

Design Policy and Standards Revisions

Design Manual – May/June 2006 Revisions The Revision starts after page 5 of this document

Revision marks are used throughout the manual to highlight content changes. These consist of sidebars, and underlining. Manual users should periodically check the *Design Manual* Errata web page. They should also report all undocumented errors they believe they have found.

General

- Review and update references, definitions, titles, & acronyms as appropriate.
- The “Documentation” subheadings are revised to direct the reader to the Documentation Checklist online.

Chapter 141 Project Development Roles and Responsibilities for Projects with Structures

May 2006 Revision:

- Minor spot revisions made to the narrative and flow chart figure to reference WSDOT’s new *Project Management On-Line Guide*

Chapter 315 Value Engineering

May 2006 Revision:

- minor spot revisions for punctuation, and:
- 315.04 (1) Selection Phase, Page 315-2: Revised preliminary project cost estimate value from \$2 million to \$5 million (relative to a statement about projects that could have high potential for value improvements through a VE study)

Chapter 330 Design Documentation, Approval, and Process Review

May 2006 Revision:

- Revised to include the use of design criteria of the AASHTO *A Policy on Geometric Design of Highways and Streets* to justify a deviation from the *Design Manual* criteria.

Chapter 410 Basic Design Level

May 2006 Revision:

- Revised 410.03 Minor Safety and Minor Preservation Work, to provide guidance on rechannelizing existing intersections to accommodate turning lanes. This further clarifies the previous guidance on intersection channelization to ensure

greater consistency in the evaluation and treatment of intersection related accidents. This guidance applies to pavement preservation projects.

Chapter 430 Modified Design Level

May 2006 Revision:

- Chapter 430 is revised to include *Design Manual* Supplements dated March 25, 2004 and June 29, 2004.
- Stopping Sight Distance revised to use 2001 values with a 2.00 ft object height.
- Superelevation rate revised to use the minimum radius equation when existing pavement remains.
- Ramp widths revised using AASHTO Exhibit 3-55.
- Chapter reformatted to more closely follow the Design Matrices

Chapter 520 Design of Pavement Structures

May 2006 Revision:

- Revised to incorporate Design Manual Supplement “Pavement Type Selection Protocol” previously approved by FHWA on April 18, 2005, and effective May 16, 2005.

Chapter 610 Traffic Analysis (previously Highway Capacity)

May 2006 Revision:

- Complete rewrite of an old chapter; new title
- Emphasis on the “what’s” and “how’s” on preparation of TIA (Traffic Impact Analysis) Report
- More emphasis added regarding WSDOT involvement with local agencies / developers when their projects affect state highways
- Designer is informed chapter no longer covers capacity analysis and directs reader to use the *Highway Capacity Manual*.

Chapter 650 Sight Distance

May 2006 Revision:

- Revised to incorporate Stopping Sight Distance *Design Manual* Supplement, which was dated October 9, 2002.
- Allow the AASHTO 2-foot object height for stopping sight distance in urban areas.
- Adopt the AASHTO 2-foot object height for evaluating existing stopping sight distance.

Chapter 700 Roadside Safety

May 2006 Revision:

- Revised to provide policy on centerline rumble strips.

- Numerous minor changes in wording to add clarity.

Chapter 720 Impact Attenuators

May 2006 Revision:

- New design guidance: Figure 720-6
- Selection criteria: Figure 720-5a & 5b
- Additional guidance for Work Zone applications
- Added two new approved systems: Quest & SCI70GM
- Reflection of manufacturer's update to existing approved system: REACT 350 Wide
- Updates to the description, function, foundation, slope, operational characteristics, etc, for some systems

Chapter 830 Delineation

May 2006 Revision:

- Changed to bring into conformity with MUTCD & to reflect organizational changes in WSDOT
- Chapter rewritten; no revision marks were included

Chapter 910 Intersections At Grade

May 2006 Revision:

- List of information to be included on Intersection Plan was replaced with an internet checklist.
- The beginning of the 50-foot opening before the left-turn storage was moved from end of taper to point where 13-foot lane width is achieved.
- Corrected chapter errata.

