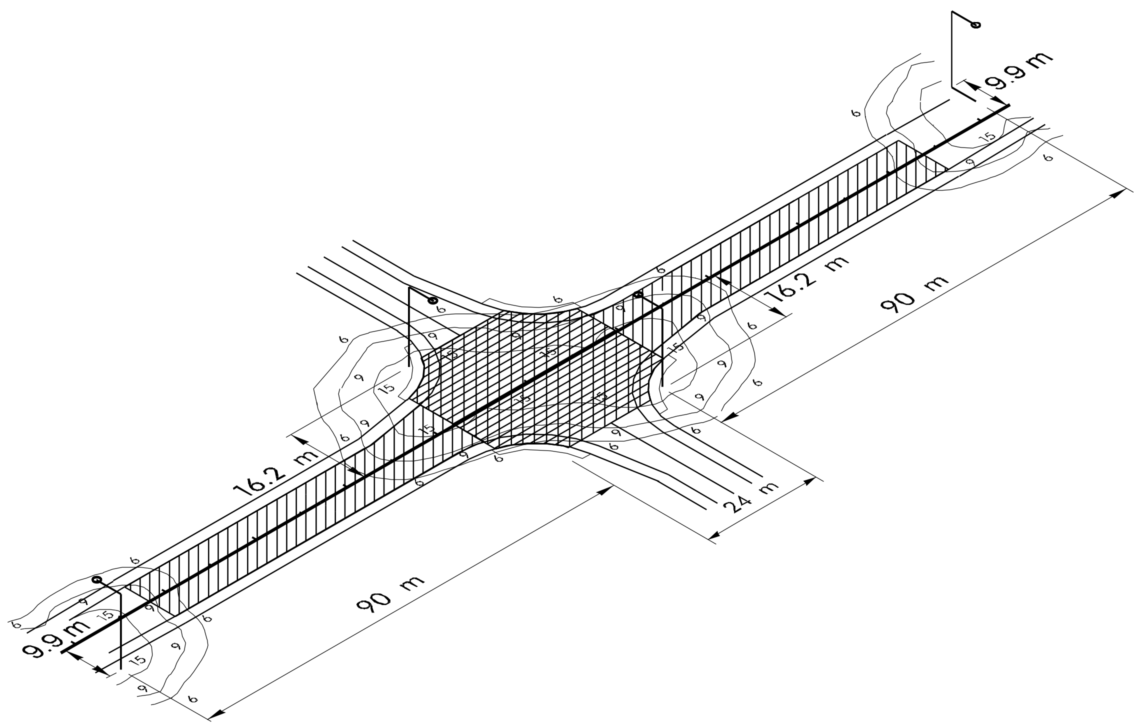
Further explanation:
Uniformity was the controlling factor in this example. By shortening the spacing on the approaches a lower value for uniformity can be obtained. The light standards at the intersection are set back to achieve the desired uniformity.

Illumination Calculation Example

Figure 840-10c



Computer-Generated Plot (Plan View) of Light Levels



Computer-Generated Plot (3D View) of Light Levels

Illumination Calculation Example

Figure 840-10d

Ramp Design Speed (mph)	25-30	35-40	45 and above
Desirable Grade (%)	5	4	3
Maximum Grade (%)	7	6	5
On one-way ramps down grades may be 2% greater.			

Maximum Ramp Grade
Figure 940-2

(4) Cross Section

Provide the minimum ramp widths given in Figure 940-3. Ramp traveled ways may require additional width to these minimums as one-way turning roadways. See Chapter 640 for additional information and roadway sections.

Number of Lanes		1	2
Traveled Way(1)		4.5(2)	7.5(3)
Shoulders	Right Left	2.4 0.6	2.4 1.2
Medians(4)		1.8	1.8

(1)See Chapter 1050 for additional width when an HOV lane is present.
(2)May be reduced to 3.6 on tangents.
(3)Add 3.6 m for each additional lane.
(4)In addition to shoulder width.

Ramp Widths
Figure 940-3

Cross slope and superelevation requirements for ramp traveled way and shoulders are as given in Chapter 640 for roadways.

Whenever feasible, make the ramp cross slope at the ramp beginning or ending station equal to the cross slope of the through lane pavement. Where space is limited and superelevation runoff is long or when parallel connections are used, the superelevation transition may be ended beyond (for on-ramps) or begun in advance of (for off-ramps) the ramp beginning or ending station, provided that the algebraic difference in cross slope at the edge of the through lane and the cross slope of the ramp does not exceed 4%. In such cases, ensure smooth transitions for the edge of traveled way.

(5) Ramp Lane Increases

When off-ramp traffic and left-turn movements volume at a crossroad terminal cause congestion, it may be desirable to add lanes to the ramp to reduce the queue length caused by turning conflicts. Make provision for the addition of ramp lanes whenever ramp exit or entrance volumes, after the design year, are expected to result in poor service. See Chapter 620 for width transition design.

(6) Ramp Meters

Ramp meters are used to allow a measured or regulated amount of traffic to enter the freeway. When operating in the "measured" mode, they release traffic at a measured rate to keep down-stream demand below capacity and improve system travel times. In the "regulated" mode, they break up platoons of vehicles that occur naturally or result from nearby traffic signals. Even when operating at near capacity, a freeway main line can accommodate merging vehicles one or two at a time, while groups of vehicles will cause main line flow to break down.

The location of the ramp meter is a balance between the storage and acceleration requirements. Locate the ramp meter to maximize the available storage and so that the acceleration lane length, from a stop to the freeway main line design speed, is available from the stop bar to the merging point. With justification, the average main line running speed during the hours of meter operation may be used for the highway design speed to determine the minimum acceleration lane length from the ramp meter. See 940.06(4) for information on the design of on-connection acceleration lanes. See Chapter 860 for additional information on the design of ramp meters.

Driver compliance with the signal is required for the ramp meter to have the desired results. Consider enforcement areas with ramp meters.

Consider HOV bypass lanes with ramp meters. See Chapter 1050 for design data for ramp meter bypass lanes.

940.06 Interchange Connections

Provide uniform geometric design and uniform signing for exits and entrances, to the extent possible, in the design of a continuous freeway. Do not design exit ramps as an extension of a main line tangent at the beginning of a main line horizontal curve.

Provide spacing between interchange connections as given by Figure 940-5.

Avoid on-connections on the inside of a main line curve, particularly when the ramp approach angle is accentuated by the main line curve, the ramp approach requires a reverse curve to connect to the main line, or the elevation difference will cause the cross slope to be steep at the nose.

Keep the use of mountable curb at interchange connections to a minimum. Justification is required when it is used adjacent to traffic expected to exceed 40 mph.

(1) Lane Balance

Design interchanges to the following principles of lane balance:

(a) At entrances, make the number of lanes beyond the merging of two traffic streams not less than the sum of all the lanes on the merging roadways less one. (See Figure 940-6a.)

(b) At exits, make the number of approach lanes equal the number of highway lanes beyond the exit plus the number of exit lanes less one. (See Figure 940-6b.) Exceptions to this would be at a cloverleaf or at closely spaced interchanges with a continuous auxiliary lane between the entrance and exit. In these cases the auxiliary lane may be dropped at a single-lane, one lane reduction, off-connection with the number of approach lanes being equal to the sum of the highway lanes beyond the exit and the number of exit lanes. Closely spaced interchanges have a distance of less than 650 m between the end of the acceleration lane and the beginning of the deceleration lane.

Maintain the basic number of lanes, as described in Chapter 620, through interchanges. When a two-lane exit or entrance is used, maintain lane balance with an auxiliary lane. The only exception to this is when the basic number of lanes is changed at an interchange.

(2) Main Line Lane Reduction

The reduction of a basic lane or an auxiliary lane may be made at a two-lane exit or may be made between interchanges. When a two-lane exit is used, provide a recovery area with a normal acceleration taper. When a lane is dropped between interchanges, drop it 450 to 900 m from the end of the acceleration taper of the previous interchange. This will allow for adequate signing but not be so far that the driver will become accustomed to the number of lanes and be surprised by the reduction. (See Figure 940-7.)

Reduce the traveled way width of the freeway by only one lane at a time.

(3) Sight Distance

Locate off-connections and on-connections on the main line to provide decision sight distance for a speed/path/direction change as described in Chapter 650.

(4) On-Connections

On-connections are the pavement at the end of on-ramps, connecting them to the main lane of a freeway. They have two parts, an acceleration lane and a taper. The acceleration lane allows entering traffic to accelerate to the freeway speed and evaluate gaps in the freeway traffic. The taper is for the entering vehicle to maneuver into the through lane.

On-connections are either taper type or parallel type. The tapered on-connection provides direct entry at a flat angle, reducing the steering control needed. The parallel on-connection adds a lane adjacent to the through lane for acceleration with a taper at the end. Vehicles merge with the through traffic with a reverse curve maneuver similar to a lane change. While the taper requires less steering control, the parallel is narrower at the end of the ramp and has a shorter taper at the end of the acceleration lane.

(a) Provide the minimum acceleration lane length given on Figure 940-8 for all on-ramps. When the grade of the acceleration lane is 3% or greater, multiply the distance from the Minimum Acceleration Lane Length table by the factor from the Adjustment Factor for Grades table. Design the acceleration lane for a higher speed than the ramp to accommodate the increasing speed of the entering traffic.

The acceleration lane is measured from the last point designed at the ramp design speed (usually the PT of the last curve) to the last point with a ramp width of 3.6 m. When the transition curve is designed for at least the posted speed of the freeway, its length may be included as part of the acceleration length.

(b) Provide the minimum gap acceptance length to allow entering traffic to evaluate gaps in the freeway traffic and position the vehicle to use the gap. The length is measured beginning at the point that the left edge of traveled way for the ramp is 3 m from the right edge of traveled way of the main line to the ending of the acceleration lane. The gap acceptance length and the acceleration length overlap with the ending point controlled by the longer of the two.

(c) Single-lane on-connections may be either taper type or parallel type. The taper type is preferred; however, the parallel may be used with justification. Design single-lane taper type on-connections as shown on Figure 940-9a and single lane parallel type on-connections as shown on Figure 940-9b.

(d) For two-lane on-connections, the parallel type is preferred. Design two-lane parallel on-connections as shown on Figure 940-9c. A capacity analysis will normally be the basis for determining whether a freeway lane or an auxiliary lane is to be provided.

When justification is documented, a two-lane tapered on-connection may be used. Design two-lane tapered on-connections in accordance with Figure 940-9d.

(5) Off-Connections

Off-connections are the pavement at the beginning of an off-ramp, connecting it to a main lane of a freeway. They have two parts, a taper for maneuvering out of the through traffic and a deceleration lane to slow to the speed of the first curve on the ramp. Deceleration is not assumed to take place in the taper.

Off-connections are either taper type or parallel type. The taper type is preferred because it fits the path preferred by most drivers. When a parallel type connection is used, drivers tend to drive directly for the ramp and not use the parallel lane. However, when a ramp is required on the outside of a curve, the parallel off-connection is preferred. An advantage of the parallel connection is that it is narrower at the beginning of the ramp.

(a) Provide the minimum deceleration lane length given on Figure 940-10 for all off-ramps. When the grade of the deceleration lane is 3% or greater, multiply the distance from the Minimum Deceleration Lane Length table by the factor from the Adjustment Factor for Grades table. Design the deceleration lane to provide a higher speed than the ramp to accommodate the changing speed of the exiting traffic.

The deceleration lane is measured from the point where the taper reaches a width of 3.6 m to the first point designed at the ramp design speed (often the PC of the first ramp curve). When the first curve is designed for at least the posted speed of the freeway, its length may be included as part of the deceleration length.

(b) Gores, Figure 940-11, are decision points that must be clearly seen and understood by approaching drivers. In a series of interchanges along a freeway, it is desirable that the gores be uniform and have the same appearance to the drivers.

The minimum distance from the physical nose to the gore nose is 27 m (see figure 940-11).

In addition to striping, raised pavement marker rumble strips may be placed for additional warning and delineation at gores. See the Standard Plans for striping and rumble strip details.

The accident rate in the gore area is greater than at other locations. Keep the unpaved area beyond the gore nose as free of obstructions as possible to provide a clear recovery area. Grade this unpaved area as nearly level with the roadways as possible. Avoid placing obstructions such as heavy sign supports, luminaire poles, and structure supports in the gore area.

When a major obstruction must be placed in a gore area, provide an impact attenuator (Chapter 720) and barrier (Chapter 710). Place the beginning of the attenuator as far back as possible, preferably after the gore nose.

(c) For single-lane off-connections, the taper type is preferred. Use the design shown on Figure 940-12a for tapered single-lane off-connections. When justification is documented, a parallel single-lane off-connection, as shown on Figure 940-12b, may be used.

(d) The single-lane off-connection with one lane reduction, Figure 940-12c, is only used when the conditions from lane balance for a single lane exit, one lane reduction, are met.

(e) The tapered two-lane off-connection design shown on Figure 940-12d is preferred where the number of freeway lanes is to be reduced, or where high volume traffic operations will be improved by the provision of a parallel auxiliary lane and the number of freeway lanes is to be unchanged.

The parallel two-lane off-connection, Figure 940-12e, allows less operational flexibility than the taper, requiring more lane changes. Use a parallel two-lane off-connection only with justification.

(6) Collector Distributor Roads

A C-D road can be within a single interchange, through two closely spaced interchanges, or continuous through several interchanges. Design C-D roads that connect three or more interchanges to be two lanes wide. All others may be one or two lanes in width, depending on capacity requirements. Consider intermediate connections to the main line for long C-D roads. See Figure 940-13a for designs of collector distributor outer separations. Use Design A, with concrete barrier, when adjacent traffic in either roadway is expected to exceed 40 mph. Design B, with mountable curb, may be used only when adjacent traffic will not exceed 40 mph.

(a) The details shown in Figure 940-13b apply to all single-lane C-D road off-connections.

Where conditions require two-lane C-D road off-connections, a reduction in the number of freeway lanes, the use of an auxiliary lane, or a combination of these, design it as a standard off-connection per 940.06(5).

(b) Design C-D road on-connections as required by Figure 940-13c.

(7) Loop Ramp Connections

Loop ramp connections at cloverleaf interchanges are distinguished from other ramp connections by a low speed ramp on-connection followed closely by an off-connection for another low speed ramp. The loop ramp connection design is shown on Figure 940-14. The minimum distance between the ramp connections is dependent on a weaving analysis. When the connections are spaced far enough apart that weaving is not a consideration, design the on-connection per 940.06(4) and off-connection per 940.06(5).

(8) Weaving Sections

Weaving sections are highway segments where one-way traffic streams cross by merging and diverging. Weaving sections may occur within an interchange, between closely spaced interchanges, or on segments of overlapping routes. Figure 940-15 gives the length of the weaving section required for the total weaving traffic in equivalent passenger cars. The total weaving traffic is the sum of the traffic entering from the ramp to the main line and the traffic leaving the main line to the exit ramp. For trucks, a passenger car equivalent of two may be estimated. Design weaving sections in accordance with the *Highway Capacity Manual*.

Because weaving sections cause considerable turbulence, interchange designs that eliminate weaving or remove it from the main roadway are desirable. Use C-D roads for weaving between closely spaced ramps when adjacent to high speed highways. C-D roads are not required for weaving on low speed roads.

940.07 Ramp Terminal Intersections at Crossroads

Design ramp terminal intersections at grade with crossroads as intersections at grade. (See Chapter 910.) Whenever possible, design ramp terminals to discourage wrong way movements. Review the location of ramp intersections at grade with crossroads to ensure signal progression if the intersection becomes signalized in the future. Provide intersection sight distance as described in Chapter 910.

In urban and suburban areas match design speed at ramp terminal to the speed of the crossroad. Provide steeper intersection angles between the ramp terminal and crossroad to slow motor vehicle traffic speeds and reduce crossing distances for bicyclists and pedestrians.

The intersection configuration requirements for ramp terminals is normally the same as for other intersections. One exception to this is an angle point is allowed between an off ramp and an on ramp. This is because the through movement of traffic getting off the freeway, going through the intersection, and back on the freeway is minor.

Another exception is at ramp terminals where the through movement is eliminated (for example at a Single Point interchange). For ramp terminals that have two wye connections, one for right turns and the other for left turns, and no through movement the intersection angle has little meaning and does not need to be considered.

940.08 Interchanges on Two-Lane Highways

Occasionally, the first stage of a conventional interchange will be built with only one direction of the main roadway and operated as a two-lane two-way roadway until the ultimate roadway is warranted and construction completed.

The design of interchanges on two-lane two-way highways may vary considerably from traditional concepts due to the following conditions:

- The potential for center-line-crossing related accidents due to merge conflicts or motorist confusion.
- The potential for wrong way or U-turn movements.
- Future construction considerations.
- Traffic type and volume.
- The proximity to multilane highway sections that might influence the driver's impression that these roads are also multilane.

The deceleration taper is required for all exit conditions. Design the entering connection with either the standard acceleration taper or a "button hook" type configuration with a stop condition before entering the main line. Consider the following items:

- Design the stop condition connection in accordance with the requirements for a Tee intersection in Chapter 910. Use this type of connection only when an acceleration lane is not possible. Provide decision sight distance as described in Chapter 650.
- Since each design will probably vary from project to project, analyze each project for most efficient signing placement such as one way, two way, no passing, do not enter, directional arrows, guide posts, and traffic buttons.
- Prohibit passing through the interchange area on two lane highways by means of signing, pavement marking, or a combination of both. A 1.2 m median island highlighted with raised pavement markers and diagonal stripes is the preferred treatment. When using a 1.2 m median system, extend the island 150 m beyond any merging ramp traffic acceleration taper. The width for the median can be provided by reducing each shoulder 0.6 m through the interchange. (See Figure 940-16.)
- Inform both the entering and through motorists of the two-lane two-way characteristic of the main line. Include signing and pavement markings.
- Use as much of the ultimate ramp and throughway roadway system as possible. Where this is not possible, leave the area for future lanes and roadway ungraded.

- Design and construct temporary ramps as if they were permanent unless second stage construction is planned to rapidly follow the first. In all cases, design the connection to meet the safety needs of the traffic. (See Figure 940-16.)

940.09 Interchange Plans

Figure 940-17 is a sample showing the general format and data required for interchange design plans.

Compass directions (W-S Ramp) or crossroad names (E-C Street) may be used for ramp designation to realize the most clarity for each particular interchange configuration and circumstance.

Include the following as applicable:

- Classes of highway and design speeds for main line and crossroads (Chapter 440).
- Curve data on main line, ramps, and crossroads.
- Numbers of lanes and widths of lanes and shoulders on main line, crossroads, and ramps.
- Superelevation diagrams for the main line, the crossroad, and all ramps (may be submitted on separate sheets).
- Channelization (Chapter 910).
- Stationing of ramp connections and channelization.
- Proposed right of way and access control treatment (Chapter 1420).
- Delineation of all crossroads, existing and realigned (Chapter 910).
- Traffic data necessary to justify the proposed design. Include all movements.

Prepare a preliminary contour grading plan for each completed interchange. Show the desired contours of the completed interchange including details of basic land formation, slopes, graded areas or other special features. Coordinate the contour grading with the drainage design and the roadside development plan.

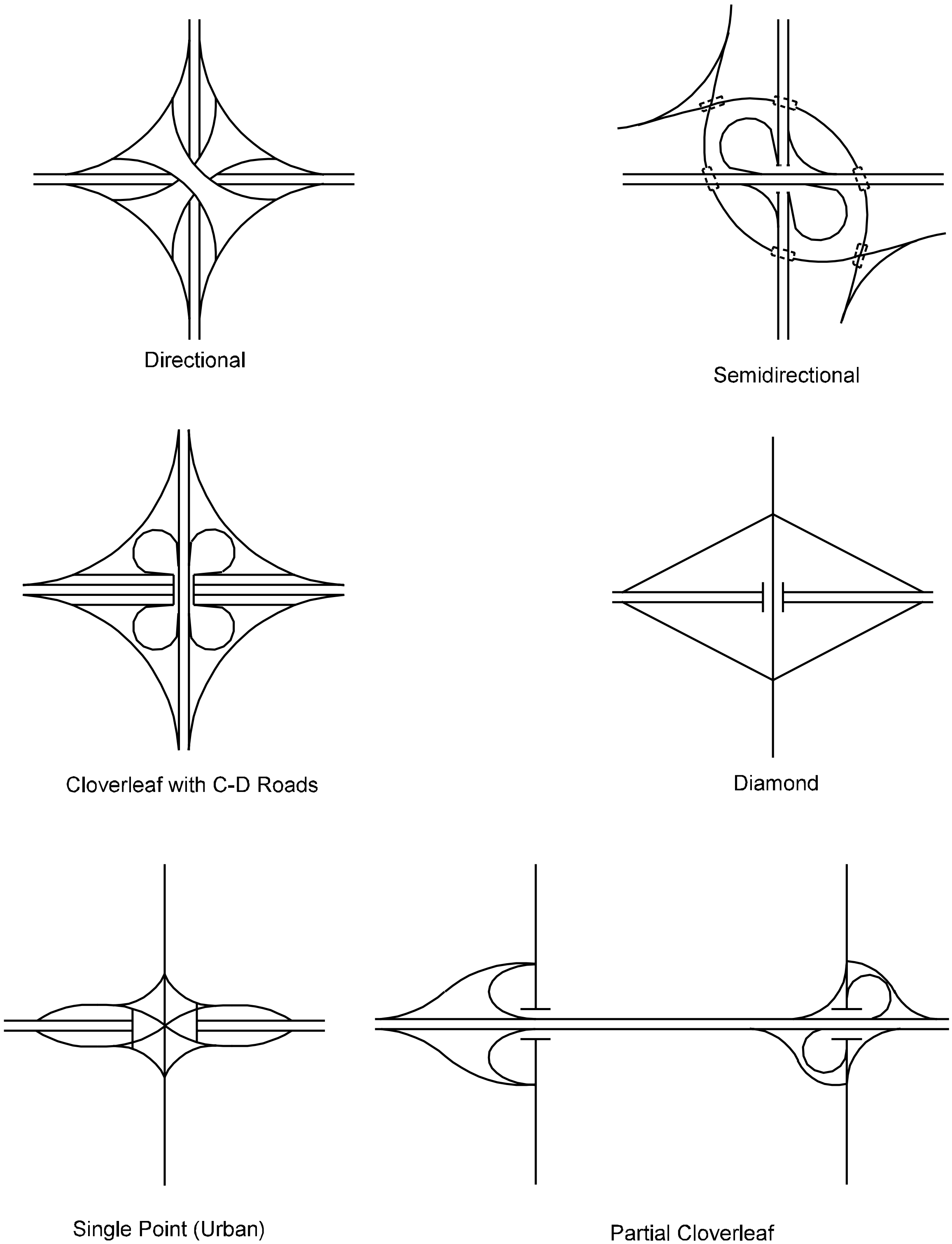
Alternative designs considered, studied, and rejected may be shown as reduced scale diagrams with a brief explanation of the advantages and disadvantages of the alternative designs, including the recommended design.

940.10 Documentation

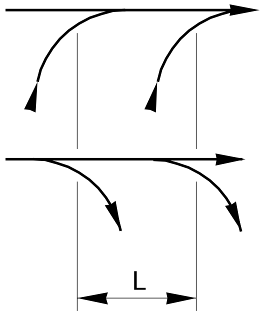
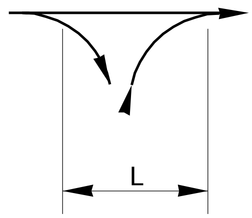
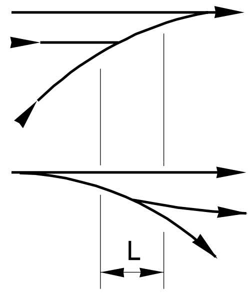
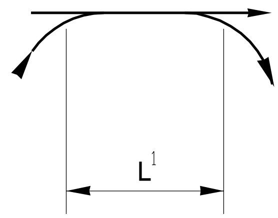
The following documents are to be preserved in the project file. See Chapter 330.

- ☐ Interchange plan
- ☐ Access Point Decision Report (Chapter 1425)
- ☐ On-connection type justification
- ☐ Off-connection type justification
- ☐ Justification for ramp metering main line speed reduction
- ☐ Weaving analysis and design
- ☐ Alternative discussion and analysis

P65:DP/DMM



Basic Interchange Patterns
Figure 940-4

On - On or Off - Off		Off - On		Turning Roadways		On - Off (weaving)			
									
Freeway	C-D Road	Freeway	C-D Road	System Interchange[2]	Service Interchange[3]	A	B	C	D
300m	240m	150m	120m	240m	180m	600m	480m	480m	300m

L = Minimum distance from nose to nose. The nose is the beginning of the unpaved area within the gore for an exit and the ending of the unpaved area for an entrance.