- The changes to Chapter 910 expand on the previous guidance related to shoulder widths in intersection areas. The intent is to reduce conflict points, while balancing the needs of motorists, bicyclists, and pedestrians. This guidance applies to all projects designed with Full Design Level.

Chapter 960 Median Crossovers

May 2006 Revision: Revised to Clarify:

- Circumstances that crossings will be considered.
- How to apply for approval of new or relocated crossings
- Provide additional guidance on the location of crossings

Chapter 1010 Auxiliary Lanes

May 2006 Revision:

- Changed size of truck used to warrant climbing lane to 200 lb/HP
- Reduced speed reduction to warrant a climbing lane from _____ to 10 mph
- Changed minimum shoulder width for slow vehicle shoulder driving to 10 feet (with 12 feet preferred.)
- The above revisions were to match AASHTO

Chapter 1025 Pedestrian Design Considerations

May 2006 Revision:

- Complete rewrite of chapter; no revision marks
- Revised to reflect ADA accessibility requirements, changes in WSDOT organizational structure
- Several new sections such as: ADA Compliance; Vehicle Bridges and Underpasses; Railroad Crossings; Managing Speed and Flow (Traffic Calming); Work Zone Pedestrian Considerations
- Some existing sections revised, including: Funding Program Structure; Pedestrian Human Factors; Pedestrian Activity Generators, which have been removed to the document: *Understanding Flexibility in Transportation Design – Washington*.

Chapter 1410 Right of Way Considerations

May 2006 Revision:

- Updated WSDOT R/W policies and procedures to reflect WSDOT organizational changes.

Chapter 1425 Interchange Justification Report (Previously Access Point Decision Report)

May 2006 Revision:

- Revised chapter; new title; complete rewrite for the most part; no revision marks
- Revised to better align with national terminology, and reflect procedural and organizational changes in WSDOT.
- New Term: IJR, Old Term: APDR
- Renumbered 8 Policy Points to coincide with national convention for IJR format / layout
- No change to Policy; simply rewrote to better clarify procedure and documentation products; and extent of documentation needed for various access breaks (from a locked gate to a full blown new interchange.)

Chapter 1440 Surveying and Mapping

May 2006 Revision:

- Revised to bring into conformity with *Highway Surveying Manual* and to reflect WSDOT organizational changes.

Chapter 1450 Monumentation

May 2006 Revision:

- Provides designer an overview of the placement, protection and replacement of highway control monuments, alignment monuments and control monuments.
- Revised to bring into conformity with *Highway Surveying Manual*.

Chapter 1460 Fencing

May 2006 Revision:

- Revised in two primary areas: fencing of special sites and deletion of two types of chain link fence:
- Text on fencing at storm-water detention facilities and wetland mitigation sites has been separated to better reflect requirements for fencing in each case.
- Types 1 and 6 chain link fence have been deleted from the chapter. These fence types have top rail.
- Justification is required for not taking corrective action to remove Type 1 or 6 within project limits.
- Other editorial or clarifying text throughout chapter



Transmittal Number PT 06-032	Date June 2006
Publication Distribution To: All English <i>Design Manual</i> holders	
Publication Title <i>Design Manual</i> (English) Revision 2006-1	Publication Number M 22-01
Originating Organization Environmental and Engineering Service Center, Design Office, Design Policy, Standards, and Safety Research Unit through Engineering Publications	

Remarks:

Additional copies may be purchased from:
Washington State Department of Transportation
Finance and Administration
Directional Documents and Engineering Publications
PO BOX 47408
Olympia, WA 98504-7408

Phone: (360) 705-7430

Fax: (360) 705-6861

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Instructions:

Page numbers and corresponding sheet-counts are given in the table below to indicate portions of the *Design Manual* that are to be removed and inserted to accomplish this revision.

Chapter	Remove		Insert	
	Pages	Sheets	Pages	Sheets
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Distributed By Directional Documents and Engineering Publications	Phone Number (360) 705-7430 FAX: 705-6861	Signature
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Washington State Department of Transportation
Design Manual Supplements and Instructional Letters
 May, 2006

In Effect	Chapter	Date	Type	Subject/Title
No	650	10/09/02	DM Supplement	Stopping Sight Distance
No	430	3/25/2004	DM Supplement	Design Speed
No	440			
No	430	6/29/2004	DM Supplement	ADA Accessible Facilities on Road, Street, and Highway Projects
No	1025			
No	325			
No	340			
Yes	520	5/16/2005	DM Supplement	Pavement Type Selection Protocol (PTSP)
Yes	820	8/5/2005	DM Supplement	Overhead Sign Illumination (Lighting)
Yes	850			
Yes	860	12/30/2005	DM Supplement	Systems Engineering for Intelligent Transportation Systems
Yes	1120	4/24/2006	DM Supplement	Vertical Falsework Clearance for Bridges Over Highways

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/eesc/design/policy/pdf/August2005DMSupplementLettersList.pdf>

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Project Development Roles and Responsibilities for Projects with Structures

Chapter 141

- 141.01 General
- 141.02 Procedures

141.01 General

This chapter presents the project development process used by Washington State Department of Transportation (WSDOT), the Regions and the Bridge and Structures Office together, to determine the roles and responsibilities for projects with structures during the project development phase of a project. This chapter complements the Project Management On-Line Guide which is located at:

<http://www.wsdot.wa.gov/Projects/ProjectMgmt/Process.htm#PMOG>

See Division 11 chapters and the *Bridge Design Manual* for design procedures.

The primary objective of this process is to provide a consistent means of selecting a bridge design team to perform all or part of the structural design work, whether it be a consultant or the WSDOT Bridge and Structures Office.

If the Local Agency will be requesting any services from WSDOT, the Local Agency will contact WSDOT's Local Program Engineer. The Local Program Engineer will help define the level of WSDOT's involvement in design and construction.