A Between two interchanges connected to a freeway, a system interchange[2] and a service interchange[3].

B Between two interchanges connected to a C-D road, a system interchange[2] and a service interchange[3].

C Between two interchanges connected to a freeway, both service interchanges[3].

D Between two interchanges connected to a C-D road, both service interchanges[3].

Notes:

These recommendations are based on operational experience, need for flexibility, and adequate signing. Check them in accordance with Figure 940-15 and the procedures outlined in the Highway Capacity Manual and use the larger value.

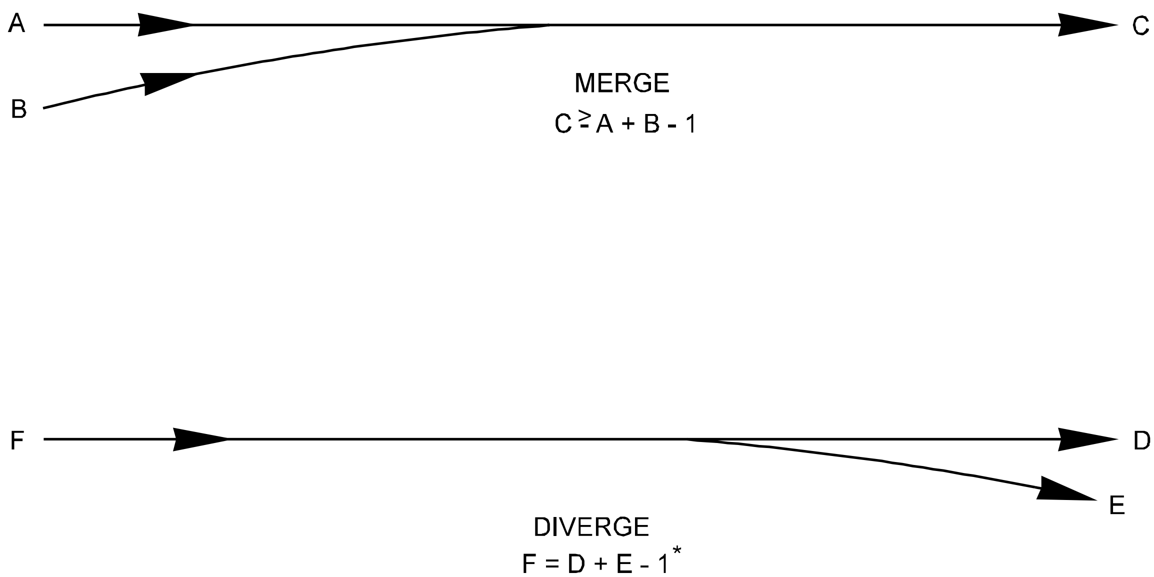
1 With justification, these values may be reduced for cloverleaf ramps.

2 A system interchange is a freeway to freeway interchange.

3 A service interchange is a freeway to local road interchange.

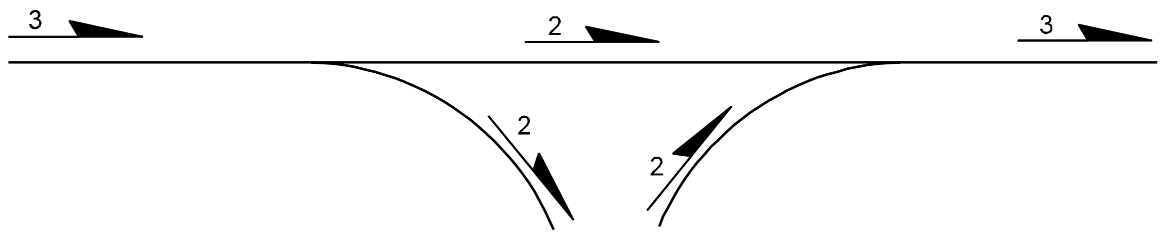
Minimum Ramp Terminal Spacing

Figure 940-5

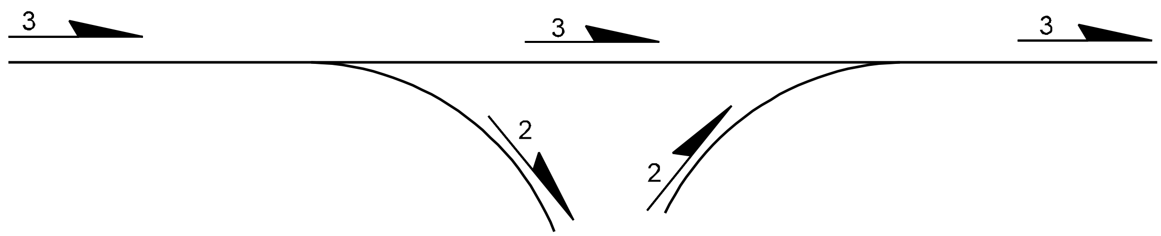


* Number of lanes, F, may be more by one lane only, provided the lane dropped is an auxiliary lane between closely spaced entrance and exit ramps.

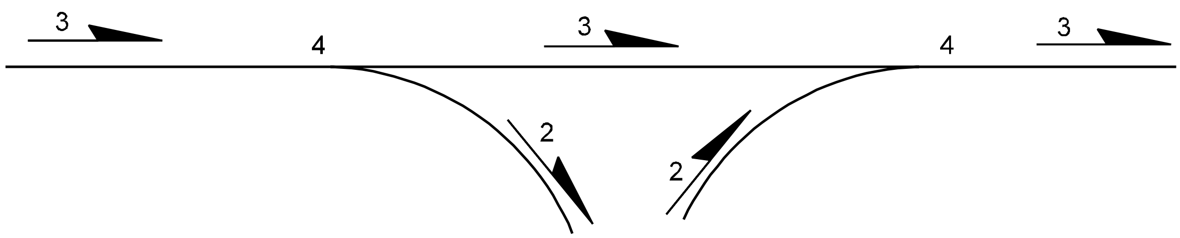
Lane Balance
Figure 940-6a



UNDESIRABLE Lane balance but no compliance with basic number of lanes.

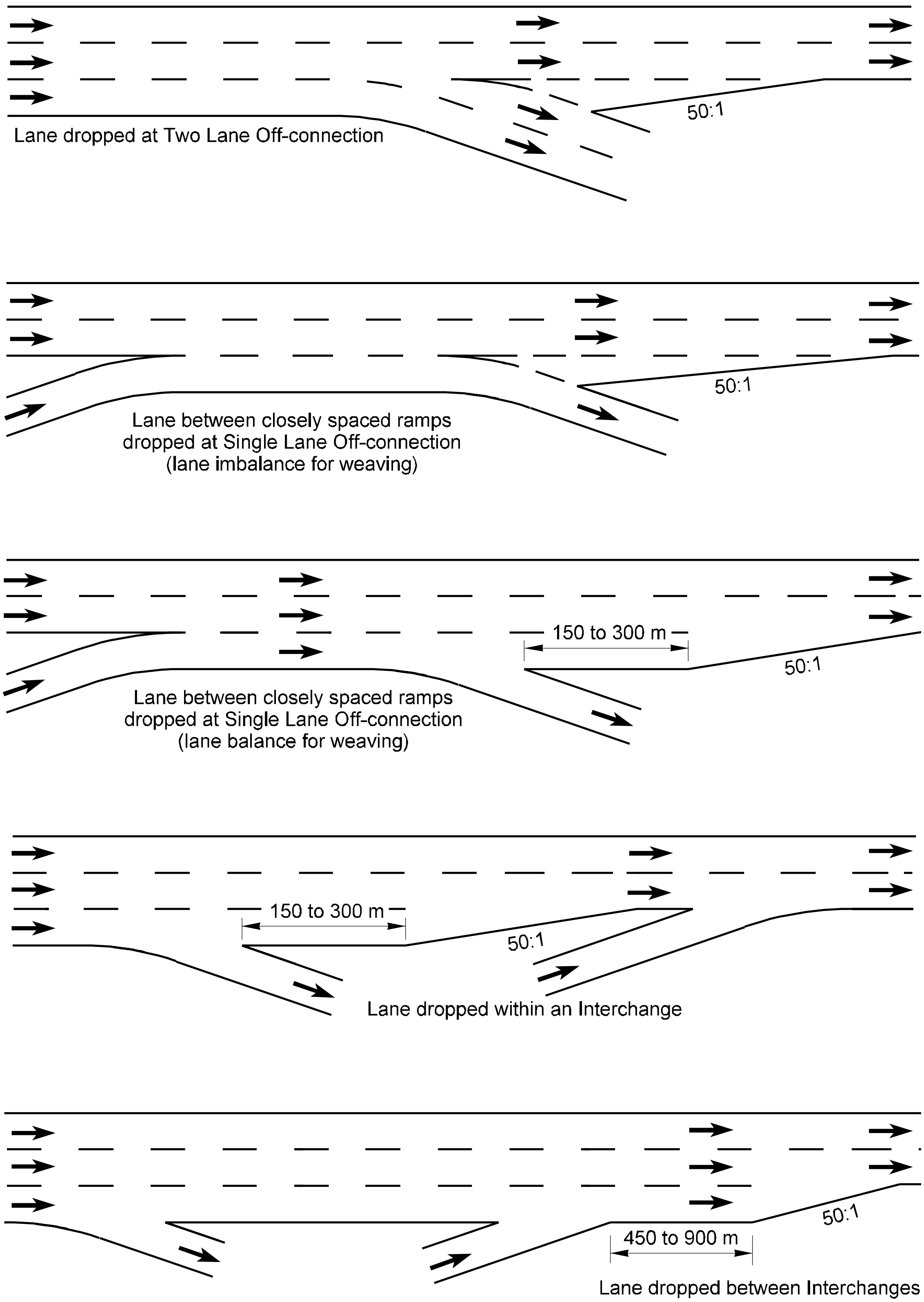


UNDESIRABLE No lane balance but compliance with basic number of lanes.

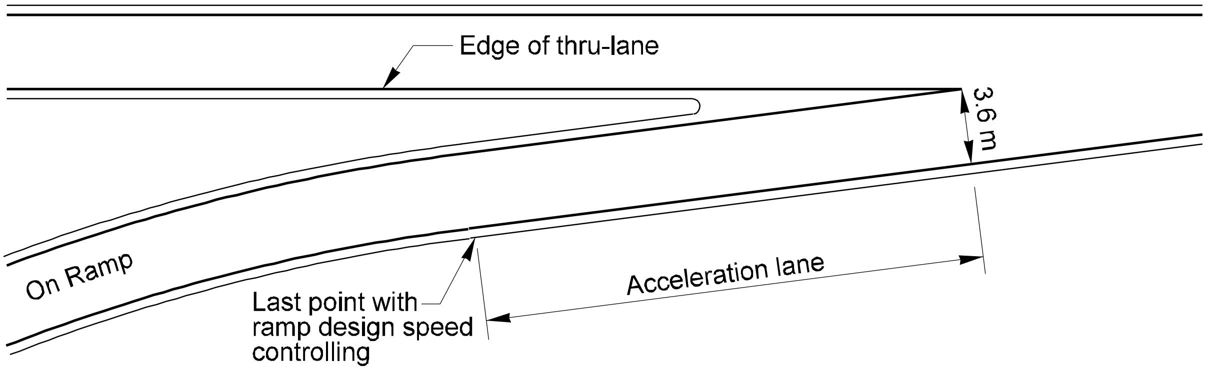


DESIRABLE Compliance with both lane balance and number of lanes.

Lane Balance
Figure 940-6b



Main Line Lane Reduction Alternatives
Figure 940-7



Highway Design Speed (mph)	Ramp Design Speed (mph)									
	0	15	20	25	30	35	40	45	50	60
30	55									
40	120	100	85	65						
50	195	170	155	135	105	75				
60	340	310	290	270	235	205	155	105	50	
70	455	430	410	390	355	315	265	215	155	
80	575	555	535	515	480	440	390	340	280	150

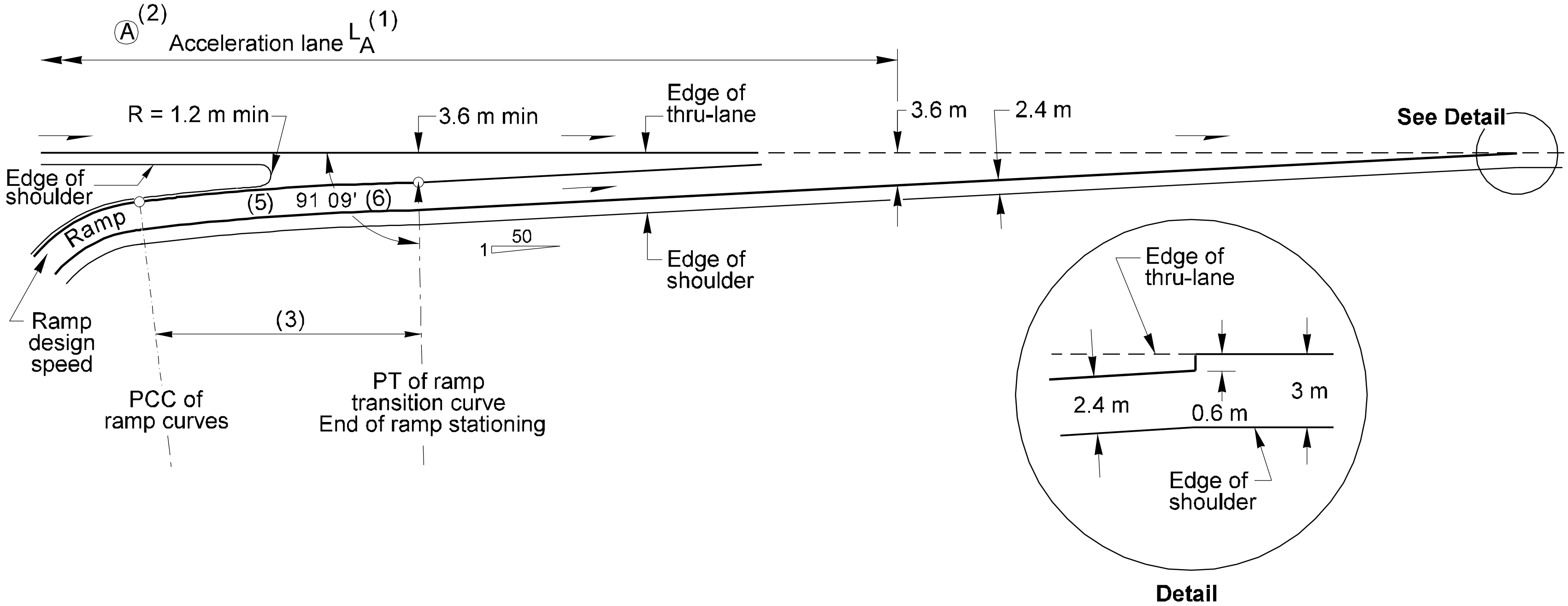
Minimum Acceleration Lane Length (m)

Highway Design Speed (mph)	Grade	Up Grade				Down Grade
		Ramp Design Speed				All Ramp
		20	30	40	50	Design Speeds
40	3% to less than 5%	1.3	1.3			0.7
50		1.3	1.4	1.4		0.65
60		1.4	1.5	1.5	1.6	0.6
70		1.5	1.6	1.7	1.8	0.6
40	5% or more	1.5	1.5			0.6
50		1.5	1.7	1.9		0.55
60		1.7	1.9	2.2	2.5	0.5
70		2.0	2.2	2.6	3.0	0.5

Adjustment Factors for Grades Greater than 3%

Acceleration Lane Length

Figure 940-8



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point Ⓐ is the point controlling the ramp design speed.

(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

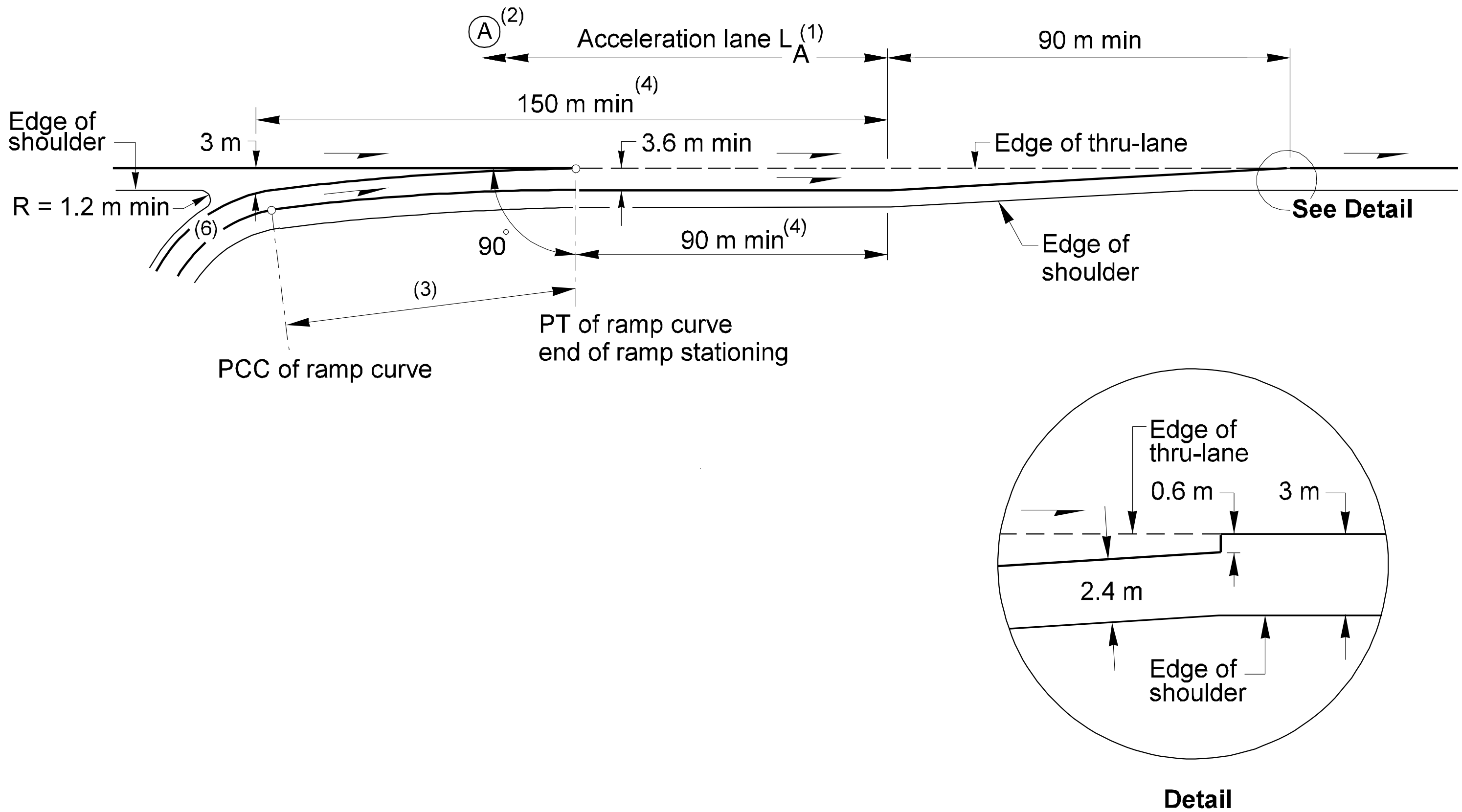
(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

(6) Approximate angle to establish ramp alignment.

On-Connection (Single-Lane, Taper Type)

Figure 940-9a



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point Ⓐ is the point controlling the ramp design speed.

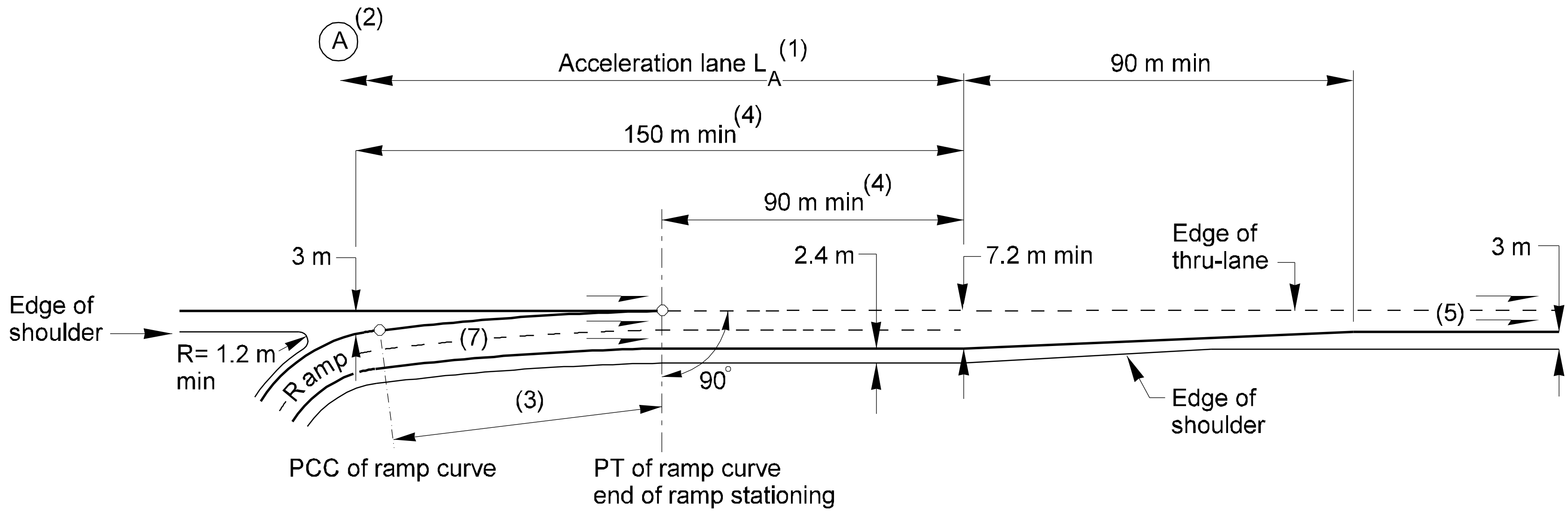
(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) Gap acceptance length L_g.

(5) For striping, see the Standard Plans

(6) For ramp lane and shoulder widths, see Figure 940-3.

On-Connection (Single-Lane, Parallel Type)
Figure 940-9b



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point (A) is the point controlling the ramp design speed.

(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) Gap acceptance length L_g.

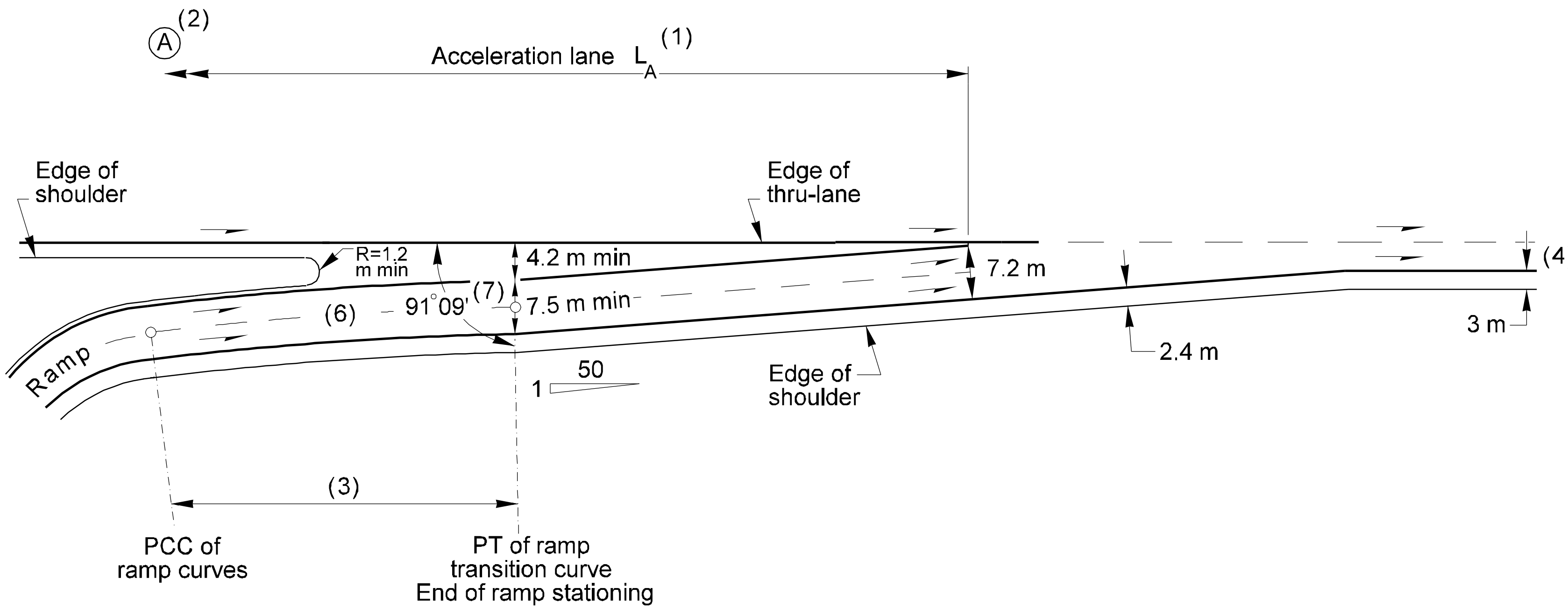
(5) Added lane or 450 m auxiliary lane, plus 180 m taper.