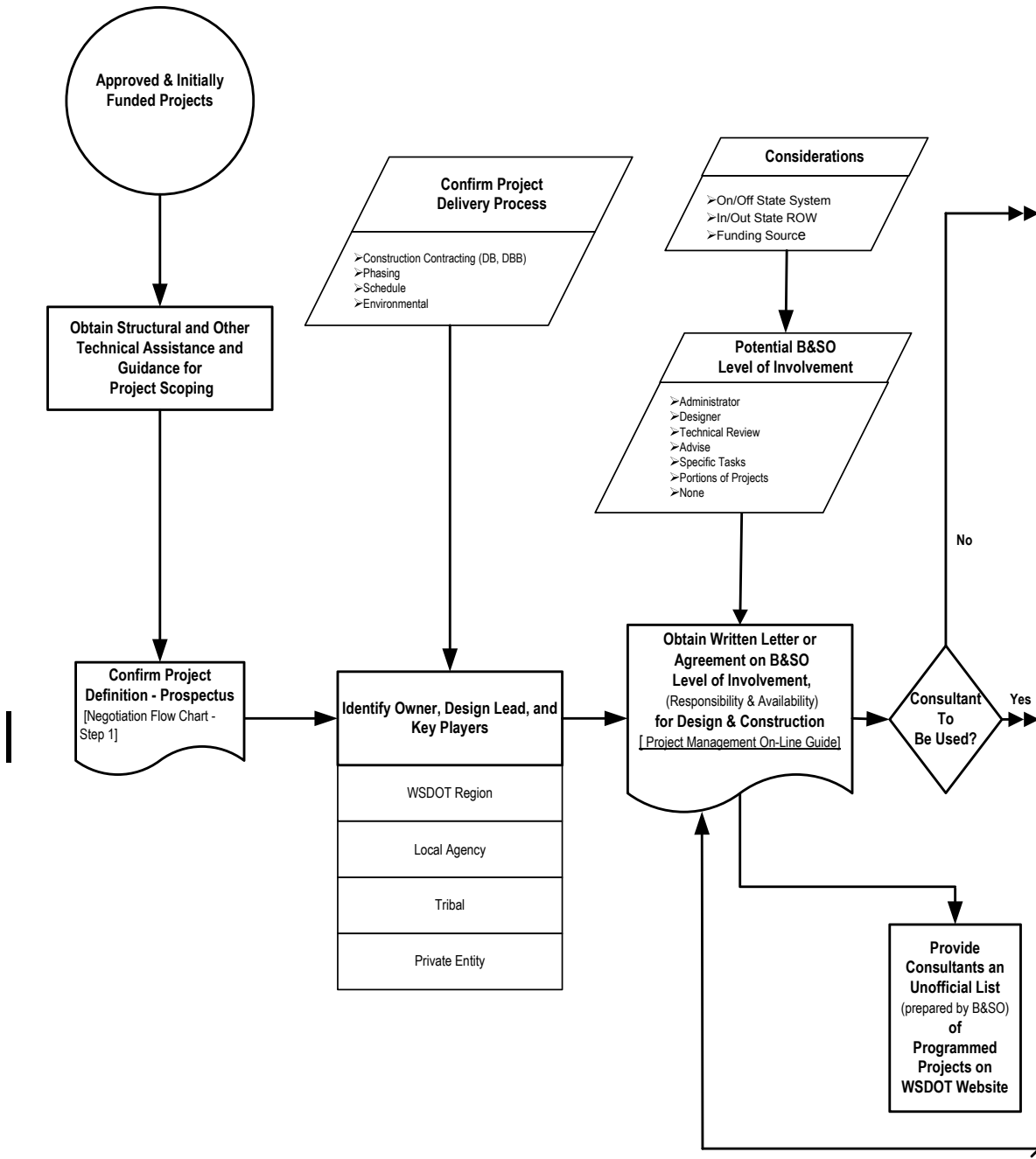
141.02 Procedures

The flow diagram, Figures 141-1a and 141-1b, begins at the left with the initial approval and funding of the project and ends at the right with the start of the project delivery process.

After a project is programmed, WSDOT is tasked with confirming the project scope and defining the structural team's level of involvement in design and construction. If a consultant is not used, all bridge design work will be performed by the Bridge and Structures Office. If a consultant is used, the WSDOT Region and Bridge and Structures Office will determine the level of involvement and responsibility for the design.

Agreements defining the level of involvement and responsibility will be developed and executed between the appropriate Regional office responsible for project development and the Bridge and Structures Office and the appropriate project delivery process will be implemented.

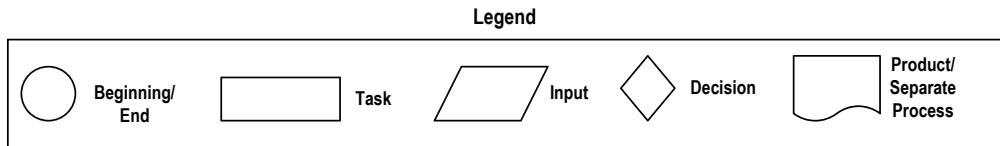
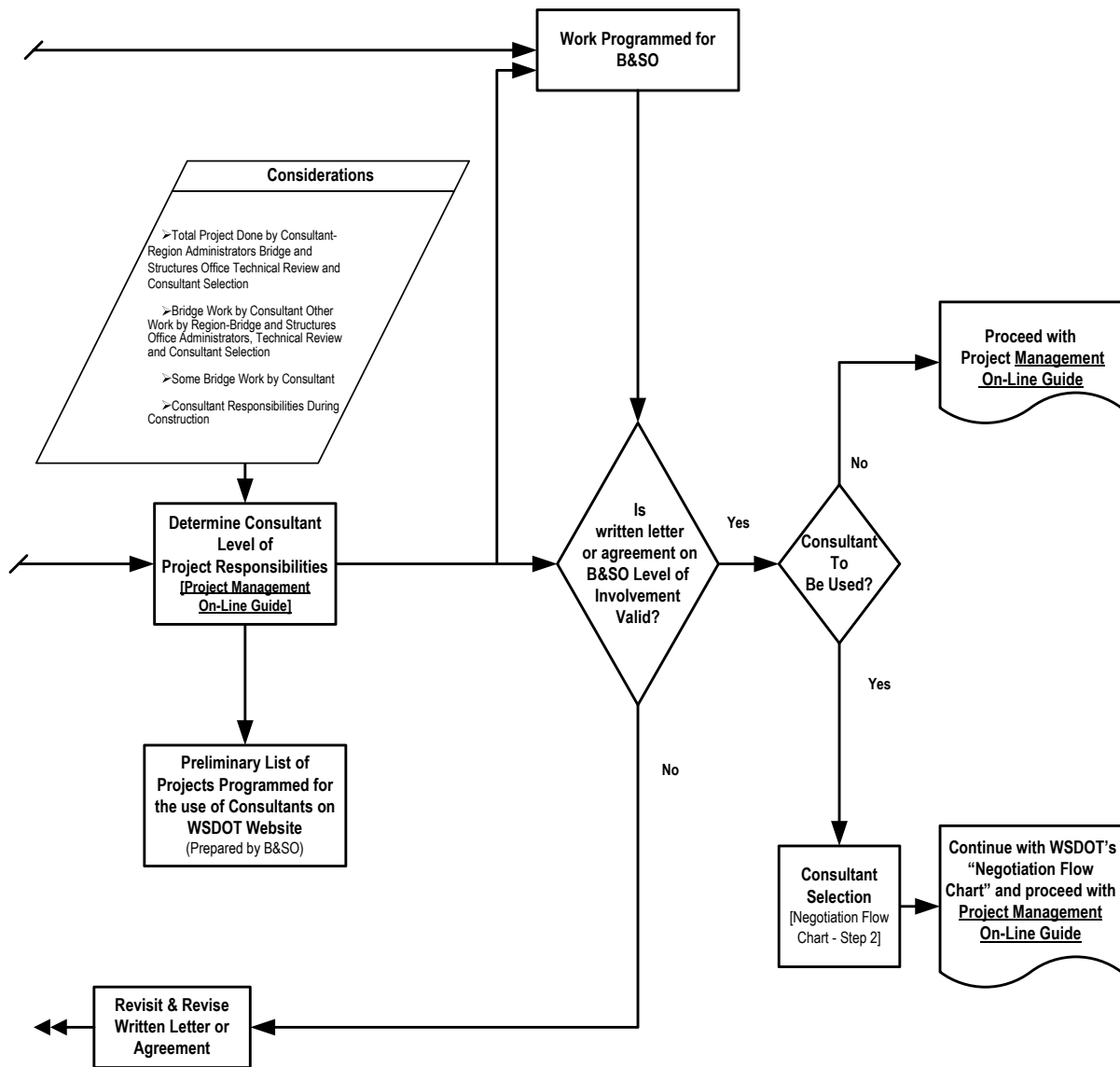
More information on this process and the desired outcomes is available on the Bridge and Structures Office's homepage at:



FHWA - Federal Highway Administration
 WSDOT - Washington State Department of Transportation
 DB - Design Build

DBB - Design Bid Build
 B&SO - Bridge & Structures Office
 ROW - Right of way

Determination of the Roles and Responsibilities for Projects with Structures (Project Development Phase)
Figure 141-1a



**Determination of the Roles and Responsibilities for Projects with Structures
(Project Development Phase)**
Figure 141-1b

- 315.01 General
- 315.02 References
- 315.03 Definitions
- 315.04 Procedure
- 315.05 Documentation

315.01 General

Value Engineering is a systematic process designed to focus on the major issues of a complex project or process. It uses a multi-disciplined team to develop recommendations for the important decisions that must be made. The primary objective of a Value Engineering study is *Value Improvement*.