(6) For striping, see the Standard Plans

(7) For ramp lane and shoulder widths, see Figure 940-3.

On-Connection (Two-Lane, Parallel Type)

Figure 940-9c



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point (A) is the point controlling the ramp design speed.

(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) Added lane or 450 m auxiliary lane, plus 180 m taper.

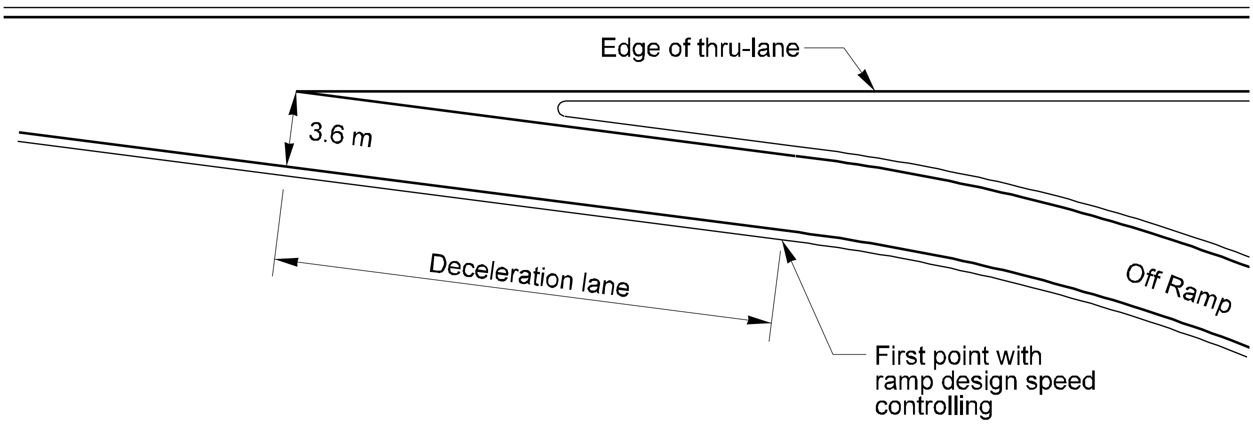
(5) For striping, see the Standard Plans

(6) For ramp lane and shoulder widths, see Figure 940-3.

(7) Approximate angle to establish ramp alignment.

On-Connection (Two-Lane, Taper Type)

Figure 940-9d



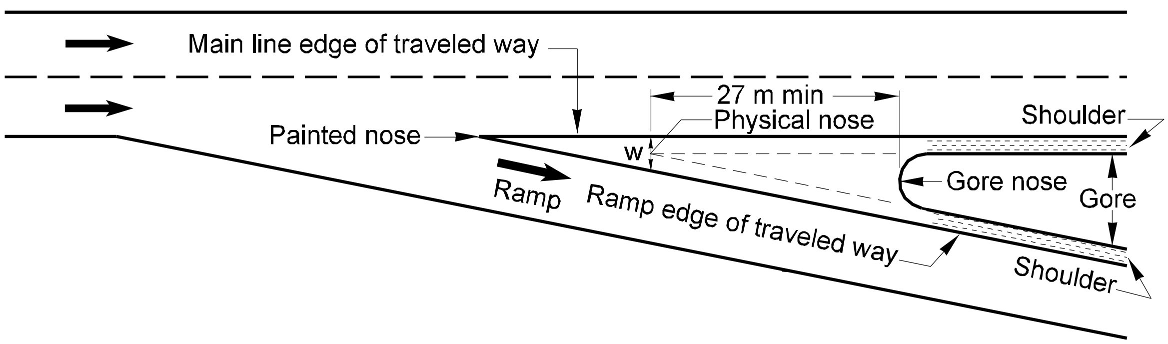
Highway Design Speed (mph)	Ramp Design Speed (mph)										
	0	15	20	25	30	35	40	45	50	60	70
30	75	55	50								
40	105	95	85	75	60	50					
50	130	120	110	100	90	75	60				
60	160	150	145	135	125	115	105	90	75		
70	185	180	175	165	155	145	135	120	105	60	
80	215	210	205	200	190	180	170	155	145	115	90

Minimum Deceleration Length (m)

Grade	Up Grade	Down Grade
3% to less than 5%	0.9	1.2
5% or more	0.8	1.35

Adjustment Factors for Grades Greater than 3%

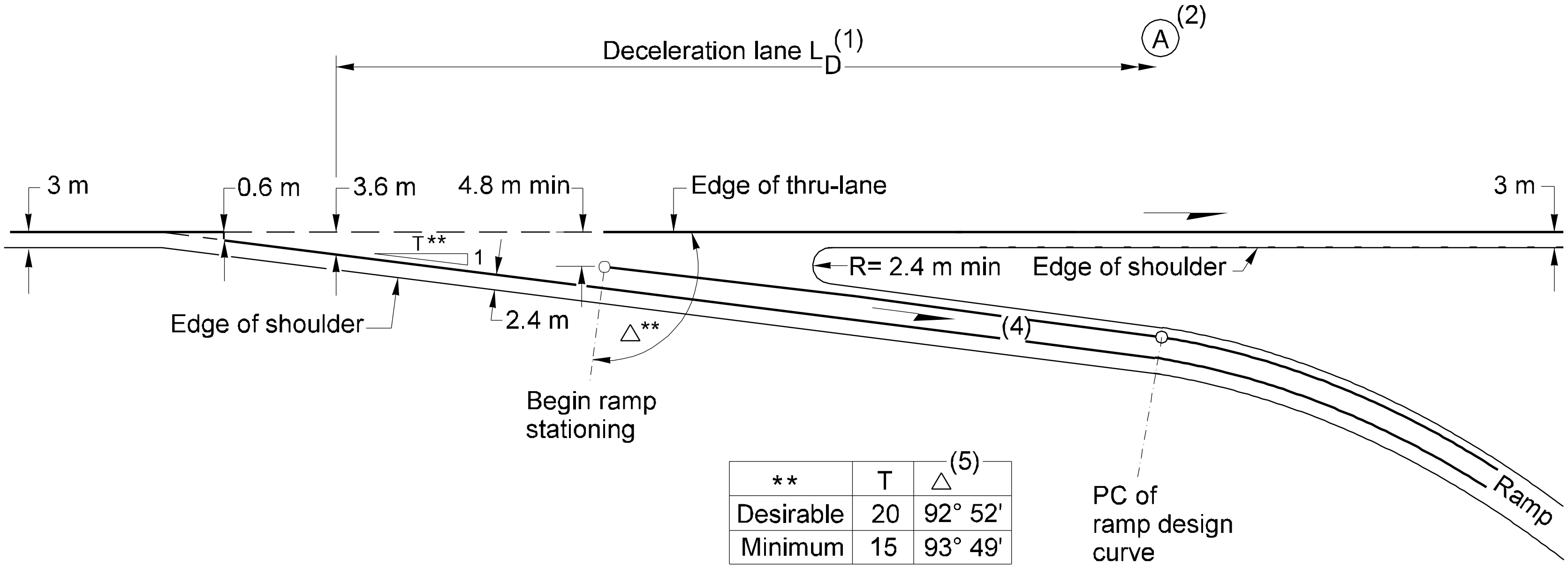
Deceleration Lane length
Figure 940-10



W = The sum of the main line shoulder width and the ramp shoulder width, but not less than 3 m

Gore Area Characteristics

Figure 940-11



**	T	△(5)
Desirable	20	92° 52'
Minimum	15	93° 49'

Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point Ⓐ is the <u>point controlling</u> the ramp design speed.

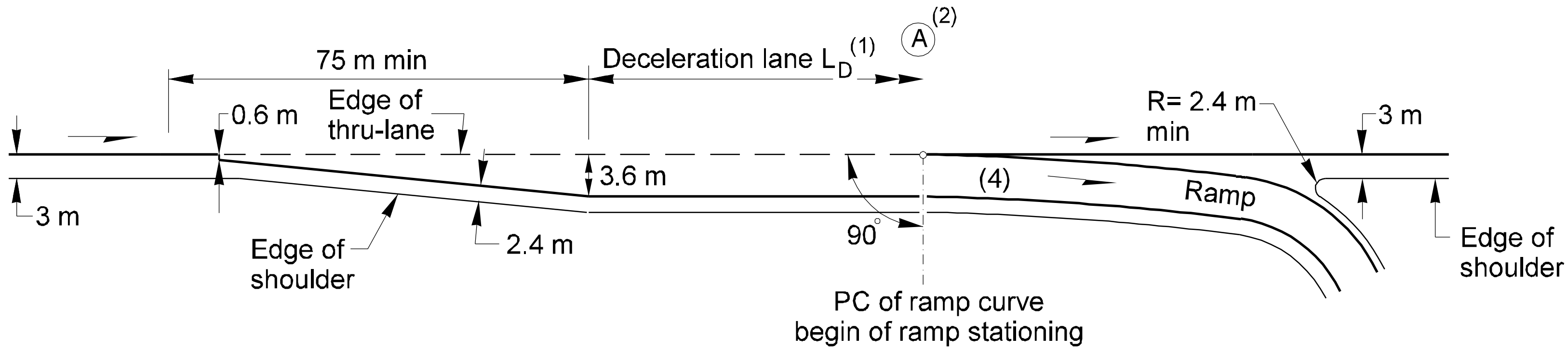
(3) For striping, see the Standard Plans

(4) For ramp lane and shoulder widths, see Figure 940-3.

(5) Approximate angle to establish ramp alignment.

Off-Connection (Single-Lane, Taper Type)

Figure 940-12a



Notes:

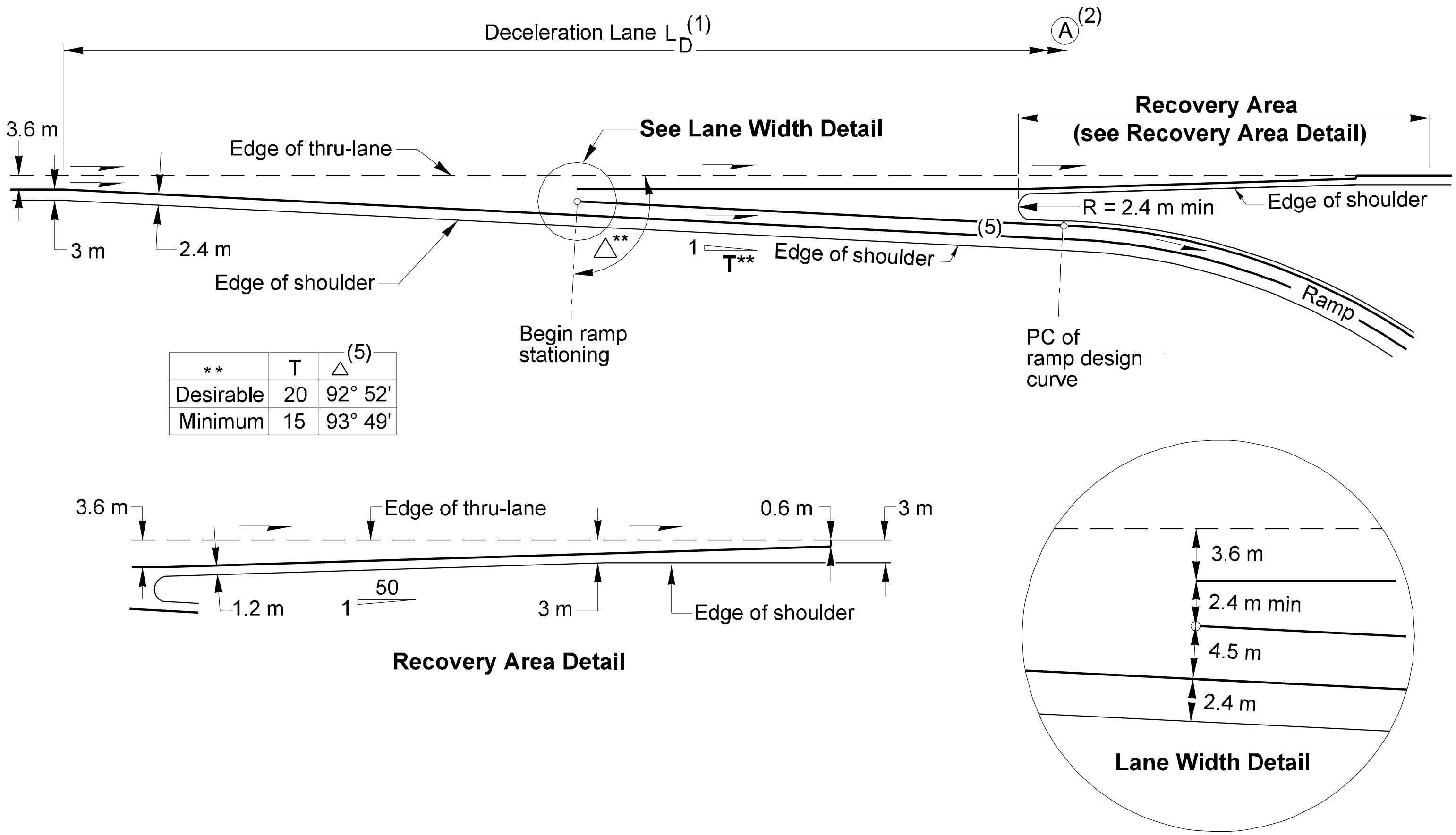
(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point Ⓐ is the point controlling the ramp design speed.

(3) For striping, see the Standard Plans.

(4) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Single Lane, Parallel Type)
Figure 940-12b



**	T	△(5)
Desirable	20	92° 52'
Minimum	15	93° 49'

Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point Ⓐ is the point controlling the ramp design speed.

(3) Auxiliary lane between closely spaced interchanges to be dropped.

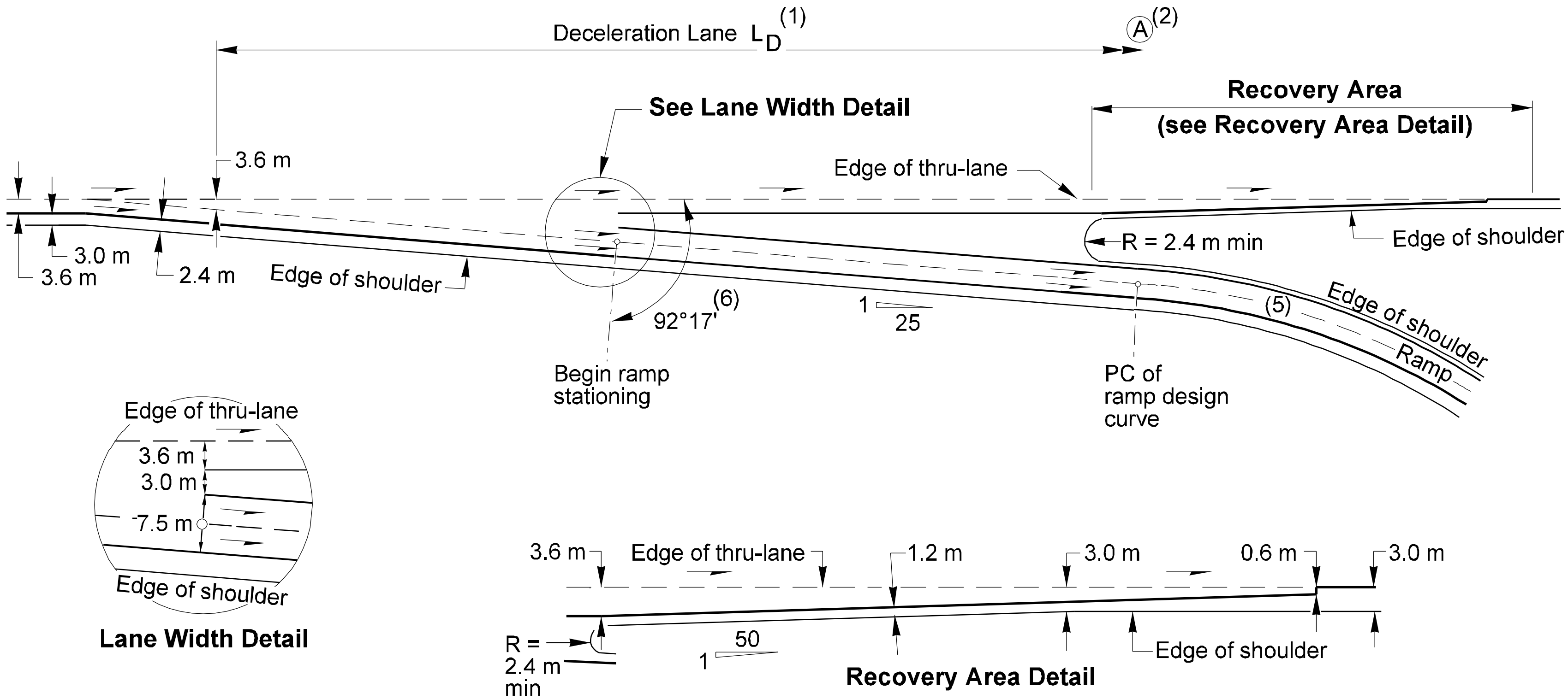
(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

(6) Approximate angle to establish ramp alignment.

Off-Connection (Single-Lane, One-Lane Reduction)

Figure 940-12c



Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point (A) is the point controlling the ramp design speed.

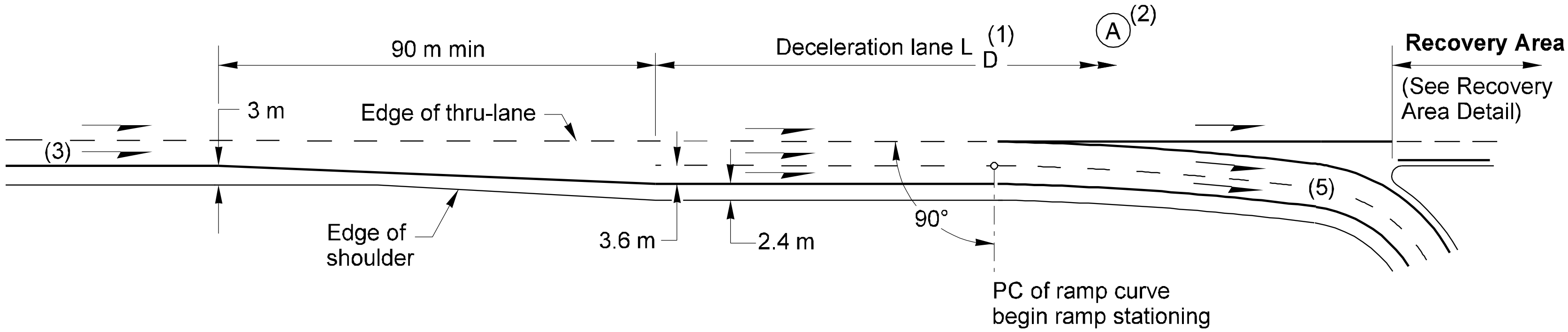
(3) Lane to be dropped or auxiliary lane with a minimum length of 450 m with a 90 m taper.

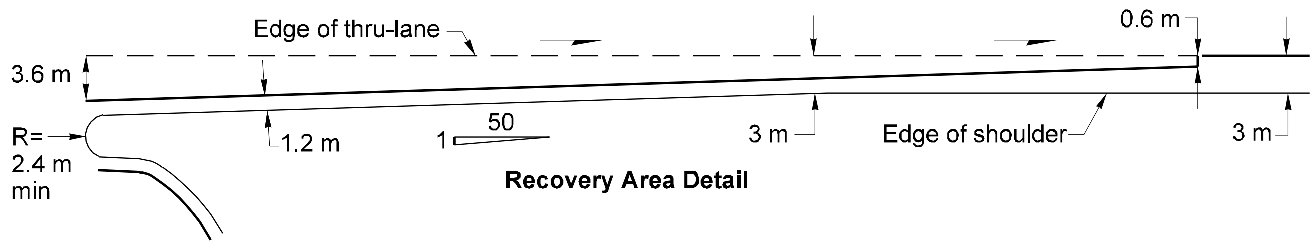
(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

(6) Approximate angle to establish ramp alignment.

Off-Connection (Two-Lane, Taper Type)
Figure 940-12d





Recovery Area Detail

Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point (A) is the point controlling the ramp design speed.