For projects, the value improvements might be improvements in scope definition, functional design, constructibility, coordination (both internal and external), or the schedule for project development. Other possible value improvements are reduced environmental impact, reduced public (traffic) inconvenience, or reduced project cost. The Value Engineering process incorporates, to the extent possible, the values of the design engineer, construction engineer, maintenance engineer, contractor, state and federal approval agencies, local agencies, other stakeholders, and the public. Important design decisions are formulated from the recommendations of the Value Engineering team.

315.02 References

CFR 23 Part 627 Value Engineering

Value Engineering for Highways, Study Workbook, U. S. Department of Transportation, FHWA

Introduction To Value Engineering Principles and Practices, Transportation Partnership in Engineering Education Development (TRANSPEED), University of Washington.

315.03 Definitions

Value Engineering (VE) A systematic application of recognized techniques by a multi-disciplined team to identify the function of a product or service, establish a worth for that function, generate alternatives through the use of creative thinking, and provide the needed functions to accomplish the original purpose; thus assuring the lowest life cycle cost without sacrificing safety, necessary quality, or environmental attributes. Value Engineering is sometimes referred to as Value Analysis (VA) or Value Management (VM).

project The portion of a transportation facility that WSDOT proposes to construct, reconstruct, or improve, as described in the *State Highway System Plan* or applicable environmental documents. A project may consist of several contracts or phases over several years that are studied together as one *project*.

315.04 Procedure

The VE process uses the Eight-Phase Job Plan in Figure 315-1. Only the phases 1 and 7 are discussed in this chapter. A detailed discussion of phases 2 through 6 can be found in the VE training manual entitled *Introduction To Value Engineering Principles and Practices*.

(1) Selection Phase

(a) Project Selection

Projects for VE studies may be selected from any of the categories identified in the Highway Construction Program, including *Preservation* or *Improvement* projects, depending on the size and/or complexity of the project. In addition to the cost, other issues adding to the complexity of the project design are considered in the selection process. These complexities include: critical constraints, difficult technical issues, expensive solutions, external influences, and complicated functional requirements.

A VE study is required for any federally funded NHS project with an estimated cost of \$25 million or more (CFR 23 Part 627). Other types of projects that usually provide the highest potential for value improvement have a preliminary estimate exceeding \$5 million and include one or more of the following:

- Projects with alternative solutions that vary the scope and cost
- New alignment or bypass sections
- Capacity improvements that widen an existing highway
- Major structures
- Interchanges on multilane facilities
- Projects with extensive or expensive environmental or geotechnical requirements
- Materials that are difficult to acquire or require special efforts
- Inferior materials sources
- Major reconstruction
- Projects requiring major traffic control
- Projects with multiple stages

(b) Statewide VE Study Plan

On a biennial basis, the state VE manager coordinates with the region VE coordinators to prepare the Two-Year VE Study Plan with specific projects scheduled by quarter. The VE Study Plan is the basis for determining the projected VE program needs, including team members, team leaders, and training. The Statewide VE Study Plan is a working document and close coordination is necessary between HQ and the regions to keep it current.

The regional VE coordinator:

- Identifies potential projects for VE studies from the Project Summaries and the available planning documents for future work.
- Makes recommendations for the VE study timing.
- Presents a list of the identified projects to regional management to prioritize into a regional Two-Year VE Study Plan. (VE studies other than projects are also included in the plan.)

The State Design Engineer:

- Reviews the regional Two-Year VE Study Plan regarding the content and schedule of the plan.

The state VE Manager:

- Incorporates the regional Two-Year VE Study Plans and the HQ Study Plans to create the Statewide VE Study Plan.

(c) VE Study Timing

Selecting the project at the appropriate stage of development (the timing of the study) is very important to the success of the VE program. Value can be added by performing a VE study any time during project development; however, the WSDOT VE program identifies three windows of opportunity for performing a VE study.