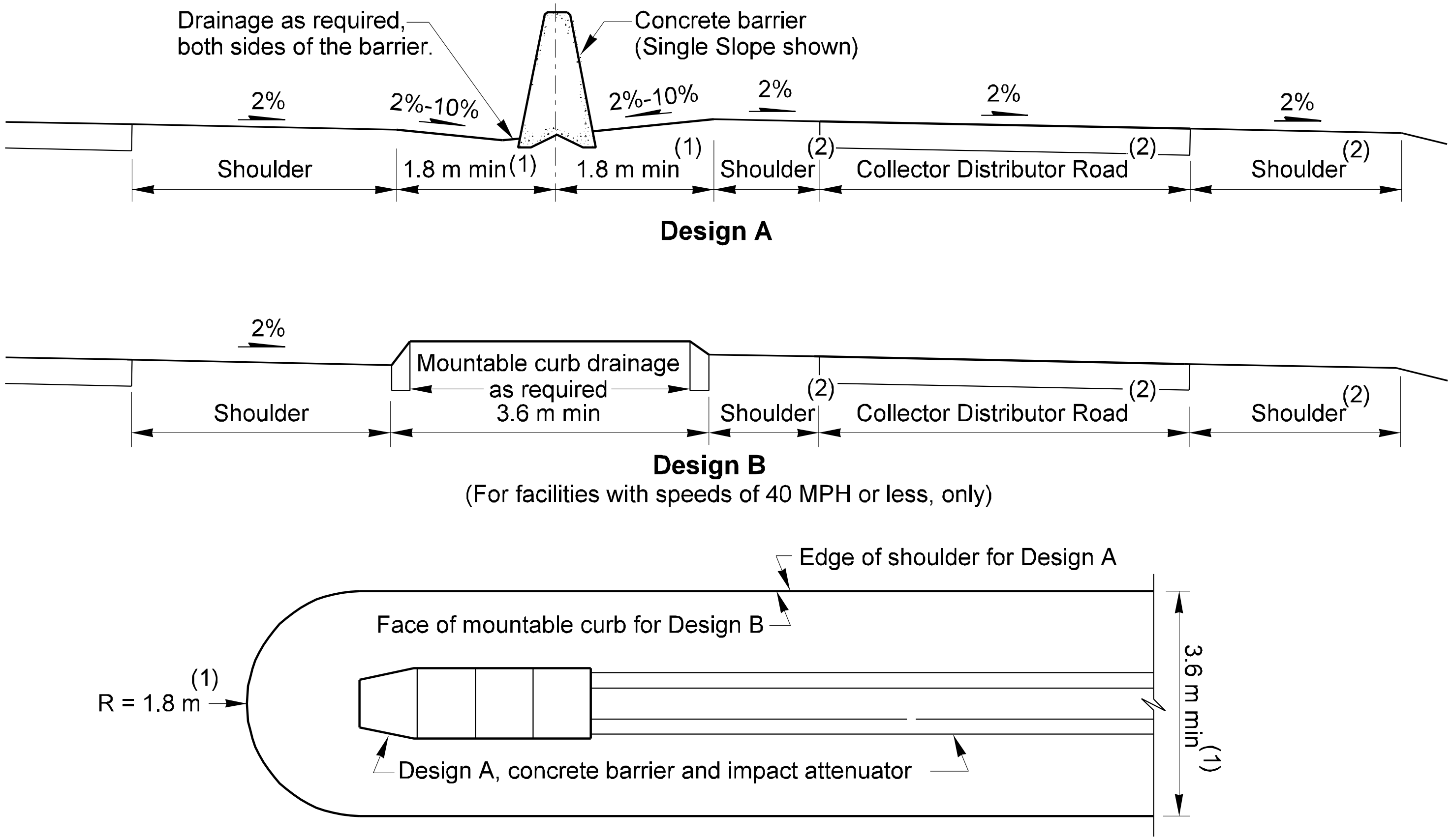
(3) Lane to be dropped or auxiliary lane with a minimum length of 400 m with a 90 m taper.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Two-Lane, Parallel Type)

Figure 940-12e

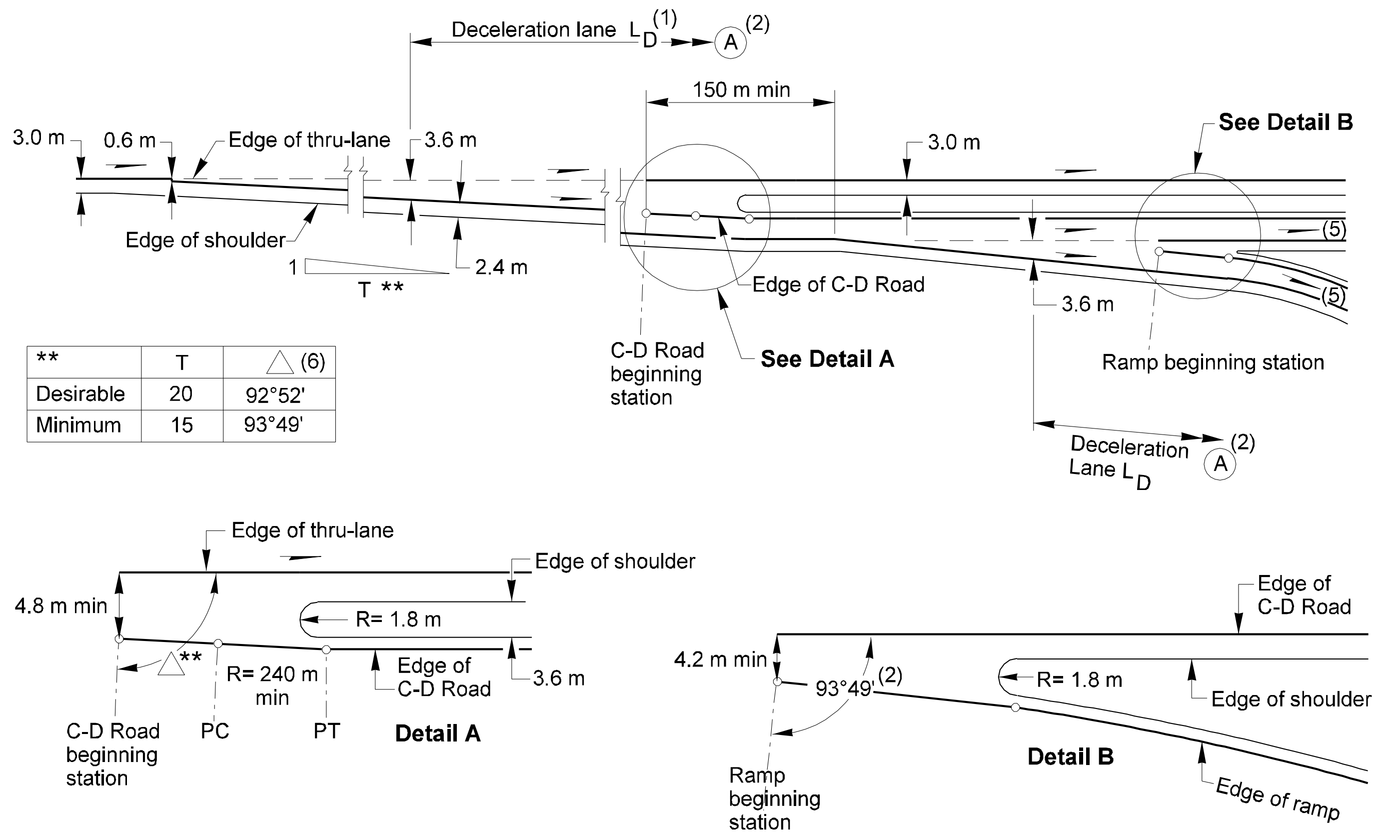


Notes:

(1) With justification, the concrete barrier may be placed with 0.6 m shy distance from the edge of either shoulder to the face of barrier. The minimum width between the edge of through-shoulder and the edge of C-D road shoulder will be reduced to 1.8 m, and the radius at the nose will be reduced to 0.9 m.

(2) For collector distributor road lane and shoulder widths, see ramp lane and shoulder widths, Figure 940-3.

Collector Distributor (Outer Separations)
Figure 940-13a



**	T	△ (6)
Desirable	20	92°52'
Minimum	15	93°49'

Notes:

(1) See Figure 940-10 for deceleration lane length L_D.

(2) Point Ⓐ is the point controlling the ramp design speed.

(3) For striping, see the Standard Plans.

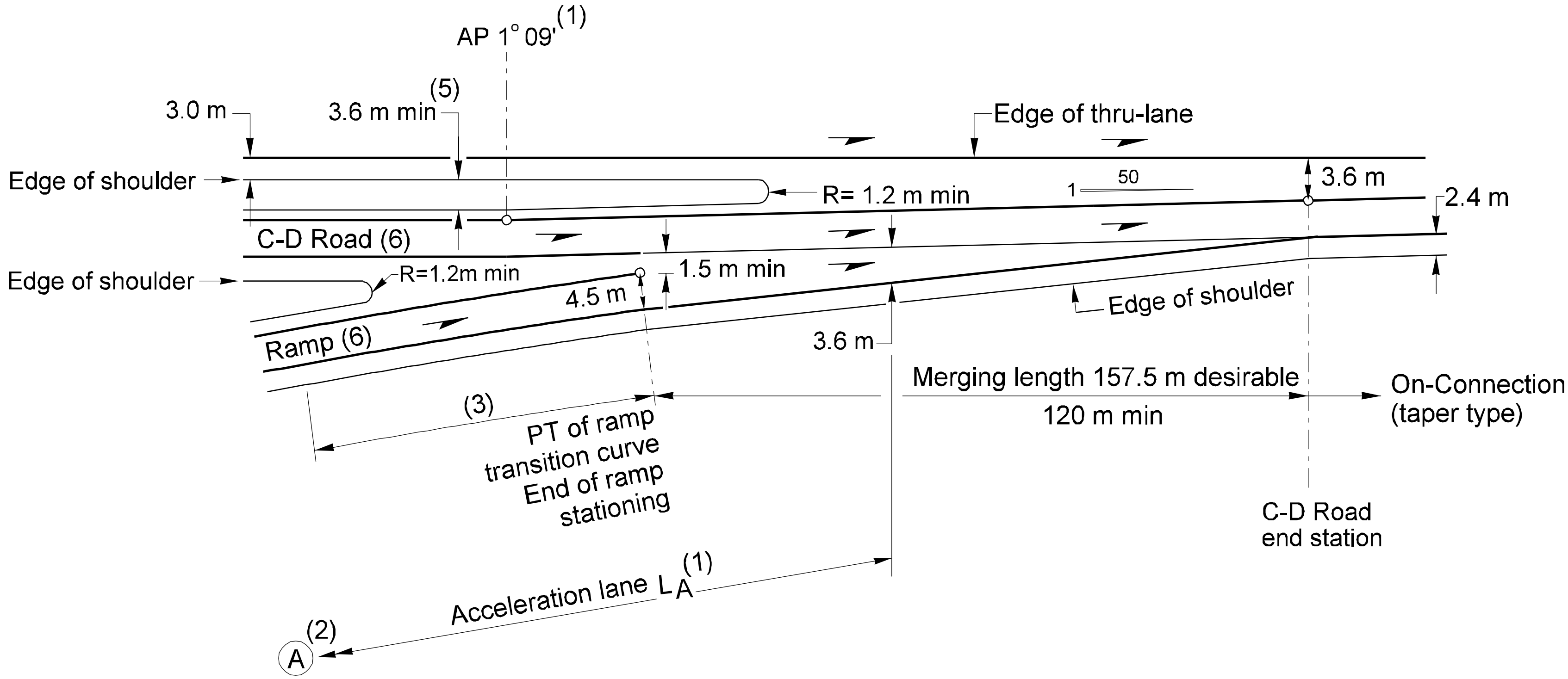
(4) May be reduced to 1.8 m with justification.

(5) For C-D road and ramp lane and shoulder widths, see Figure 940-3.

(6) Approximate angle to establish alignment.

Collector Distributor (Off-Connections)

Figure 940-13b



Notes:

(1) See Figure 940-8 for acceleration lane length L_A.

(2) Point (A) is the point controlling the ramp design speed.

(3) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the left, the transition may vary from a 900 m radius to tangent to the main line.

(4) For striping, see the Standard Plans

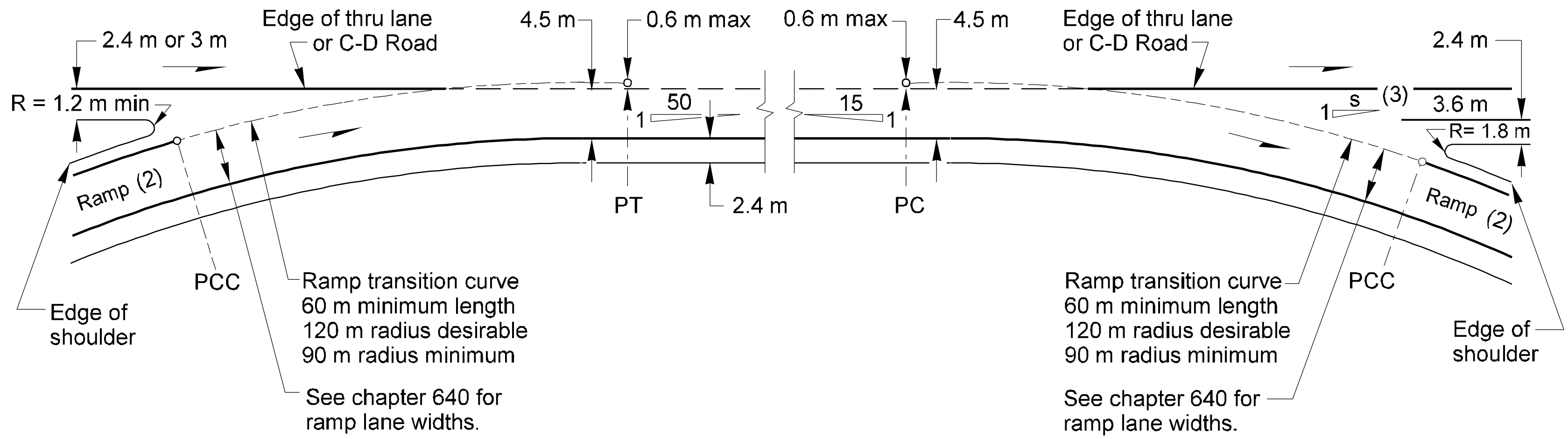
(5) May be reduced to 1.8 m with justification.

(6) For C-D road and ramp lane and shoulder widths, see Figure 940-3.

(7) Approximate angle to establish alignment.

Collector Distributor (On-Connections)

Figure 940-13c



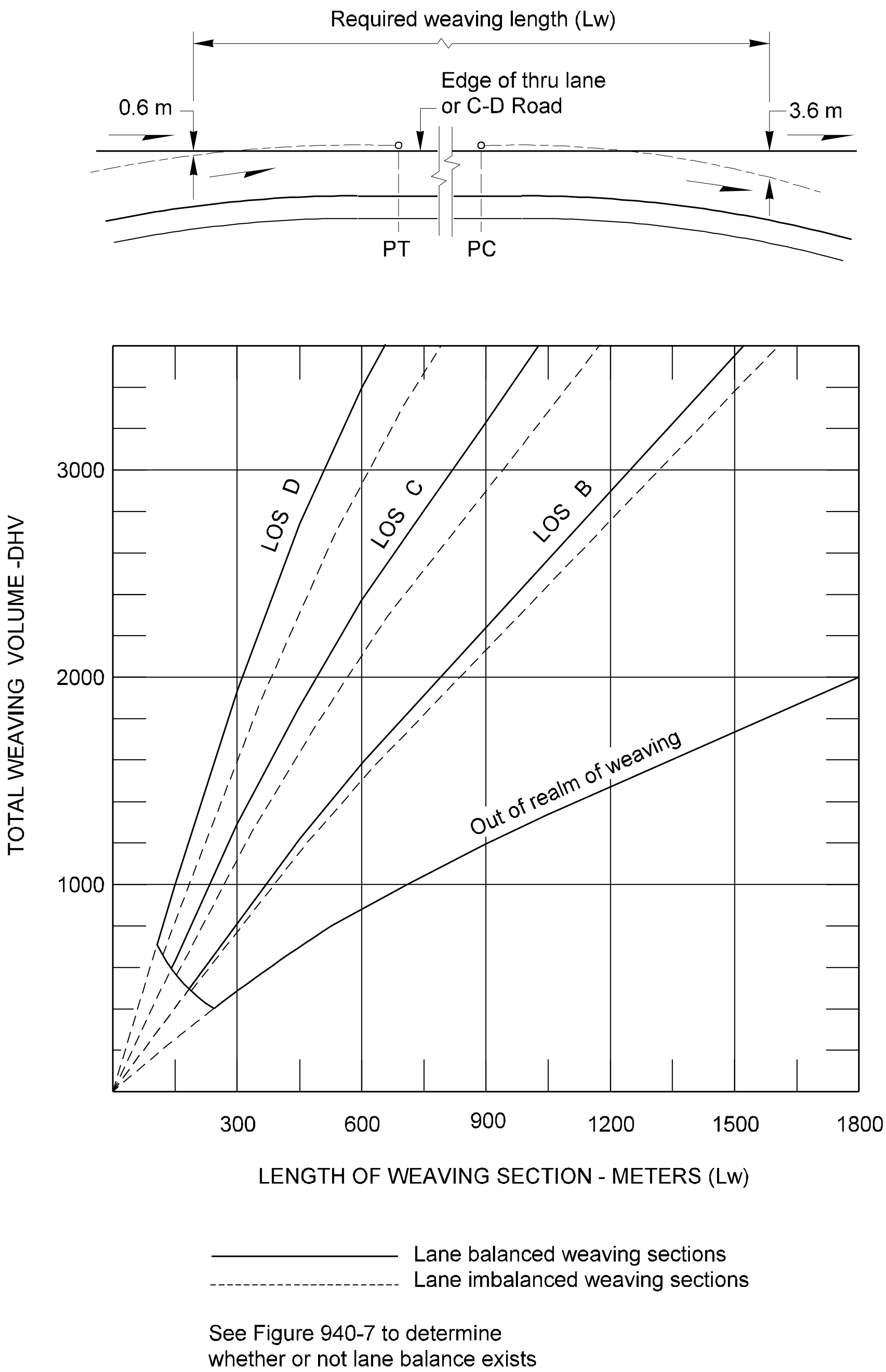
Notes:

(1) See Figure 940-15 for required minimum weaving length.

(2) For minimum ramp lane and shoulder widths, see Figure 940-3.

(3) Accleration taper:
S = 50:1 adjacent to a freeway
S = 40:1 adjacent to a C-D road

Loop Ramps Connections
Figure 940-14



Length of Weaving Sections

Figure 940-15

1040.01 General

Truck weighing facilities are needed to protect state highways from overweight vehicles, to provide for vehicle safety inspection, and to provide a source of data for planning and research. The development, construction, and maintenance of these facilities is a cooperative effort between the Washington State Department of Transportation (WSDOT) and the Washington State Patrol (WSP).

1040.02 Definitions

Commercial Vehicle Information Systems and Networks (CVISN) A network that links intelligent transportation systems (ITS) to share information on commercial vehicles. When in operation at a weigh site it can enable commercial vehicles to clear the facility without stopping.

decision sight distance The sight distance required for a driver to detect an unexpected or difficult-to-perceive information source or hazard, interpret the information, recognize the hazard, and select and complete an appropriate maneuver safely and efficiently.

functional classification The grouping of streets and highways according to the character of the service they are intended to provide. (See Chapter 440.)

frontage road An auxiliary road that is a local road or street located beside a highway for service to abutting property and adjacent areas and for control of access.

lane A strip of roadway used for a single line of vehicles.

median The portion of a divided highway separating the traveled ways for traffic in opposite directions.

outer separation The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road.

roadway The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

sight distance The length of roadway visible to the driver.

shoulder The portion of the roadway contiguous with the traveled way, primarily for accommodation of stopped vehicles, emergency use, lateral support of the traveled way, and use by pedestrians and bicycles.

static scale A scale that requires a vehicle to stop for weighing.

stopping sight distance The sight distance required to safely stop a vehicle traveling at design speed.

traveled way The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

usable shoulder The width of the shoulder that can be used by a vehicle for stopping.

weigh in motion (WIM) A scale facility capable of weighing a vehicle without the vehicle stopping.

1040.03 Planning, Development, and Responsibilities

The WSP works with the WSDOT's Planning and Programming Service Center to develop a prioritized list of weigh facility needs for each biennium. The list includes:

- New permanent facilities
- New portable facilities
- New shoulder sites

- WIM equipment
- Vehicle inspection facilities
- Scale approach slab reconstruction

The WSP provides Program Management a project definition, that includes:

- A statement of need, the purpose of the project, and the type of work
- The general location of the project

Program Management sends this information to the region for preparation of a Project Summary. The region works with the WSP to identify the specific location of the facility, prepares a design decision estimate, and submits it to Program Management.

The region negotiates and the Regional Administrator executes any formal agreements with the WSP required for the design, construction, or maintenance of vehicle weighing and inspection facilities.

The Memorandum of Understanding Related to Vehicle weighing and Equipment Inspection Facilities on State Highways, Figure 1040-8, contains details about the various responsibilities of the WSDOT and the WSP.

1040.04 Permanent Facilities

Permanent truck weighing facilities have permanent scales and may have buildings. When these facilities are in operation, trucks are required stop. However, when Weigh In Motion (WIM) and Commercial Vehicle Information Systems and Networks (CVISN) capabilities have been installed, the driver may be notified to continue without stopping. The notification to continue may be through the use of signs or transponders.

(1) Site Locations

The exact location of a truck weighing facility is generally controlled by topography, highway alignment, and geometrics. It is also desirable to select a site where adequate right of way is already available. Select the most economical site to minimize site preparation, expense, or impact on the environment. Water, electricity availability, and sewage treatment and disposal are other considerations for site selection.

Locate the facility so that its operation will not hinder the operation of the highway or other related features such as intersections and interchanges.

To the extent possible, locate the facility to prevent truck traffic avoiding the facility on other roadways and the type and volume of truck traffic using the highway.

An Access Point Decision Report is required for weigh sites on multilane divided highways with access control. (See Chapter 1425.)

(2) Design Features

On multilane highways, provide standard off- and on-connections, as shown in Chapter 940. Figure 1040-1 is the minimal design of a weigh site on multilane highways.

Design weigh facilities on two-lane highways to best fit the existing conditions, with particular consideration given to the matter of access to and from the site. Standard off- and on-connections, as shown in Chapter 940, are preferred; however, with justification on-connections may be designed as intersections. (See Chapter 910.) Figure 1040-2 is a guide for the design of weigh sites on two-lane highways.

The following special design features apply:

- Level cement concrete approach slabs are required at both ends of the scales.

  Asphalt concrete pavement approach slabs will be allowed only when adequate soil conditions exist, projected truck volume is light, and benefit/cost analysis justifies the use of asphalt concrete pavement based on the small percentage of time the scales will be in operation.

  The approach slabs must be level and in the same plane as the scale.

- Provide adequate parking and storage to ensure that trucks do not impede the mainline through traffic. The WSDOT Regional Administrator and the WSP agree on the area to be provided.

- On multilane divided highways, install illuminated electronically controlled "open" and "closed" message signs that can be operated from the scale house or the control cabinet. Provide permanent signing for the facility, as requested by the WSP.
- The need for a vehicle safety inspection facility at any site is identified by the WSP. Figure 1040-3 is a guide for a site plan for a single bay vehicle inspection facility. Additional bays and site adaptation will be on a site by site basis. The WSDOT Regional Administrator and the WSP agree on the area to be provided.
- The need for some form of approach protective treatment for the scale house or a protective fence between the scale and roadway is identified by the WSP and agreed upon by the WSDOT Regional Administrator and the WSP. The need for the device is to protect the scale house from errant vehicles. See Chapter 700 for additional clear zone considerations.
- The need for WIM or CVISN capabilities is identified by the WSP. Design the in-place facilities to provide the ability to notify drivers whether to continue on or to stop for further investigation before they reach the exit for the static scale. The design is agreed upon by the WSDOT Regional Administrator and the WSP.
- Where WIM and CVISN are not included in the project, provide conduit for their future installation.
- With justification, at locations where space is limited, the depressed outer separation between the weigh facility and the through lanes may be replaced with concrete traffic barrier. (See Collector Distributor Outer Separations, Chapter 940.)
- Provide a clear view of the entire weigh site for the facility's operator and the driver of an approaching vehicle.
- Asphalt concrete pavement is acceptable for use on the ramp and storage areas. Design the depth in accordance with the surfacing report.
- To optimize scale efficiency, make the storage area flat; however, to facilitate drainage, the slope may be up to 2%.
- Provide illumination when requested by the WSP. Illumination is required if the facility is to be operated during the hours of darkness and may be desirable at other locations to deter unauthorized use of the facility. See Chapter 840 for additional information on illumination.

1040.05 Portable Facilities

Portable truck weighing facilities have no permanent scales or buildings. When these facilities are in operation, they operate in the same manner as permanent facilities.

(1) Site Locations

Design portable truck weighing facilities located on two-lane and multilane roadways to best fit the existing conditions. Minor portable scale sites, as shown on Figure 1040-4, are used with two-way traffic and on multilane highways with low traffic volumes. Major portable scale sites, Figure 1040-5, are for use on expressways, freeways, and where traffic volumes are high.

Locate the weighing facility so that its operation will not hinder the operation of the highway or other related features such as an intersection.

An Access Point Decision Report is required for weigh sites on multilane divided highways with access control. (See Chapter 1425.)

(2) Design Features

The following special design features apply:

- Off- and on-connections, as shown in Figures 1040-4 and 5, are preferred; however, with justification on highways with no access control, on-connections may be designed as intersections. (See Chapter 910.)
- With justification, at locations where space is limited, the depressed outer separation between the weigh facility and the through lanes may be replaced with concrete traffic barrier. See the collector distributor outer separation figure in Chapter 940.

- Provide adequate parking and storage to ensure that trucks do not impede the main-line through traffic. The WSDOT Regional Administrator and the WSP agree on the area to be provided.
- Asphalt concrete pavement is acceptable for use on the ramp and storage areas. Design the depth in accordance with the surfacing report.
- To optimize portable scale efficiency, make the storage area flat; however, to facilitate drainage, the slope may be up to 2%.
- Provide permanent signing for the facility, as requested by the WSP.
- Provide illumination when requested by the WSP. Illumination is required if the facility is to be operated during the hours of darkness and may be desirable at other locations to deter unauthorized use of the facility. See Chapter 840 for additional information on illumination.

1040.06 Shoulder Sites

Shoulder sites are used by the WSP to pull a truck over for inspection and weighing with portable scales.

(1) Site Locations

Design shoulder sites to best fit the existing conditions. Small shoulder sites (Figure 1040-6) are for use on lower volume roadways (ADT 5,000 or less) with two-way traffic. Large shoulder sites (Figure 1040-7) are to be used with higher volume two-way roadways and multilane highways.

Locate the weighing facility so that its operation will not hinder the operation of the highway or other related features such as an intersection.

(2) Design Features

Shoulder sites are designed in coordination with the WSP. Input from the local WSP Commercial Vehicle Enforcement personnel will ensure that the proposed site will meet their needs without over-building the facility. Obtain written concurrence from the WSP for the length, width, and taper rates before the design is finalized.

When the ADT is 1,500 or less and with the written approval of the WSP, the tapers at small shoulder sites may be eliminated. The shoulders on either side of the site may be used as acceleration and deceleration lanes, whether or not they were designed for this use. Therefore, provide adequate strength to support truck traffic.

Asphalt concrete pavement is acceptable for use on all shoulder sites. Design the depth in accordance with the surfacing report. Design the shoulder pavement at this depth for a length not less than the deceleration lane length before, and the acceleration lane length after, the site (Chapter 940).

When the shoulders are designed to be used for deceleration and acceleration lanes, the minimum width is 3.6 m with full pavement depth for the deceleration/acceleration lane lengths (Chapter 940).

Use a maximum of 2% slope in order to optimize portable scale efficiency and to facilitate drainage.

1040.07 Federal Participation

Federal funds appropriate to the system being improved may be used for the acquisition of right of way and the construction of truck weighing facilities and vehicle inspection facilities. This includes, but is not limited to on and off ramps, deceleration and acceleration lanes, passing lanes, driveways, parking areas, scale approach slabs, vehicle inspection facilities, roadway illumination, and signing.

1040.08 Procedures

Prepare site plans for all truck weigh facilities that include:

- Class of highway and design speed for main line (Chapter 440).
- Curve data on main line and weigh site.
- Numbers of lanes and widths of lanes and shoulders on main line and weigh site.
- Superelevation diagrams for the main line and weigh site.
- Stationing of ramp connections and channelization.

- Illumination.
- Signing.
- Water supply and sewage treatment.
- Roadside development.

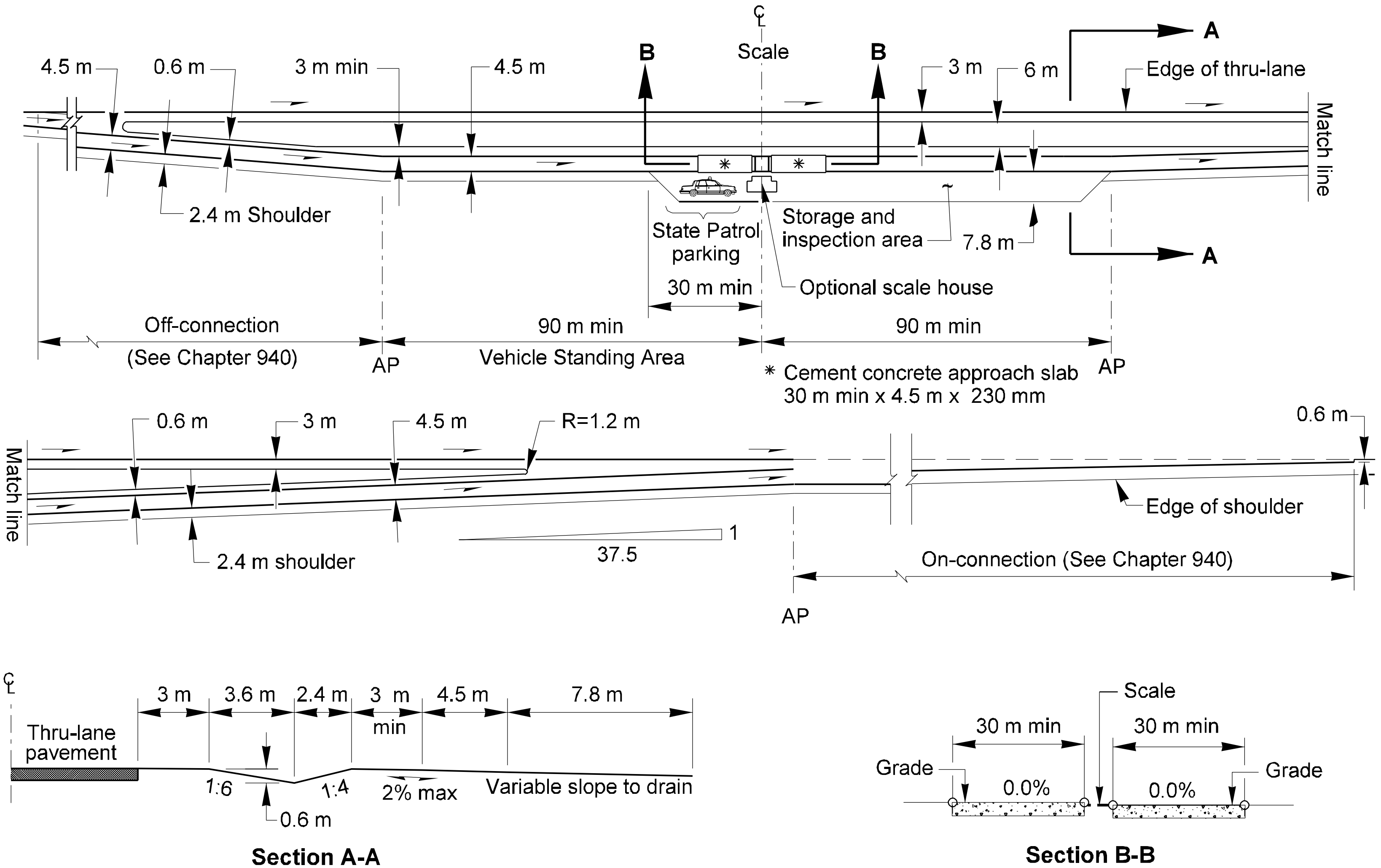
Get WSP approval of the site plans before the final plan approval.

1040.09 Documentation

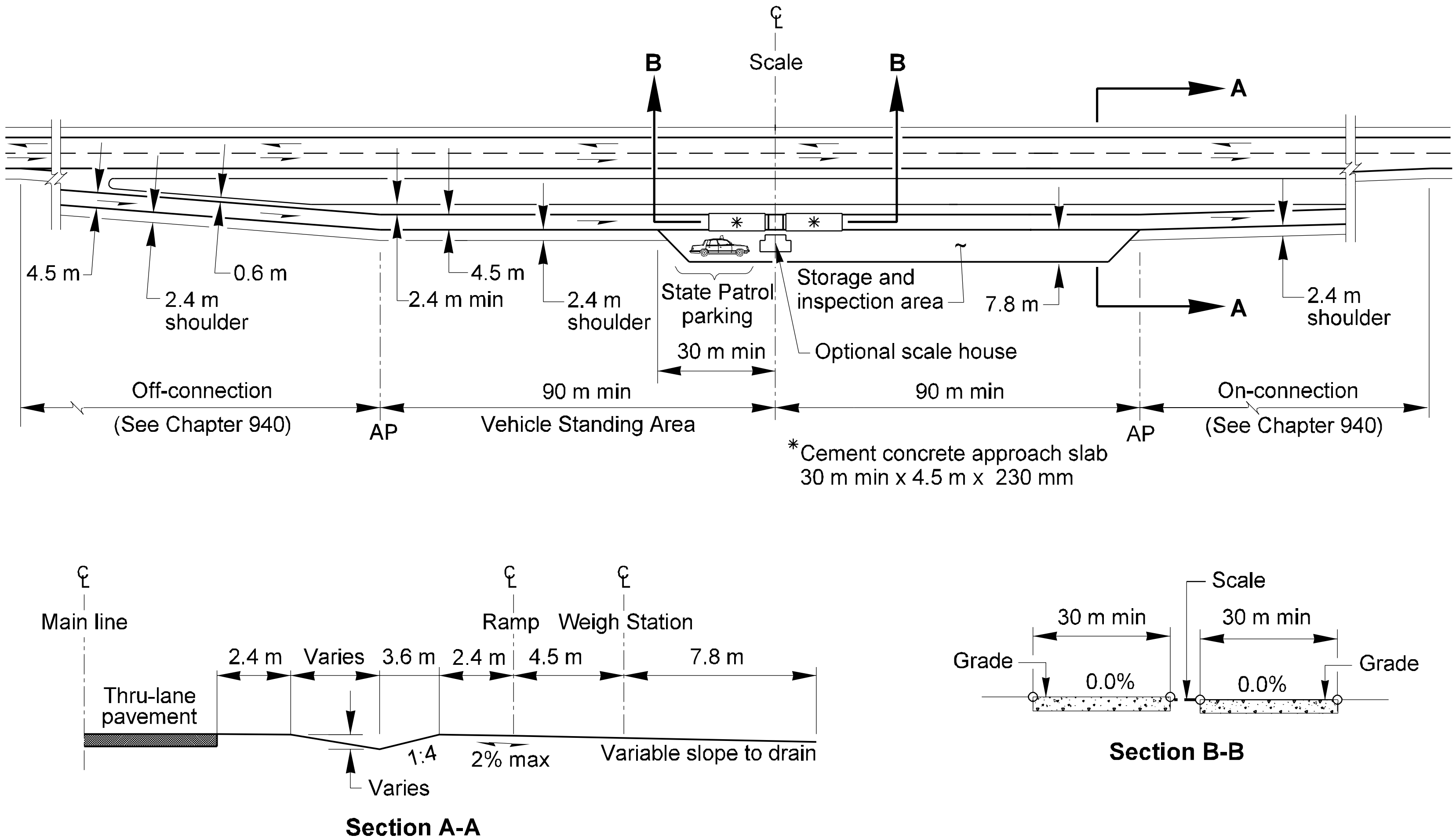
The following documents are to be preserved in the project file. See Chapter 330.

- ☐ Truck weigh facilities site plans.
- ☐ All correspondence with the WSP.
- ☐ Access Point Decision Report (Chapter 1425).
- ☐ Justification for any on-connection designed as an intersection.
- ☐ Justification for the use of concrete traffic barrier at the outer separation.

P65:DP/DMM

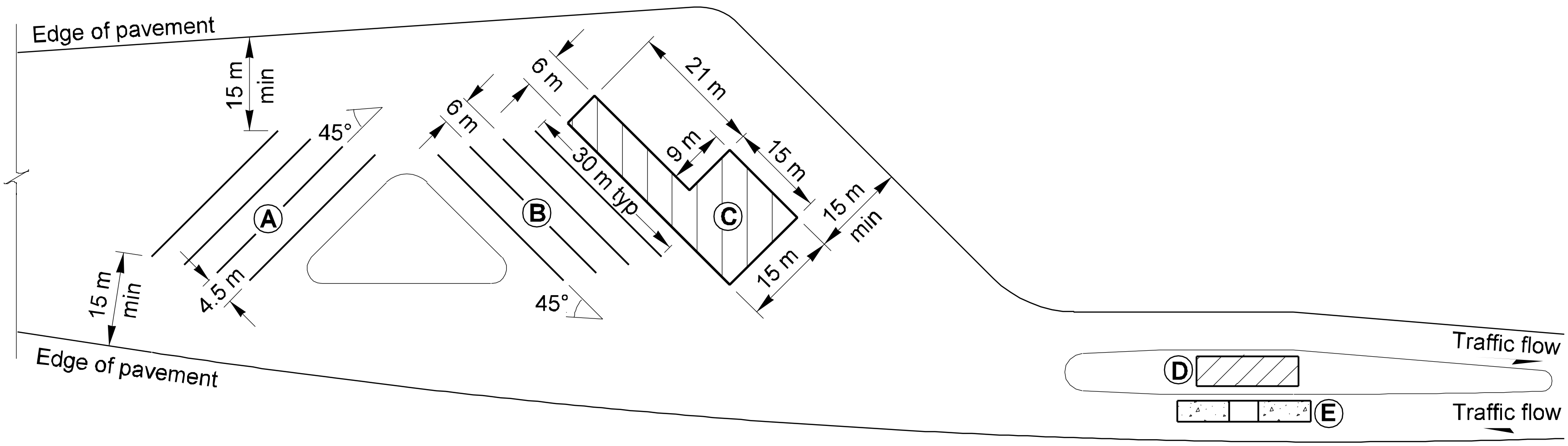


Truck Weigh Site (Multilane Highways)
Figure 1040-1



Truck Weigh Site (Two Lane Highways)

Figure 1040-2



Ⓐ Truck storage and parking

Ⓑ Outside truck inspection and parking

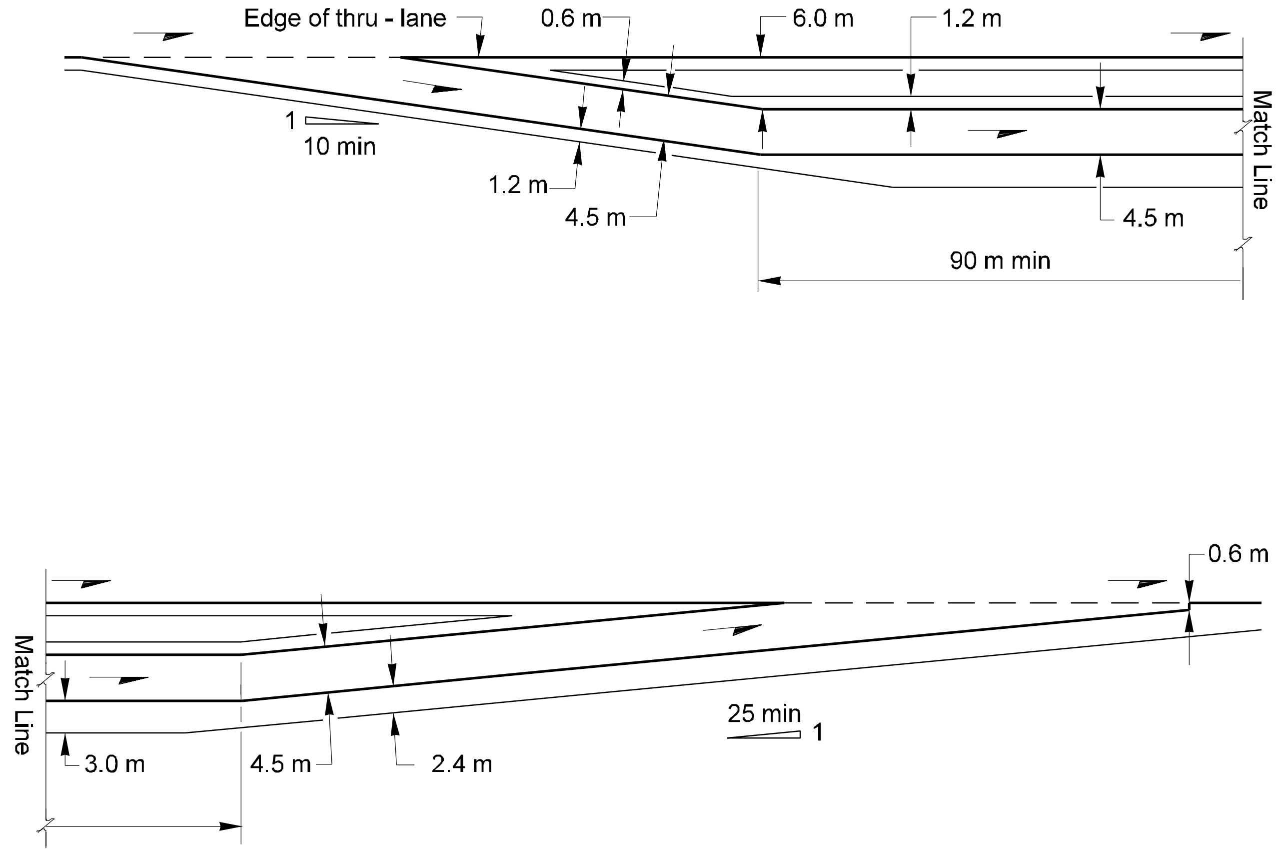
Ⓒ Truck inspection building

Ⓓ Scalehouse

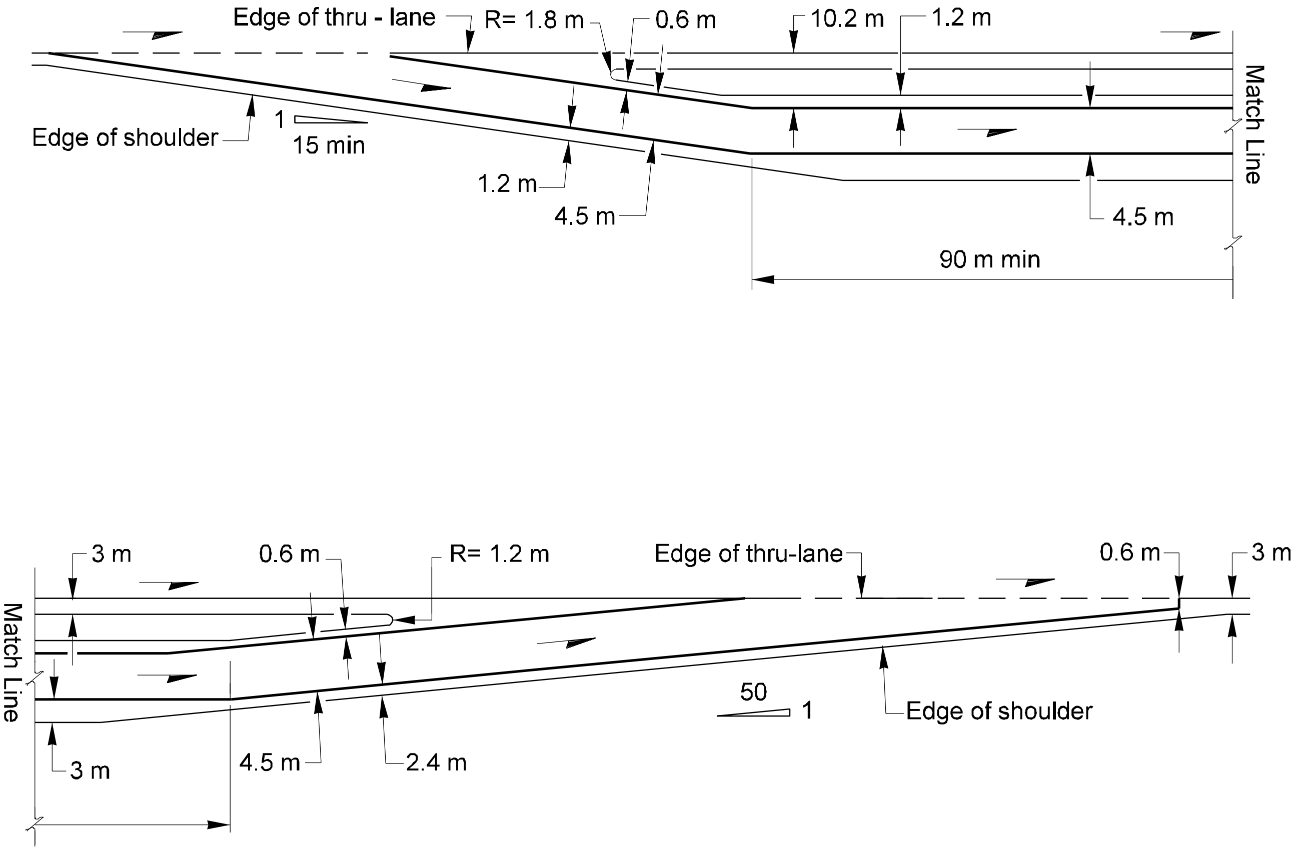
Ⓔ Scale

Vehicle Inspection Installation

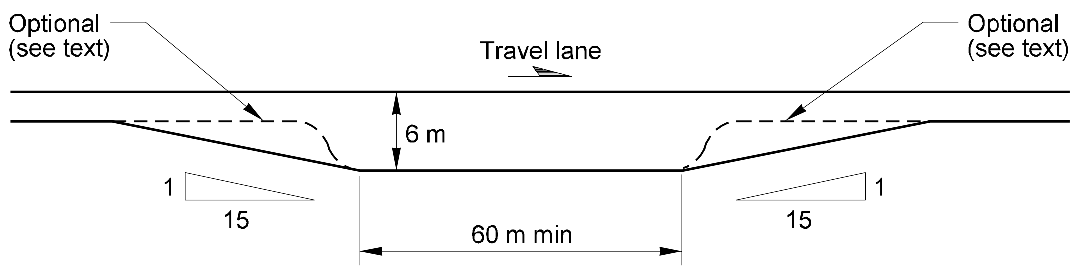
Figure 1040-3



Minor Portable Scale Site
Figure 1040-4



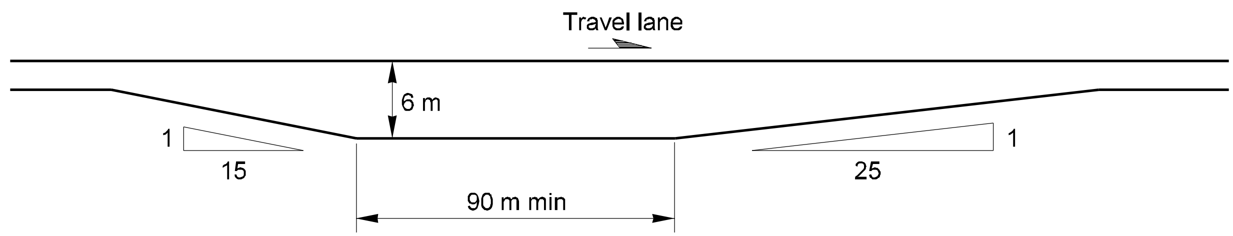
Major Portable Scale Site
Figure 1040-5



Length to be established by agreement with the WSP, but not less than 60 m.

Small Shoulder Site

Figure 1040-6



Large Shoulder Site
Figure 1040-7

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Memorandum of Understanding

Related to Vehicle Weighing and
Equipment Inspection Facilities on State Highways

This Memorandum of Understanding by and between the Washington State Department of Transportation hereinafter called the "Department of Transportation," and the Washington State Patrol, hereinafter called the "State Patrol," establishes procedures for coordinating and delineating the responsibilities for the location, design, construction, maintenance, signing, and other matters related to vehicle weighing and equipment inspection facilities and the state highway improvements needed as a result of these facilities.

It is mutually recognized that:

The Department of Transportation is responsible for planning, designing, constructing, and perpetuating public highways of the State Highway system for the safety and benefit of the traveling public;

The State Patrol is responsible for enforcement of the laws of the state of Washington regarding vehicle weight enforcement programs and vehicle safety inspection programs;

Nothing in this agreement is to be construed as conflicting with existing laws, regulations, and prescribed responsibilities, and

In recognition of the responsibilities, interest, and limitations set forth above and of the mutual benefits of established procedures to facilitate agreement on specific matters, the Department of Transportation and the State Patrol mutually agree as follows:

I. Planning

A. The State Patrol will work with the Department of Transportation's Planning and Programming Service Center to develop a prioritized list of weigh station needs at each biennium. The list will include:

- New permanent facilities
- New portable facilities
- Weigh-in-Motion (WIM) equipment
- Vehicle inspection facilities
- Scale approach slab construction

B. The State Patrol will provide the Planning and Programming Service Center with a project definition for each project, which will include statement of need, purpose of project, type of work, and general location of the project.

C. The Planning and Programming Center will send the information to the Regional Administrator for preparation of a project summary. The Regional Administrator will work with the State Patrol to identify the specific location of the facility, prepare a design decision estimate, and submit it to the Planning and Programming Service Center for inclusion in the biennial program.

D. The Regional Administrator will negotiate and execute any formal agreements required for design, construction, or maintenance of vehicle weighing and inspection sites.

MOU Related to Vehicle Weighing and Equipment Inspection Facilities on State Highways

Figure 1040-8a

C990477GSC

II. Responsibilities

Vehicle weighing and equipment inspection facilities shall meet highway standards for acceleration and deceleration lanes, on and off ramps, illumination, and other related equipment. These facilities will be provided through the cooperative efforts of the State Patrol and Department of Transportation as needed on state highways.

A. The State Patrol will:

1. Initiate the action and submit recommendations for the addition of a new facility or expansion of an existing facility or the relocation of an existing facility, and negotiate agreements, e.g. siting of a new facility, etc. with the Department of Transportation through the appropriate region and the Olympia Service Center.

2. Perform the preliminary engineering and submit the design and PS&E documents for the scale, WIM, scalehouse, and inspection facility to the Department of Transportation for review and processing for approval with the Federal Highway Administration (FHWA), if applicable, at the State Patrol's expense.

3. Construct, operate, and maintain the weigh station scale, WIM, scalehouse, and equipment inspection facility with all related equipment thereto including lighting, water, heat, telephone, and toilet facilities at the State Patrol's expense.

4. For WIM facilities and for facilities deploying Commercial Vehicle Information Systems and Networks (CVISN), select sites in cooperation with DOT that minimize the need for pavement reconstruction, and, at the State Patrol's expense, install, operate, and maintain any weigh-in-motion signs and related equipment, purchase and install all WIM hardware and software, and provide electrical conduit and an equipment storage room within the scale facility.

5. In the event the State Patrol cannot fulfill the responsibilities specified above for preliminary engineering (design and PS&E documents), construction, or maintenance, they may request that the Department of Transportation perform the work on the basis of a written agreement that includes reimbursement to the Department of Transportation for the costs.

6. Construct the CVISN roadside apparatus at the same time as WIM equipment is installed, e.g.; cantilevered mounting poles, guard rail, conduit/raceway installation at DOT expense. All construction in the state or interstate right-of-way will be under the responsibility of a DOT region engineer.

B. The Department of Transportation will:

1. Initiate action for the relocation of an existing installation when necessary because of the relocation of a highway or expansion of an existing highway, and obtain concurrence of the State Patrol.

2. Negotiate agreements with the State Patrol regarding addition, expansion, and relocation of facilities.

MOU Related to Vehicle Weighing and Equipment Inspection Facilities on State Highways

Figure 1040-8b

C990477GSC

3. On all newly located or existing highways, at Department of Transportation expense, acquire the necessary right of way, construct and maintain the required acceleration and deceleration lanes, on and off ramps, driveways, passing lanes, scale approach slabs, and parking areas, including the surfacing thereof, excavate the scale pit, and construct and maintain the inspection, parking, and roadway illumination and standard signing at approved locations.

4. For WIM facilities and for facilities deploying Commercial Vehicle Information Systems and Networks (CVISN), at Department of Transportation's expense, construct the special approaches, provide maintenance of CVISN hardware and software located within the facility, and provide traffic control for installation of the scale and, when closure of any lane is required, for maintenance of the scale.

5. For facilities deploying Commercial Vehicle Information Systems and Networks (CVISN), at WSDOT's expense install mainline hardware (Automated Vehicle Identification equipment) and software for conformance with CVISN standards and provide maintenance of CVISN hardware and software located within the facility.

6. Upon request of the State Patrol, in accordance with a written agreement and on a reimbursement basis, perform other preliminary engineering, construction, and maintenance, which is the sole responsibility of the State Patrol.

Additionally, the State Patrol and the Department of Transportation agree to follow the Federal Highway Administration's *Guidance for Local Agency Roadway Projects within Interstate Rights-of-Way*, as outlined in Attachment A.

III. Conclusions and Approvals

A. The Regional Administrators for the Department of Transportation and the Commercial Vehicle Division Commander for the State Patrol are encouraged to consult with each other and to agree on such matters that fall within their scope of responsibility.

B. This memorandum may be amended or supplemented by mutual agreement between the signers or their successors.

C. Either party may terminate this MOU upon thirty- (30) days' written notification. If this MOU is so terminated, the terminating party shall be liable only for performance in accordance with the terms of the MOU for performance rendered prior to the effective date of the termination.

D. In the event a dispute arises under this MOU, it shall be resolved as follows: The Secretary of WSDOT and the Chief of the WSP shall each appoint a member, not affiliated with either agency, to a conflict resolution board. Then these two members shall appoint a third member. The decision made by this board shall be final and binding on the parties to the MOU.

E. In the event funding from state, federal, or other sources is withdrawn, reduced, or limited in any way after the effective date of this MOU and prior to normal completion, the WSDOT or WSP may terminate the MOU under the TERMINATION clause, subject to renegotiation under those new funding limitations and conditions.

MOU Related to Vehicle Weighing and Equipment Inspection Facilities on State Highways

Figure 1040-8c

C990477GSC

F. We have read the foregoing and agree to accept and abide by the procedures herein.

Annette M. Sandberg, Chief
Washington State Patrol

Date 12/16/99

Sid Morrison, Secretary
Washington State
Department of Transportation

Date 3/9/00

APPROVED AS TO FORM:

Assistant Attorney General

Date 9/7/99

Washington State Patrol
Budget and Fiscal Services

Date 12/27/99

MOU Related to Vehicle Weighing and Equipment Inspection Facilities on State Highways
Figure 1040-8d

C99047/CSC

ATTACHMENT A
Guidance for Local Agency Roadway Projects within Interstate Rights-of-Way

Since all projects within the Interstate rights-of-way (ROW) have the potential to impact safety and operations on the Interstate route, they must incorporate Interstate design criteria and construction quality. It is the Federal Highway Administration's (FHWA) policy that the Washington State Department of Transportation (WSDOT) should administer all projects within the Interstate ROW. However, given the scope and extent of non-Interstate projects within the Interstate ROW, it is recognized that local agency administration of some projects may be desirable.

Whenever a local agency proposes a project within the Interstate ROW, they must develop an agreement with WSDOT that clearly outlines their duties and responsibilities to maintain the integrity of the Interstate facility, from both the safety and quality perspectives. The agreement must be executed prior to beginning design and must incorporate the following requirements:

Responsibilities: WSDOT and the local agency must each assign a responsible Project Engineer.

Design: WSDOT must review and approve all highway plans, profiles, deviations structural plans false-work plans, shoring plans, and traffic control plans for any work within the Interstate ROW.

Plans, specification and estimates: WSDOT must review and approve the plans and specifications for any work within Interstate ROW.

Advertising and aware: The local agency must confer with the WSDOT Project Engineer on any pre-aware issues affecting the quality and timing of the contract.

Construction: All construction, materials, and quality control requirements contained in the current editions of the WSDOT Standard Specifications and Construction Manual must be incorporated into the agreement.

Contract changes: All contract changes affecting work within the Interstate ROW must have the prior concurrence of the WSDOT Project Engineer.

Final inspection: The final inspection of the project must be performed by WSDOT Olympia Service Center and must evidence their approval.

Only local agencies with full certification acceptance authority may enter into such an agreement with the WSDOT.

The agreement must be submitted to FHWA for approval. FHWA reserves the right to assume full oversight of the project.

MOU Related to Vehicle Weighing and Equipment Inspection Facilities on State Highways
Figure 1040-8e

1120 Bridges

1120.01 General

A bridge is a structure having a clear span of 6.1 m or more. Bridge design is the responsibility of the Bridge and Structures Office in Olympia. A project file is required for all bridge construction projects. The Bridge Office develops a preliminary bridge plan for a new or modified structure in collaboration with the region. This chapter provides basic design considerations for the development of this plan. Unique staging requirements, constructibility issues, and other considerations are addressed during the development of this plan. Contact the Bridge Office early in the planning stage on issues that might affect the planned project.

1120.02 References

Bridge Design Manual, M 23-50, WSDOT

Local Agency Guidelines, M 36-63, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, Washington DC, 1988, including the Washington State Modifications to the MUTCD, M 24-01, WSDOT, 1996

Traffic Manual, M 51-02, WSDOT

1120.03 Bridge Location

Bridges are located to conform to the alignment of the highway. Providing the following conditions can simplify design efforts, minimize construction activities, and reduce structure costs:

- A perpendicular crossing
- The minimum required horizontal and vertical clearances
- A constant bridge width (without tapered sections)
- A tangential approach alignment of sufficient length to not require superelevation on the bridge
- A crest vertical curve profile that will facilitate drainage
- An adequate construction staging area

1120.04 Bridge Site Design Elements

(1) Structural Capacity

The structural capacity of a bridge is a measure of the structure's ability to carry vehicle loads. For new bridges, the bridge designer chooses the design load that determines the structural capacity. For existing bridges, the structural capacity is calculated to determine the "load rating" of the bridge. The load rating is used to determine whether or not a bridge is "posted" for legal weight vehicles or if the bridge is "restricted" for overweight permit vehicles.

(a) **New Structures.** All new structures <u>that carry vehicular loads are</u> designed to HL-93 notional live load in accordance with AASHTO LRFD Bridge Design Specifications or HS-25 live loading in accordance with the AASHTO Standard Specifications for Highway Bridges.

(b) **Existing Structures.** When the Structural Capacity column of a Design Matrix applies to the project, request a Structural Capacity Report from the Risk Reduction Engineer in the Bridge and Structures Office at mail stop 47341. The report will state:

- The structural capacity status of the structures within the project limits.
- What action, if any, is appropriate.
- Whether a deficient bridge is included in the six-year or 20 year plans for replacement or rehabilitation under the P<u>2</u> program and, if so, in which biennium the P<u>2</u> project is likely to be funded.

Include the Structural Capacity Report in the design file.

The considerations used to evaluate the structural capacity of a bridge are as follows:

1. On National Highway System (NHS) routes (including Interstate routes):

- Operating load rating is at least 33 tonnes (which is equal to HS-20).
- The bridge is not permanently posted for legal weight vehicles.
- The bridge is not permanently restricted for vehicles requiring overweight permits.

2. On non-NHS routes:

- The bridge is not permanently posted for legal weight vehicles.
- The bridge is not permanently restricted for vehicles requiring overweight permits.

(2) Bridge Widths for Structures

(a) **New Structures.** Full design level widths are provided on all new structures. See Chapter 440. All structures on city or county routes crossing over a state highway must conform to the Local Agency Guidelines. Use local city or county adopted and applied standards when their minimums exceed state criteria.

(b) **Existing Structures.** See the design matrices in Chapter 325 for guidance.

(3) Horizontal Clearance

Horizontal clearance for structures is the distance from the edge of the traveled way to bridge piers and abutments, bridge rail ends, or bridge end embankment slopes. Minimum distances for this clearance vary depending on the type of structure. The Bridge Design Manual provides guidance on horizontal clearance.

(4) Medians

For multilane highways, the minimum median widths for new bridges are as shown in Chapters 430 and 440. An open area between two bridges is undesirable when the two roadways are separated by a median width of 7.9 m or less. The preferred treatment is to provide a new, single structure that spans the area between the roadways. When this is impractical, consider widening the two bridges on the median sides to reduce the open area to 150 mm. When neither option is practical, consider installing netting or other elements to enclose the area between the bridges. Consideration and analysis of all site factors are necessary if installation of netting or other elements is proposed. Document this evaluation in the project file and obtain the approval of the State Design Engineer.

(5) Vertical Clearance

Vertical clearance is the critical height under a structure that will safely accommodate vehicular and rail traffic based on its design characteristics. This height is the least height available from the lower roadway surface (including useable shoulders), or the plane of the railroad tracks, to the bottom of the bridge. Usable shoulders are the design shoulders for the roadway and do not include paved widened areas that may exist under the structure.

(a) **Minimum Vertical Clearance.** For new structures, the minimum vertical clearances are as follows:

1. A bridge over a roadway. The minimum vertical clearance is 5.0 m.

2. A bridge over a railroad track. The minimum vertical clearance is 7.2 m. Vertical clearance is provided for the width of the railroad freight car. (See Figure 1120-1a.)

3. A pedestrian bridge over a roadway. The minimum vertical clearance is 5.3 m.

(b) **Vertical Clearance for Existing Structures.** The criteria used to evaluate the vertical clearance of existing structures depends on the work that is being done on or under that structure.

1. For a project that will widen a structure over a highway or where the highway will be widened under a structure, evaluate the vertical clearance using the criteria for a new structure. With an approved deviation, the vertical clearance of these structures can be as little as 4.9 m on the Interstate System (see 1120.04 (5) (d), Coordination) or 4.7 m on non-Interstate highways.

2. For a project at an existing bridge where no widening is proposed on or under the structure, the bridge may remain in place if at least 4.4 m of vertical clearance is provided.

3. For a planned resurfacing of the highway under an existing bridge, if the clearance will be less than the minimum vertical clearance for a new bridge, consider:

- Pavement removal and replacement
- Roadway excavation and reconstruction to lower the profile of the roadway
- Providing a new bridge with the required vertical clearance

Reducing roadway paving and surfacing thickness under the bridge to achieve the minimum vertical clearance can cause accelerated deterioration of the highway and is not allowed. Elimination of the planned resurfacing in the immediate area of the bridge might be a short term solution if recommended by the region's Materials Engineer.

4. For an existing structure over a railroad track, the vertical clearance can be as little as 6.9 m with an approved deviation. (See Figure 1120-1b.) A lesser clearance can be used with the agreement of the railroad company and the Washington State Utilities and Transportation Commission.

(c) **Signing.** Low clearance warning signs are necessary when the vertical clearance of an existing bridge is less than 4.6 m. Other requirements for low clearance signing are contained in the Manual on Uniform Traffic Control Devices and the Traffic Manual.

(d) **Coordination.** The Interstate system is used by the Department of Defense (DOD) for the conveyance of military traffic. The Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) represents the DOD in public highway matters. The MTMCTEA has an inventory of vertical clearance deficiencies over the Interstate system in Washington State. Contact the MTMCTEA, through FHWA, if any of the following changes are proposed to these bridges:

- A project would create a new deficiency of less than 4.9 m vertical clearance over an Interstate highway.
- The vertical clearance over the Interstate is already deficient (less than 4.9 m) and a change (increase or decrease) to vertical clearance is proposed.

Coordination with MTMCTEA is required for these changes on all rural Interstate highways and for one Interstate route through each urban area.

(6) Bridge Approach Slab

Bridge approach slabs are reinforced concrete pavement installed across the full width of the bridge ends. They provide a stable transition from normal roadway cross section to the bridge ends and compensate for differential expansion and contraction of the bridge and the roadway. Bridge approach slabs are provided on all new bridges. If an existing bridge is being widened and it has an approach slab, slabs are required on the widenings. The region, with the concurrence of the State Geotechnical Engineer and the State Bridge Engineer, may decide to omit bridge approach slabs.

(7) Pedestrian and Bicycle Facilities

Accommodations for pedestrians and bicycles on bridges are addressed in Chapter 1020.

(8) Bridge Rail End Treatment

Plans for new bridge construction and bridge rail modifications include provisions for the connection of traffic barriers to the bridge rail. Indicate the preferred traffic barrier type and connection during the review of the bridge preliminary plan.

(9) Bridge Slope Protection

Slope protection provides a protective and aesthetic surface for exposed slopes under bridges. Slope protection is normally provided under:

- Structures over state highways
- Structures within an interchange
- Structures over other public roads unless requested otherwise by the public agency

- Railroad overcrossings, if requested by the railroad

Slope protection is usually not provided under pedestrian structures. The type of slope protection is selected at the bridge preliminary plan stage. Typical slope protection types are concrete slope protection, semi-open concrete masonry, and rubble stone.

(10) Slope Protection at Watercrossings

The Olympia Service Center (OSC) Hydraulics Branch determines the slope protection requirements for structures that cross waterways. The type, limits, and quantity of the slope protection are shown on the bridge preliminary plan.

(11) Protective Screening for Highway Structures

The Washington State Patrol classifies the throwing of an object from a highway structure as an assault, not an accident. Therefore, records of these assaults are not contained in the Patrol's accident databases. Contact the region's Maintenance Engineer's office and the Washington State Patrol for the history of reported incidents.

Protective screening might reduce the number of incidents but will not stop a determined individual. Enforcement provides the most effective deterrent.

Installation of protective screening is analyzed on a case-by-case basis at the following locations:

- On existing structures where there is a history of multiple incidents of objects being dropped or thrown and enforcement has not changed the situation.
- On a new structure near a school, a playground, or where frequently used by children not accompanied by adults.
- In urban areas, on a new structure used by pedestrians where surveillance by local law enforcement personnel is not likely.
- On new structures with walkways where experience on similar structures within a 1.6 kilometer radius indicates a need.
- On structures over private property that is subject to damage, such as buildings or power stations.

In most cases, the installation of a protective screen on a new structure can be postponed until there are indications of need.

Submit all proposals to install protective screening on structures to the State Design Engineer for approval. Contact the Bridge and Structures Office for approval to attach screening to structures and for specific design and mounting details.

1120.05 Documentation

Include the following items in the project file. See Chapter 330.

- ☐ Structural Capacity Report
- ☐ Evaluation of need and approval for enclosing the area between bridges
- ☐ Correspondence involving the MTMCTEA
- ☐ Justification for eliminating an overlay in the vicinity of a bridge
- ☐ Final Foundation Report
- ☐ Justification and OSC concurrence for omitting approach slabs
- ☐ Analysis of need and approval for protective screening on highway structures

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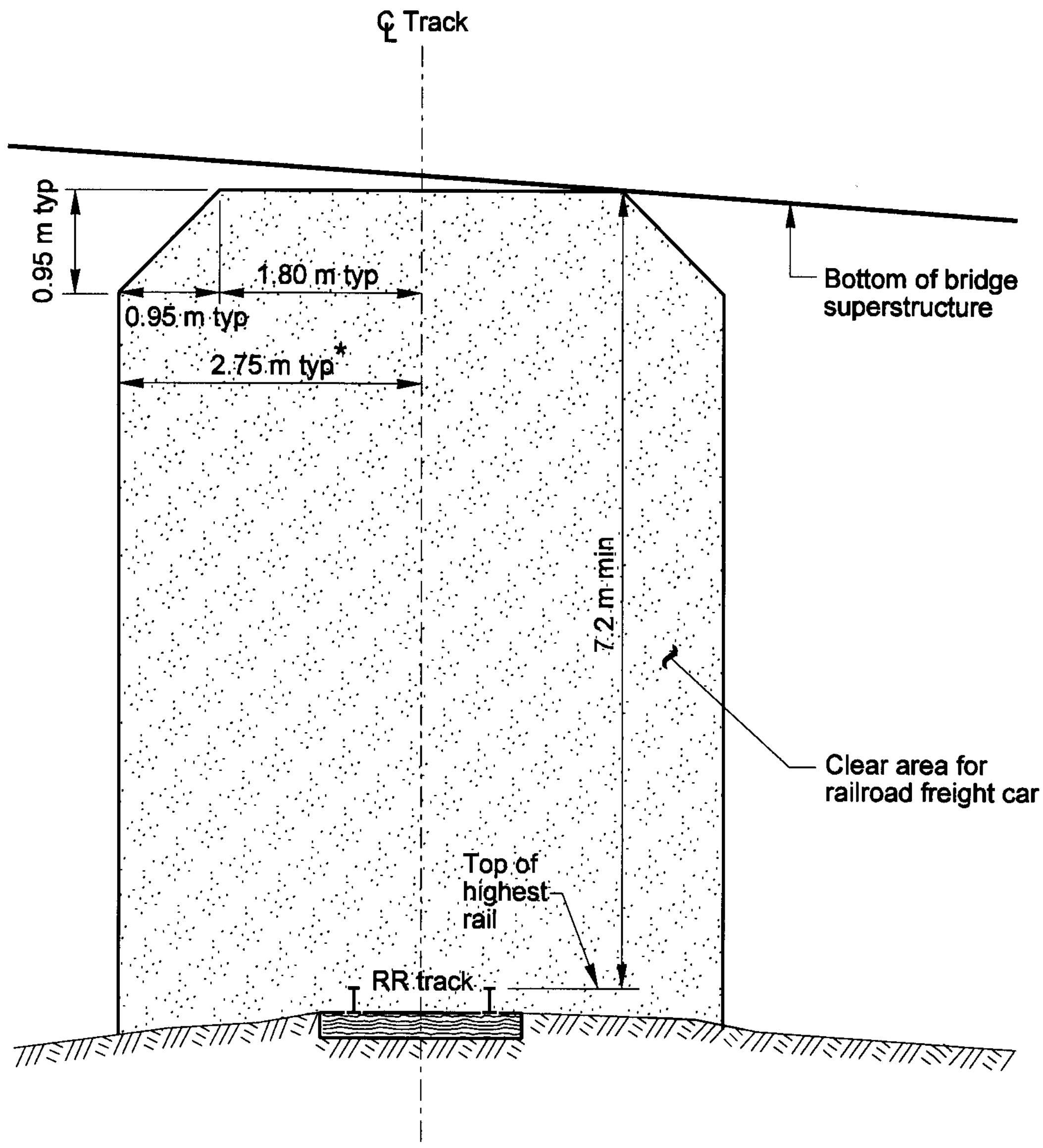
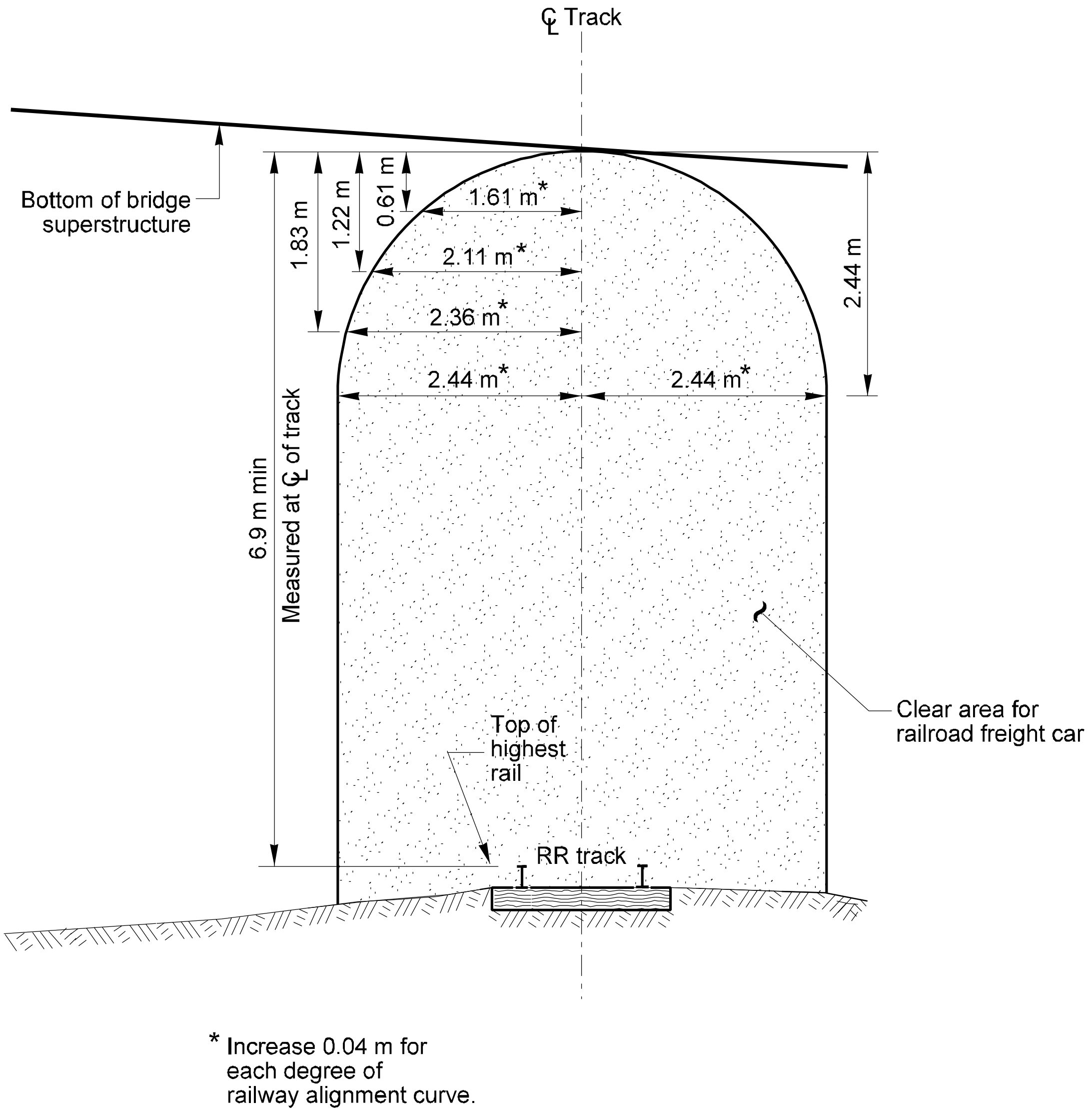


* Increase 0.04 m for each degree of railway alignment curve.

Railroad Vertical Clearance for New Bridge Construction
Figure 1120-1a



Railroad Vertical Clearance for Existing Bridge Modifications

Figure 1120-1b

1350 Soil Bioengineering

1350.01 General

Soil bioengineering is a land stabilization technology applied to disturbed sites and on slope and streambank projects. A multidisciplinary partnership is used to implement soil bioengineering techniques. Project managers initiate and design bioengineering features by employing the expertise of WSDOT hydraulic engineers, geotechnical engineers, engineering geologists, landscape architects, horticulturists, biologists, water quality specialists, environmental planners, and others. Soil bioengineering for slope stabilization provides additional environmental benefits such as habitat enhancement and water quality improvement.

All soil bioengineering proposals should include consideration of slope geometry, climate, water regime, soil properties, and surrounding vegetation. Applications of soil bioengineering are divided into three general categories: erosion control, streambank or shoreline stabilization, and upland slope stabilization. Refer to manuals according to the related discipline.

1350.02 References

For more detailed information, see:

Design Manual chapters, M 21-01, WSDOT:

- 1300 Roadside Development
- 510 Investigation of Soils, Rock, and Surfacing Materials
- 640 Geometric Cross Section
- 1210 Hydraulics
- 1130 Retaining Walls

Geotechnical Guidance — see geotechnical report for slope/soil stability. If further assistance is needed, contact Regional Materials Engineer.

Hydraulics Manual, M 23-03, WSDOT — for hydrology criteria.

Highway Runoff Manual, M 31-16, WSDOT — for Stormwater Site Plans, Temporary Erosion and Sediment Control Plans, and best management practices.

Roadside Manual, M 25-30, WSDOT — for vegetation and site preparation criteria, plant selection, design configurations, and other related topics.

Roadside Classification Plan, M 25-31, WSDOT — policy and guidelines for roadside treatment. Contact the region's Landscape Architect Office or the OSC Roadside and Site Development Services Unit at the Olympia Service Center.

Environmental Procedures Manual, M 31-11, WSDOT — permits.

Internet Bioengineering Drawings, WSDOT Homepage (http://www.wsdot.wa.gov/eesc/cae/design/roadside/bioeng.htm)

1350.03 Uses

(1) General

Soil bioengineering combines the use of live plants or cuttings, dead plant material, and inert structural members to produce living, functioning land stabilization systems. This technique uses living plants to control and prevent soil erosion, sedimentation, and shallow slope instability. The bioengineered solution benefits from engineering techniques that use live plant material.

Soil bioengineering methods can be cost effective and a useful mitigation solution for site specific problems. Soil bioengineering is effective in erosion control, streambank stabilization, and some upland instabilities. Soil bioengineering, like other engineering techniques, is not applicable in all situations. Soil bioengineering techniques may not effectively mitigate severe bridge scour, severe roadway erosion conditions, or deep seated slope instabilities. In such cases, soil bioengineering can be used in combination with other engineering techniques.

The use of native vegetation that is adapted to the conditions of the project site will increase the success of the application of soil bioengineering techniques. Over time, native vegetation will encourage the establishment of a diverse plant community and discourage undesirable and invasive plant species.

Other applications of soil bioengineering include:

- Wildlife and fisheries habitat enhancement
- Reinforcement and steepening of cut and fill slopes to limit impacts to adjacent properties and sensitive areas
- Vegetated buffer enhancement on steep slopes
- Enhancement of stormwater treatment areas and stabilization of drainage ways by providing erosion prevention and sediment control
- Site specific mitigations using standard geotechnical solutions in combination with vegetative control

(2) Erosion Prevention

Soil Bioengineering techniques can provide erosion prevention in the top soil layers. Erosion is the detachment and transport of surficial soil particles through the action of water, wind, and ice. Plant shoots and foliage diminish rainfall erosion and remove excess moisture through transpiration. Roots reinforce the soil mantle, allowing the system to grow more stable with age. Vegetative material slows down runoff and traps soil thereby reversing the effects of erosion. Refer to the *Roadside Manual* for more information.

(3) Streambank Stabilization

Soil bioengineering techniques can be used to stabilize streambanks, enhance wildlife habitat, improve water quality by controlling sediments, and protect structures. Bioengineering in the riparian zone (banks of streams, wetlands, lakes, or tidewater) requires an hydraulic study of stream characteristics and changes in stream alignment. Refer to the *Hydraulics Manual* for more information.

(4) Upland Slope Stabilization (generally less than one meter in depth)

Upland slope stabilization refers to the use of vegetation and plant materials to reduce or prevent soil erosion caused by wind or water on slopes not directly adjacent to riparian zones.

There are three classifications of unstable slopes:

- **Surface movement** refers to surface erosion caused by wind or water on slopes
- **Shallow-seated instability** is defined as a failure surface less than one meter in depth
- **Deep-seated instability** is defined as a failure surface greater than one meter in depth

Soil bioengineering is used for slopes that are at risk of shallow landslides, slumps, sloughing, and surface erosion. Soil bioengineering techniques are most applicable to shallow slope stabilization projects characterized by unstable slopes that have surface movement. Surface movement of soils can be induced by soil creep, repeated freeze-thaw cycles, and soil erosion. The processes that influence overall slope stability, such as heavy and prolonged erosion and continuous slow soil movement, can significantly alter slope geometry.

Soil bioengineering alone is not appropriate for deep-seated landslides, but can be used in conjunction with other engineering methods to treat associated shallow instabilities.

Soil bioengineering techniques can be used to stabilize the slopes of construction sites or to repair disturbed or damaged slopes. Soil bioengineering is applied to both cut and fill slopes.

Factors	Parameters	Design Considerations/Specifications
Climate/ Microclimate	Growing season Exposure/Aspect	Select suitable plants, methods and construction timing
Soil, Physical	Density and rootability Permeability	Modify during construction Select suitable plants
Soil, Water	Profile available water	Modify soil during construction Install structures (drains, ditches etc.) to remove excess water
Soil, Chemical	pH Fertility Cation Exchange	Select suitable plants Add lime, fertilizers Ameliorate soil
Erosion Risk	Soil erodibility Rainfall erosivity Channel discharge Slope Wind, Water, Ice	Temporary or Permanent covers Select suitable plants Management Reinforcement with geotextile
Geotechnical	Shear strength Slope Factor of Safety	Select suitable soil materials Structures Soil density and moisture Reinforcement with geosynthetics (Chapter 530)

(5) Strategies

When planning for site specific soil bioengineering design, consider the factors, parameters, and design considerations/ specifications in the following table.

1350.04 Design Responsibilities and Considerations

Consider the possible applications for soil bioengineering during the project definition process. Address soil bioengineering applications during the design process as part of the recommendations in the Hydraulic Report (for streambank/shoreline), Stormwater Site Plan (SSP), Geotechnical Report (for slope stabilization), and in the Environmental Documents. These reports provide design criteria and guidelines.

1350.05 Documentation

For all applications, include in the documentation a summary of site analysis, a list of design options considered along with a summary of evaluations, and management plans. The following is a list of soil bioengineering applications and the documents that support the designs.

(1) Erosion Control

- ☐ Temporary Erosion and Sediment Control Plan (TESC), *Highway Runoff Manual*
- ☐ Stormwater Site Plan (SSP), *Highway Runoff Manual*
- ☐ Roadside Restoration Plan including the Horticultural Report, OSC Horticulturalist and the region’s Landscape Architect Office or the OSC Roadside and Site Development Unit

(2) Streambank/Shoreline Stabilization

- ☐ Hydraulics Report, *Hydraulics Manual*
- ☐ Roadside Restoration Plan, region's Landscape Architecture Office or the OSC Roadside and Site Development Unit

(3) Upland Slope Stabilization

- ☐ Geotechnical Report, *Design Manual*
- ☐ Geotechnical Report, Geotechnical Branch
- ☐ Roadside Restoration Plan, region's Landscape Architecture Office or the OSC Roadside and Site Development Unit

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1425 Access Point Decision Report

1425.01 General

It is in the public's interest that the state's freeways be maintained and protected to provide the highest practical level of service in terms of safety and mobility. Federal laws and both FHWA and WSDOT policies require a formal request, with an Access Point Decision Report, for any access point revision that might adversely affect through traffic on a freeway in Washington State. The report is used for a decision-making process and documents the planning, evaluation, design, and coordination that support and justify the request.

In theory, a transportation project such as a new interchange would begin with a study of a large section of the freeway system to determine existing and future access needs. The needs would become part of a statewide plan. Alternatives would be suggested and evaluated. Preliminary proposals would be selected and evaluated. A final proposal would be selected, analyzed, approved, designed, constructed, maintained, and monitored.

But that is not always the source of a proposal.

If a revised access point proposal is not the result of system planning, then the process of evaluating the alternative has to go back to the beginning to study the system throughout the affected area and determine whether or not an access point revision will be the best reasonable alternative. Sometimes it is not — for example, because it would interfere with Interstate travel, or because modifications to the local surface system would be a better and more reasonable solution for accommodating local traffic.

For all but the simplest projects, WSDOT recommends that a support team be used to help integrate the planning, programming, and design efforts that lead to development of a proposal. The Project Definition process, Value Engineering studies, public involvement efforts, environmental analyses, and analyses for the Access Point Decision Report all use similar data and try to find the best way to meet the needs. The team is charged with achieving creative and reasonable identification of possible alternatives — guiding selection of the best from the alternatives to develop a proposal — and providing guidance from potential reviewers to the decision report developers in order to streamline the report-development process and meet the reviewers' requirements.

An Access Point Decision Report is a stand-alone decision document that includes all supporting information for ready reference by those reviewing the request. (For example, information drawn from the planning documents and the Project Summary is included.) It includes information about the proposed project that includes the access point revision and information about all other improvements that are needed for the access revision to function as intended.

After the Access Point Decision Report is reviewed, if the revised access proposal is acceptable it is given a *finding of engineering and operational acceptability* and approved concurrently with the appropriate environmental documents.

For consistency, this chapter provides the sequence of presentation and guidance for developing the required documentation.

1425.02 References

Notice of policy statement: "Additional Interchanges to the Interstate System," Federal Highway Administration notice published in the Federal Register, October 22, 1990. (Vol. 55, No. 204)

Notice of policy statement: "Additional Interchanges to the Interstate System," Federal Highway Administration notice published in the Federal Register on Wednesday, February 11, 1998. (Vol. 63, No. 28) (Accessible in http://www.access.gpo.gov/su_docs/fedreg/a980211c.html, under FHWA notices, "Interstate system, additional interchanges, policy statement, 7045-7047.")

United States Code 23 USC section 111

Code of Federal Regulations 23 CFR part 450 (implementing 23 USC section 111)

Code of Federal Regulations 40 CFR parts 51 and 93 (regarding federal conformity with state and federal air quality implementation plans)

Highway Capacity Manual, Special Report No 209 (HCM), Transportation Research Council

Forcasting and Methods Matrix, WSDOT (when available)

1425.03 Definitions

alternatives Possible components of a proposal — including design options, locations, and travel demand management and transportation system management type improvements such as ramp metering, mass transit, and high occupancy vehicle (HOV) facilities.

access point Any point that allows entrance to or exit from the traveled way of a freeway. (This includes "locked gate" access.)

access point revision A new access point, a change in existing interchange/intersection configuration, or the relocation of an existing access point.

freeway For this chapter only, a *freeway* is any multilane divided highway with limited access control that is on the Interstate System or the Washington State Highway System.

need For this chapter only, an existing or anticipated travel demand requiring a change in access to the state's freeway system.

proposal The combination of alternatives that is being submitted for approval by way of a request and an Access Point Decision Report. A proposal would have one or more projects involving access point revision alternatives and other projects and actions necessary for the needs to be addressed and the access revisions to function as intended.

traveled way The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

1425.04 Procedures

Figures 1425-1a and 1b list the project types most likely to affect freeway efficiency, thus requiring a formal request and an Access Point Decision Report. Figure 1425-2 lists the project types least likely to require a request and decision report. If there is any question whether an Access Point Decision Report is required, consult the OSC Access and Hearings Engineer and, if on the Interstate System, the FHWA Transportation and Environmental Engineer.

Gaining acceptance and approval for an access point revision is a multistep process. (See the Access Point Decision Report Flow Chart, Figures 1425-3a and 3b.)

(1) The first step: to identify needs and develop a proposal. When going through the process of developing a proposal, it is important to use the data and analysis methods required for an Access Point Decision Report in order to easily document the process.

(a) Are there existing or anticipated needs? Might a new or revised access point be an appropriate solution (Figure 1425-3a, box 1)?

(b) If the proposed solution includes an access point revision, determine whether the proposed access point revision is reflected in a Regional Transportation Improvement Plan, a Metropolitan Transportation Improvement Plan, or the State Highway System Plan, or whether it is the result of a developer, local agency, or regional request. If needed, conduct a comprehensive freeway study, revisit the land use and transportation plans, and revise the State Highway System Plan to include the need for an access point revision (Figure 1425-3a, boxes 2 and 3).

(c) Establish a support team for all new access points and for major revisions to existing access points (Figure 1425-3a, box 4). The core decision-making team consists of:

- FHWA Transportation and Environmental Engineer (if Interstate)
- Region's Design or Project Development Engineer
- OSC Assistant State Design Engineer
- OSC Access and Hearings Engineer
- OSC Traffic Office representative
- Representative of the proponent
- Recorder

The core team is encouraged to call upon specialists as needed, for example:

- Metropolitan Planning Organization
- WSDOT region
  - Planning
  - Environmental
  - Traffic
  - Maintenance
  - Safety
  - Access Point Decision Report writer
- OSC
  - Design
  - Bridge
  - Geotechnical
- Local agencies
- Transit agencies

The team's role is to:

- Develop a charter that includes the processes for reaching consensus, resolving disputes, and assigning responsibility for final decisions when consensus is not reached.
- Expedite the decision report development and review process through early communication and agreement.
- Provide guidance and support.
- Contribute to identification of possible alternatives.
- Define the study and decision report parameters.
- Ensure compatibility of data used in various studies.
- Agree on impact areas and travel forecasts for each of the alternatives being considered.
- Help integrate the Project Definition process studies, Value Engineering studies, public involvement efforts, environmental analyses, operational analyses, and analyses for the Access Point Decision Report. This can encourage use of consistent data.
- Address deviation issues. (Representatives from approving agencies participate in problem-solving.)
- Provide conclusions promptly, in writing, to the persons preparing the Access Point Decision Report.
- Contribute material for the decision report that documents the opposing point of view when consensus was not reached.
- Review results.

(2) The second step: to prepare a detailed decision report using the guidance in 1425.05 "Access Point Decision Report and Supporting Analyses" (Figure 1425-3a, boxes 5 through 9).

The Access Point Decision Report usually addresses eight specific policy topics in detail. (See Figures 1425-1a and 1b for exceptions.) They are, in order of presentation:

1. Future Interchanges
2. Land Use and Transportation Plans
3. Reasonable Alternatives
4. Need for the Access Point Revision
5. Access Connections and Design
6. Operational and Accident Analyses
7. Coordination
8. Planning and Environmental Processes

The extent of the decision report varies considerably with the scope of the access point revision. For example, for locked gates and emergency temporary access to sites normally accessed by another route, the application for approval may be condensed to a letter format that includes adequate justification.

The Access Point Decision Report is begun early in the environmental process because it's analyses help define the area of impact and the range of alternatives. Since the traffic data required for NEPA or SEPA and the operational analyses of the decision report are similar, these documents are usually developed together using the same data sources and procedures.

(3) The third step: acceptance based on an Access Point Decision Report that defines the proposed access point revision and other needed modifications to the main line and the local surface system to protect freeway operations and safety.

The region, with the help of the support team, prepares the Access Point Decision Report and submits four copies (two for non-Interstate) to the Access and Hearings Engineer (in the Design Office, Olympia Service Center) for review and submittal for acceptance and approval. When the access point revision is on an Interstate freeway, regardless of funding sources, the State Design Engineer submits the decision report to FHWA with a request for acceptance and approval (Figure 1425-3b, box 10).

Acceptance of the proposed access point revision by FHWA or the State Design Engineer is a *finding of engineering and operational acceptability*. For state routes, the State Design Engineer's acceptance is given concurrently with environmental approval (Figure 1425-3b, boxes 11 through 14).

Some Interstate access point revisions are reviewed by FHWA at the local divisional level in Washington State and consequently require less time for a determination of acceptability and final approval. Others are reviewed by the Federal Highway Administrator in Washington, DC, and can require a more protracted review and acceptance process. See Figure 1425-1b for details.

FHWA final approval requires that the National Environmental Policy Act (NEPA) procedures are followed. The NEPA procedures are accomplished as part of the normal project development process and as a condition of the access approval. Final access point approval cannot precede the completion of the NEPA process. To offer maximum flexibility, however, any proposed access point(s) may be submitted for a determination of engineering and operational acceptability prior to completion of the NEPA process. A determination can be made as to whether or not a proposal is acceptable for inclusion as an option in the environmental process.

(4) The fourth step: for Interstate projects, is the FHWA final approval of the access point revision that is given concurrently with the local division level environmental approval (as in the case of a Record of Decision) or as part of the NEPA approval (Figure 1425-3b, box 15).

1425.05 Access Point Decision Report and Supporting Analyses

Begin the Access Point Decision Report with an executive summary. Briefly state what access point revision is being submitted for a decision and why the revision is needed. Include a brief summary of the proposal and the impacts and mitigative measures of the proposal.

For any new access point on an existing freeway to be considered for acceptance and approval, all eight policy points must be addressed in the Access Point Decision Report. If the project modifies an existing access point, see Figures 1425-1a and 1b for the required policy points. (See Figure 1425-2 for project types that might not require a decision report.)

Follow the summary statement with a numbered outline representing the eight policy points being covered in the decision report. In the outline, provide a sentence or two that very briefly answers each policy point's question. If one of the eight policy points is not included, briefly justify its omission. Figure 1425.1a or 1b might be referenced as justification or, for instance, if there are no documents for number seven, its outline entry might read: "**7. Coordination.** No developers are involved and no work on the local system is proposed."

All eight policy points are provided numbered tabs in the decision report. The Access Point Decision Report must be assembled in the numbered order. An empty tab is justified in the outline.

The following guidance for each policy point is written for the most extreme condition — a new interchange in an urbanized area. The scope of the analyses and documentation need not be as extensive for more modest access point revisions. Factors that affect the scope include location (rural or urban), access points (new or revised), ramps (new or existing), ramp terminals (freeway or surface system), and intersections (revise or replace with interchange or over/undercrossing).

The following guidance on the preparation of the decision report applies to routes in both rural and urban areas.

Each of the policy points is part of the decision report to answer the question given at the beginning of the discussion.

(1) Future Interchanges

Is the proposed access point revision compatible with a comprehensive network plan?

In areas where the potential exists for future multiple interchange additions, support all requests for revised access points by a comprehensive freeway network study with recommendations that address all proposed, reasonable, and desired access points within the context of a long-term plan for that area.

In larger urban areas, regional plans might be too generalized to specify individual interchanges. To plan the relative priority of new access points, a plan refinement study or traffic circulation study must be completed.

The study must demonstrate that the proposed revised access point is compatible with other feasible new access points that have already been proposed.

Reference and summarize any comprehensive freeway network study, plan refinement study, or traffic circulation study.

Explain the consistency of the proposed access point revision with those studies.

(2) Land Use and Transportation Plans

Is the proposed access point revision compatible with all land use and transportation plans for the area?

Show that the proposal is based on consideration of and is consistent with local and regional land use and transportation plans. Before final approval, all requests for access point revisions must be consistent with the metropolitan and/or statewide transportation plan, as appropriate. (See Chapter 120.)

Reference the existing and proposed land use plan and the regional and local transportation plans and studies that apply to the area.

Explain the consistency of the proposed access point revision with those plans and studies, the applicable provisions of 23 CFR Part 450, and the applicable transportation conformity requirements of 40 CFR Parts 51 and 93.

If the proposed access is not specifically referenced in the transportation plans, define its consistency with the plans and indicate the process for the responsible planning agency to incorporate the project. In urban areas, the plan refinement must be adopted by the metropolitan planning organization (MPO) before the project is designed.

The proposed access point revision will affect adjacent land use and, conversely, land use will affect travel demand generated. Therefore, reference and show compatibility with the land use plans, zoning controls, and transportation ordinances in the affected area.

(3) Reasonable Alternatives

Have all reasonable alternatives been assessed and provided for?

Explain how the preferred proposal provides for all reasonable alternatives that are currently justified and includes provisions to accommodate alternatives that meet the identified future (design year) needs. (For example, if ramp metering and an HOV bypass meet future needs, they are provided for by constructing adequate storage or by acquiring adequate right of way for future construction.) Future projects must be coordinated as described in policy point 7 below.

Describe all reasonable alternatives that have been considered — the design options, locations, and transportation system management type improvements (such as ramp metering, mass transit, and HOV facilities) that have been assessed.

Describe alternatives that were proposed and then rejected as being unreasonable.

Explain why omitted reasonable alternatives were dismissed.

(4) Need for the Access Point Revision

What are the current and projected needs and why won't the existing access points and existing or improved local system meet the needs? Is the anticipated demand short or long trip?

Provide a narrative section that describes the need for an access point revision and explains why existing access points do not address the need and how the proposal does meet the anticipated travel demand. Provide the analysis and data to support the access request.

(a) **Narrative.** Describe the needs being addressed and describe the proposal in detail. Include all reasonable alternatives for design options, location, and travel demand management and transportation system management type improvements that are proposed to address the needs. Show that any alternative that might affect the need for the proposal has been considered in the needs analyses.

Show that the existing interchanges/intersections and the local surface system can neither provide the necessary access nor be improved to satisfactorily accommodate the design-year travel demands. Describe traffic mitigation measures considered at locations where the level of service is or will be below service standards.

Show that the access point revision portion of the proposal is primarily to meet regional (not local) travel demands. Distinguish between local and regional traffic (trip link and/or route choice).

(b) **Analysis and Data.** The data analysis procedures and study areas used must be acceptable to the support team.

Show that a preliminary (planning level) analysis, comparing build to no-build data, was conducted and included the following steps:

- Define the study areas. The proposed access point revision will affect adjacent land use and, conversely, land use will affect travel demand generated. For a possible new interchange, there might be more than one study area depending on build/no-build options and the associated land use development levels.
- Develop current and design year (20 years from start of construction) peak hour traffic estimates for the regional and local systems in the subarea of the proposal. Use regional transportation planning organization based forecasts refined, as necessary, by accepted travel demand estimating procedures. Forecasts for specific ramp traffic can require other methods of estimation procedures and must be consistent with the projections of the travel demand models. (See the *Forcasting and Methods Matrix*, when available.)
- Identify the origins and destinations of trips on the local systems, the existing interchange/intersections, and the proposed access.
- Assign the appropriate travel demand to improvements that might be made to:

- The surface system such as: widen, add new surface routes, coordinate the signal system, control access, improve local circulation, or improve parallel roads or streets.
- The existing interchanges such as lengthen or widen ramps, add park and ride lots, or add frontage roads.
- The freeway lanes such as add collector-distributor roads or auxiliary lanes.
- Transportation system management and travel demand management measures.

- Describe the current and design year level of service at all affected locations within the study area; including local systems, existing ramps, and freeway lanes.

(5) Access Connections and Design

Will the proposal provide fully directional interchanges connected to public roads, spaced appropriately, and designed to full design level geometric control criteria?

Wherever possible, provide for all directions of traffic movements. The intent is to try to provide full movement at all interchanges. Less than fully directional interchanges for special-purpose access for transit vehicles, for HOVs, or to or from park and ride lots will be considered on a case-by-case basis.

A proposed interchange access must connect to a public highway, road, or street.

Discuss interchange spacing and how the proposed access point relates to present and future proposed configurations and the spacing recommendations.

Show that the proposed access point revision will be designed to meet or exceed current full design level (Chapters 325, 440, 640, 940, and 1050, for example). Present the information in sufficient detail to be used for an operational analysis. For example, include the number of lanes, horizontal and vertical curvature, lateral clearance, lane width, shoulder width, weave distance, ramp taper, and all traffic movements, if appropriate. This information is presented as a simple sketch or a more complex layout depending on the complexity of the proposal. Construction plans, specifications, and estimates of quantities are not necessary.

When existing nonstandard features are to be retained, explain why they are nonstandard and justify the decision not to improve them to standard. The support team helps determine the extent of reconstruction to be proposed and rules on any suggestions regarding deviations for new work that are being considered to become part of the proposal.

Show that all new ramp terminals will be designed to meet or exceed current state and local full design level geometric control criteria.

(6) Operational and Accident Analyses

How will the proposal affect safety and traffic operations now and for the next 20 years?

The support team plays a critical role in operational and accident analysis decisions such as selecting appropriate procedures, defining affected areas, selecting appropriate data, and defining "significant adverse impact." These are project-specific decisions.

The reporting for policy point six is documentation of the procedures used to do the operational and accident analyses and the results that support and justify the proposal.

Once the (preferred) proposed access revision has been selected, show that it will not have a significant adverse impact on the (a) operation and (b) safety of the freeway and the affected surface system, or that the impacts will be mitigated. If this cannot be shown, the needs and alternatives are revisited, using more detailed information, to develop a different proposal.

Show that the analysis procedures and study areas used are acceptable to the support team.

Document the results of the following analyses in the decision report as appropriate:

- An operational analysis for both the opening and design years of the existing freeway and the affected surface system.

- An operational analysis for both the opening and design years of the proposed future freeway and the affected surface system for the preferred proposal.
- An accident analysis for both opening and design years of the existing freeway and the affected surface system, and for the proposed future freeway and affected surface system.

The data used must be consistent with the data used in the environmental documentation. If not, provide justification for the discrepancies.

(a) **Operational Analyses.** Demonstrate that the proposal does not have a significant adverse impact on the operation of the freeway or the adjacent affected surface system or that the impacts will be mitigated.

Use appropriate operational analysis procedures. For complex urban projects, a refined model might be necessary. As a minimum, the latest accepted *Highway Capacity Manual* (HCM) might be appropriate. Any procedure used must provide a measure of effectiveness compatible with the HCM. Include data sufficient to allow independent verification of the results by using the HCM.

All (design level) operational analyses shall be of sufficient detail and include sufficient data and procedure documentation to allow independent analysis and concurrence during FHWA or OSC evaluation of the proposal.

Prepare a sketch or layout displaying adjacent affected facilities and the following data. Include this sketch or layout in the body of the decision report where it is readily available to the reviewers. Show:

- Distances between intersections or ramps of a proposed interchange and that of adjacent interchanges.
- Design speeds.
- Grades.
- Truck volume percentages on the freeway, ramps, and affected roadways.
- Adjustment factors (peak hour factors, etc.).
- Freeway, ramp, and affected surface system traffic volumes (including turning volumes) forecasts for each option, including a "no-build" scenario, in the AM and PM peaks (also, noon peaks, if applicable) and average daily traffic (ADT), for the opening and design year.
- Current year (report year) traffic volumes based on traffic counts.
- Main line, ramp, and affected surface system lane configurations.

The required minimum limits of the analysis on the freeway are through the adjacent and proposed interchanges/intersections on both sides of the access point revision unless it is documented that the proposal has no impacts on the adjacent interchanges/intersections. If the interchanges/intersections are closely spaced, it might be necessary to go beyond adjacent interchanges/intersections. In urban areas, extend the analyses far enough to include the extent of the traffic impacts.

The required limits of the capacity analysis on the surface system are the extent necessary to show that the system can safely and adequately collect and distribute any new traffic loads resulting from the access point revision. Expand the limits of the study area, if necessary, to analyze the coordination required with an in-place or proposed traffic signal system. Document the limits of the analysis as well as how the limits were established.

Document the results of analyzing the existing access and the proposed access point revision at all affected locations within the limits of the study area (such as, weave, merge, diverge, ramp terminals, accident sites, and HOV lanes) along the affected section of freeway (main line and ramps) and on the affected surface system. In the decision report, highlight the following:

- Any location for which there is a significant adverse impact on the operation or safety of the freeway facility (such as causing a reduction of the operational efficiency of a merge condition at an existing ramp, introducing a weave, or significantly reducing the level of service on the main line due to additional travel demand) as well as what will be done to mitigate this adverse impact.

- Any location where a congestion point will be improved or eliminated by the proposal (such as proposed auxiliary lanes or collector-distributor roads for weave sections).
- Any surface system conditions that will affect traffic entering or exiting the freeway. If entering traffic is to be metered, explain the effect on the connecting surface system (for example, vehicle storage).
- When the existing facility does not meet the desired level of service, show how the proposal will improve the level of service or keep it from becoming worse than the future level with no change in access.

(b) **Accident analyses.** Demonstrate that the proposal does not have a significant adverse impact on the safety of the freeway or the adjacent affected surface system or that the impacts will be mitigated.

The required minimum limits of study are the same as for the operational analyses.

Identify all safety program (I2) locations. Where appropriate, identify accident histories, rates, and types for the freeway section and the adjacent affected surface system. Project the rates that will result from traffic flow and geometric conditions imposed by the proposed access point revision. Document the basis for all assumptions.

(7) Coordination

Are all coordinating projects and actions programmed and funded?

When the request for an access point revision is generated by new or expanded development (such as private developer or new park and ride lot), demonstrate appropriate coordination between the development and the changes to the transportation system.

Show that the proposal includes a commitment to complete the other noninterchange/nonintersection improvements that are necessary for the interchange/intersection to function as proposed. For example, the local circulation system must be in place before new ramps are opened to traffic and there must be commitment to the travel demand management and transportation system management concepts included in the proposal. If future reconstruction is part of the mitigation for design year level of service, the reconstruction projects must be in the State Highway System Plan.

All elements for improvements must be shown to include a fiscal commitment and a definite time for completion.

If the access point is to be designed as a left-side connection for HOV use only, include a commitment to close the access, rather than to open it to general use, if the HOV demand is moved to another access point or it declines to a level that no longer justifies the access.

(8) Planning and Environmental Processes

What is the status of the proposal's planning and environmental processes?

All requests for access point revisions on Interstate freeways must contain information on the status of the planning process. Show that the following federal objectives have been considered and report the proposed project's relationship to meeting them.

Federal law (23 USC 111) requires that *"each state carry out a transportation planning process that provides for consideration of projects and strategies that will:*

(a) Support the economic vitality of the United States, the states, and metropolitan areas, especially by enabling global competitiveness, productivity, and efficiency.

(b) Increase the safety and security of the transportation system for motorized and nonmotorized users.

(c) Increase the accessibility and mobility options available to people and for freight.

(d) Protect and enhance the environment, promote energy conservation, and improve quality of life.

(e) Enhance the integration and connectivity of the transportation system, across and between modes throughout the state, for people and freight.

(f) Promote efficient system management and operation.

(g) Emphasize the preservation of the existing transportation system."

All requests for access point revisions on freeways must contain information on the status of the environmental process. The following are just a few examples of status information that might apply.

- Are the environmental documents presently or soon-to-be submitted for approval?
- What applicable permits and approvals have been obtained and are pending?
- Are there hearings still to be held?
- Is the environmental process waiting for an engineering and operational acceptability decision?

1425.06 Documentation

The following documents are to be preserved in the project file.

- ☐ Request for acceptance and approval and the associated Access Point Decision Report and records.
- ☐ Acceptance and approval documents.
- ☐ Justification for omitting a request and decision report.

P65:DP/DMM

Project Type	Support Team	Policy Point								Accept-ance *	Approval *
		1	2	3	4	5	6	7	8		
Full and Partial Access Control (See Chapter 1420.)											
For Interstate Freeways										FHWA	FHWA
For Non-Interstate Freeways										OSC	OSC
New freeway-to-crossroad interchange in a transportation management area (1)	R	S F	S F	S F	S F	S F	S F	S F	S F	N or ✓	L or ✓
New freeway-to-crossroad interchange not in a transport-ation management area (1)	R	S F	S F	S F	S F	S F	S F	S F	S F	L or ✓	L or ✓
New partial interchange	R	S F	S F	S F	S F	S F	S F	S F	S F	N or ✓	L or ✓
New HOV direct access to and/or from the median	R	S F	S F	S F	S F	S F	S F	S F	S F	N or ✓	L or ✓
New freeway-to-freeway interchange	R	S F	S F	S F	S F	S F	S F	S F	S F	N or ✓	L or ✓
Modification to freeway-to-freeway interchange in a transportation management area (1)(2)	R	S F	S F	S F	S F	S F	S F	S F	S F	N or ✓	L or ✓
Modification to freeway-to-freeway interchange not in a transportation management area (1)(2)	R	S F	S F	S F	S F	S F	S F	S F	S F	L or ✓	L or ✓
Modification to interchange (3)	R	S F	S F	S F	S F	S F	S F	S F	S F	L or ✓	L or ✓
Addition of entrance or exit ramps that complete basic movements at existing interchange	R	S F	S F	S F	S F	S F	S F	S F	S F	L or ✓	L or ✓
Abandonment of a ramp (4)	R	S F	S F	S F	S F	S F	S F	S F	S F	L or ✓	L or ✓
Locked gate (Letter Format)	No			B	B	(5)	B			L or ✓	L or ✓
Emergency temporary access to site normally accessed by another route. (Letter Format)	No			B	B	(5)	B			L or ✓	L or ✓

See legend and notes next page.   * See legend item next page.

Access Point Decision Report Content and Review Levels
Figure 1425-1a

Project Type	Support Team	Policy Point 1	2	3	4	5	6	7	8	Accept-ance *	Approval *
For Partial and Modified Access Control Freeways (See Chapter 1420.)										OSC	OSC
New intersection or access point, partial access control	R	S	S	S	S	S	S	S	S	✓	✓
New intersection or access point, modified access control	R			S	S	(5)	S			✓	✓
Change intersection to interchange or over/undercrossing (6)	R	S		S	S	S	S			✓●●	✓●●
Modify interchange with effects	R			S	S		S		(7)	✓	✓
Modify intersection with effects	R			S	S					✓	✓

* See 1425(3) regarding acceptance and 1425(4) regarding approval.

●● See Figure 1425-2 for exceptions

FHWA Federal Highway Administration.

OSC Olympia Service Center, Design Office. The Access and Hearings Engineer coordinates acceptance and approval.

B Brief (policy point) report item required.

✓ OSC acceptance and approval.

F On the Interstate system, a (policy point) report item required by FHWA.

L For Interstate, FHWA acceptance or approval at the local division level, which can be expected to take from 1 to 4 months, or longer, depending on the complexity of the project and its environmental processes.

N For Interstate, FHWA acceptance at the national level, which can be expected to take from 3 to 12 months, or longer, depending on the complexity of the project and its environmental processes.

R Recommended.

S On a non-Interstate route, a (policy point) report item required by the state.

Notes:

(1) A transportation management area is a county with a population greater than 200,000. In Washington they are Clark, King, Pierce, Snohomish, Spokane, and Yakima Counties.

(2) "Modification" includes changes in interchange configuration even though the number of access points does not change. Changing from a cloverleaf to a directional interchange is an example of a "modification." However, for non-Interstate, if the modification does not add new lanes and can be shown to have no adverse impacts, and the spacing and geometric control criteria requirements will be met, omit the request and document justification to the design file.

(3) Modifications that might adversely affect the level of service of the through lanes. Examples: doubling lanes for an on-ramp with double entry to the freeway; adding a loop ramp to an existing diamond interchange, replacing a diamond ramp with a loop ramp.

(4) Unless it is a condition of the original approval.

(5) Sketch only.

(6) Changing an intersection to an over/undercrossing if all conditions on Figure 1425-2 are met.

(7) Only if data is not consistent between the decision report and the environmental analyses.

Access Point Decision Report Content and Review Levels

Figure 1425-1b

Project Type	Comments
Modify existing freeway to freeway interchange	To bring to standard
Revise existing component (lengthening or widening)	To meet current geometric control criteria
Ramp modification at the crossroad with no effect on the through lanes of the freeway	New right turn pocket, for example
Add a lane to a ramp that merges before entering the through lane	Adding a lane at the on/off access point requires a decision report
Reconstruct intersection at grade having HAL, HAC, or FAL concerns	Changing an intersection to an interchange or over/undercrossing requires a report unless all geometric control and policy criteria are met.
Modification of the intersection of a ramp and a crossroad	Signalize, redo radii, for example

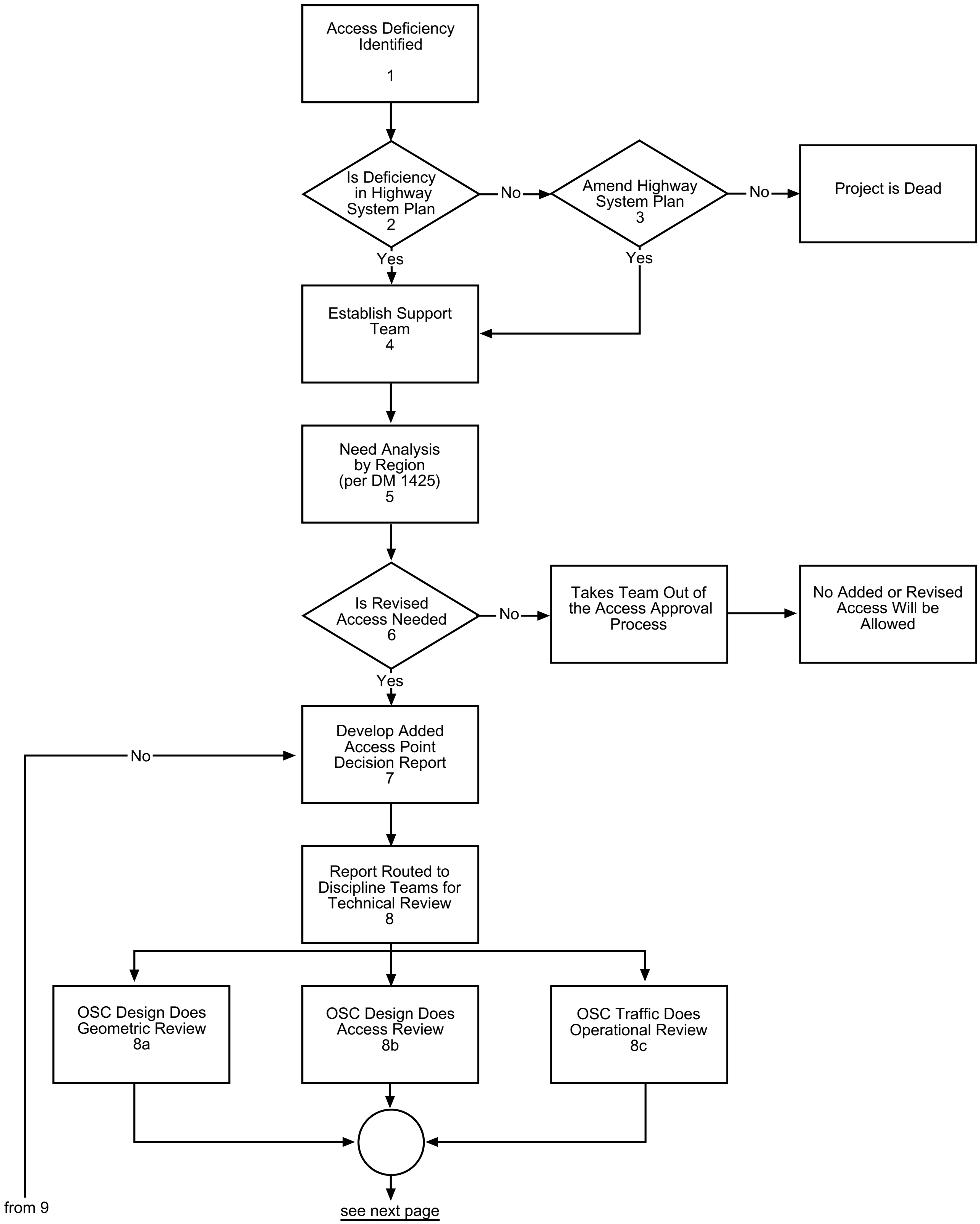
Note:

The table above shows some, but not all, of the types of access revisions that do not require a request and Access Point Decision Report if the following conditions are met.

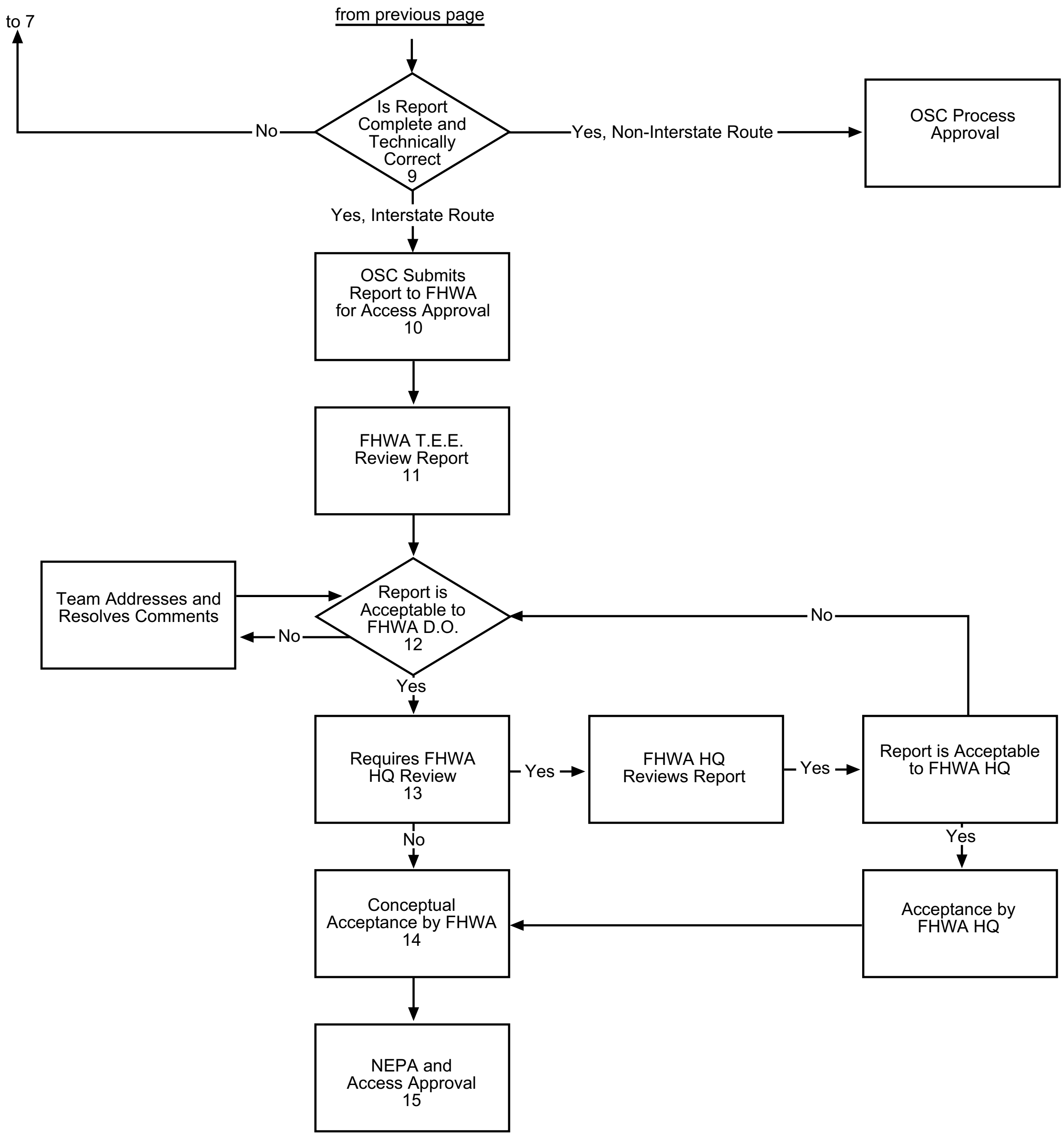
- It is documented that there will be no adverse impact on the freeway.
- The data used is consistent with the data used in the environmental analyses.
- The access is designed to the design level required by the appropriate Design Matrix.
- Access spacing meets requirements in Chapter 940.
- The project is approved per Chapter 330 as part of the Project Summary approval process.
- Omission of the request and decision report is justified to file with a copy sent to the state Access and Hearings Engineer.

Access Point Decision Report Possibly Not Required

Figure 1425-2



Access Point Decision Report Flow Chart
Figure 1425-3a



Access Point Decision Report Flow Chart
Figure 1425-3b

A

B

C

D

E

F

G

H

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J

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2:P65:DP/DMM

Washington State Department of Transportation

Design Manual Supplement

/s/ Clifford E. Mansfield
Deputy State Design Engineer

Effective Date: May 3, 2000

Left-Side HOV Parallel On-Connection

I. Introduction

A. Purpose

To modify Washington State Department of Transportation (WSDOT) policies regarding left-side HOV on-connections.

B. Background

In April 1998, WSDOT published a draft *HOV Direct Access Design Guide* (HOV Guide) that gives guidance for facilities that provide direct access for high occupancy vehicles (HOVs) between an HOV lane on a freeway and a facility off that freeway. The parallel on-connection provided in the HOV Guide was for a right-side ramp with modifications for left-side connections because the *Design Manual* did not include parallel on-connections. In June 1999 the *Design Manual* was revised to include parallel on and off-connections for connections on the right. Therefore, Figure 5-3 of the HOV Guide is revised to include only left-side HOV on-connections.

In response to feedback and experience gained following the publication of the HOV Guide, Figure 5-3 is also revised to make the intended meaning clearer.

C. References

Design Manual, M 22-01

HOV Direct Access Design Guide (HOV Guide), Draft M 22-98

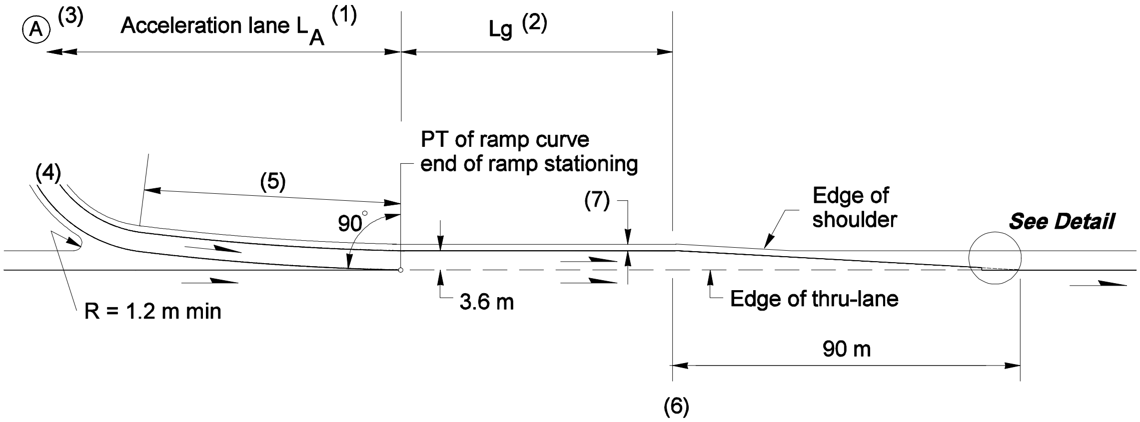
D. Effective Date and Term

These rules and procedures are effective on the date of this letter and will expire when the changes are incorporated in the referenced manuals.

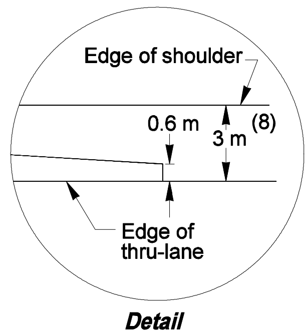
II. Instructions

Revise Draft HOV Direct Access Guide Chapter 5

Replace Figure 5-3 with the attached revised Figure 5-3.



Notes:



(1) See Figure 5-4 for acceleration lane length L_A. Check L_A for each ramp design speed.

(2) L_g is the gap acceptance length. Begin L_g at the beginning of the parallel lane, as shown, but not before the end of the acceleration lane L_A. See Figure 5-2 for the length L_g.

(3) Point Ⓐ is the point controlling the ramp design speed or the end of the transit stop zone or other stopping point.

(4) See 5.06 for ramp lane and shoulder widths.

(5) A transition curve with a minimum radius of 900 m is desirable. The desirable length is 90 m. When the main line is on a curve to the right, the transition may vary from a 900 m radius to tangent to the main line. The transition curve may be replaced by a 50:1 taper with a minimum length of 90 m.

(6) Angle point for width transitions, when required. See *Design Manual* Chapter 620 for pavement transitions.

(7) See 5.06 (2) for ramp shoulder width.

(8) The 3 m left shoulder is the minimum width; 4.2 m is preferred. Maintain this shoulder width for at least 150 m; 300 m is preferred.

(9) For striping, see the Standard Plans.

Single Lane Left-Side HOV On-Connection
***Figure* 5-3**

Washington State Department of Transportation

Design Manual Supplements and Instructional Letters

May 2000

In Effect	Chapter	Date	Type	Subject/Title
No		07/06/94	Memorandum to: Reg. Proj. Dev. Engr.	Chapter 1040, Weigh Stations
Yes	150	01/18/99	IL 4015.00	Right of Way Plan Development Process Improvements
No	330			(Chapter 330 revised June 1999)
No	1410			(Chapter 1410 revised June 1999)
Yes	915	06/01/99	IL 4019.00	Roundabouts
Yes	1050 940 HOV*	9/28/99	DM Supplement	Left-Side HOV Direct Access Connections
Yes	**1050 HOV***	**05/03/00**	**DM Supplement**	**Left-Side HOV Parallel On-Connection**

* The *HOV Direct Access Design Guide*, Draft M 22-98

Notes:

- Changes since the last revision to the *Design Manual* are shown in bold print.
- Items with **No** in the **In Effect** column were superseded by the latest revision and will be dropped from the next printing of this list.
- The listed items marked *yes* have been posted to the web at the following location:

http://www.wsdot.wa.gov/fasc/engineeringpublications/DesignLettersMemoInstruction.htm