1. Problem Definition Stage

As soon as preliminary engineering information is available and the specific deficiencies or “drivers” are identified, the project scope and preliminary cost are under consideration. This is the best time to consider the various alternatives or design solutions and there is the highest potential that the related recommendations of the VE team can be implemented. At the conclusion of the VE study, the project scope, preliminary cost, and major design decisions can be based on the recommendations.

When conducting a study in the problem definition stage, the VE study focuses on issues affecting project “drivers.” This stage often provides an opportunity for building consensus with stakeholders.

2. Conceptual Design Stage

At the conceptual design stage, the project scope and preliminary cost have already been established and the major design decisions have been made. Some PS&E activities might have begun and coordination has been initiated with the various service units that will be involved with the design. At this stage, the established project scope, preliminary cost, and schedule will define the limits of the VE study. There is still opportunity for a VE study to focus on the technical issues for each of the specific design elements.

3. 30 % Development Stage

At the 30% stage, most of the important project decisions have been made and the opportunity to affect the project design is limited. The VE study focuses on constructibility, construction sequencing, staging, traffic control elements, and any significant design issues that have been identified during design development.

(d) Study Preparation

To initiate a VE study, the project manager submits a Request for Value Engineering Study form (shown in Figure 315-2) to the region VE coordinator at least one month before the proposed study date.

The regional VE coordinator then works with the state VE Manager to determine the team leader and team members.

The design team prepares a study package that includes project information for each of the team members. A list of potential items is shown in Figure 315-3.

The region provides a facility and the equipment for the study (Figure 315-3).

(e) Team Leader

The quality of the VE study is dependent on the skills of the VE team leader. This individual guides the team efforts and is responsible for its actions during the study. The best VE team leader is knowledgeable and proficient in transportation design and construction, and in the VE study process for transportation projects.

For best results, the team leader should be certified by the Society of American Value Engineers (SAVE) as a Certified Value Specialist (CVS) or as a Value Methodology Practitioner (VMP).

Team leadership can be supplied from within the region or from other regions, HQ, consultants, or other qualified leaders outside the department. The state VE Manager coordinates with the regional VE coordinator to select the team leader. A statewide pool of qualified team leaders is maintained by the state VE Manager.

(f) Team Members

The VE team is usually composed of five to eight persons with diverse backgrounds that are relevant to the specific study. The team members may be selected from the regions, HQ, other state and federal agencies, local agencies, and the private sector.

The team members are selected on the basis of the kinds of expertise needed to address the major functional areas and critical high-cost issues of the study. All team members must be committed to the time required for the study. For best results, the team members have had VE training before participating in a VE study.

(g) VE Study Requirements

The time required to conduct a VE study varies with the complexity and size of the project, but typically ranges from three to five days.

The VE study Final Report and Workbook include a narrative description of project input information, background and history, constraints and drivers, VE team focus areas, and a discussion of the team speculation, evaluation, and recommendations. All of the team's evaluation documentation (including sketches, calculations, analyses, and rationale for recommendations) is included in the Workbook as part of the Final Report. Include a copy of the Final Report and Workbook in the Project File. The number of copies of the Final Report and Workbook is specified by the project manager.

(2) Implementation Phase

The VE team's recommendations are included in the Final Report and Workbook. The project manager reviews and evaluates the recommendations and prepares a VE Decision Document. This document has a specific response for each of the VE team recommendations and a summary statement containing the managers' decisions and schedule for implementation regarding further project development.

The VE Decision Document also includes estimated costs or savings of the recommendations, as well as the estimated cost to implement the recommendations. A copy of this document is sent to the state VE Manager so the results can be included in the annual VE report to FHWA.

The VE Decision Document is submitted to the State Design Engineer and a copy becomes a vital element in the design file for the project. Project development then continues based on the decisions developed from the preliminary engineering and the VE study recommendations (barring participation agreements funded by other agencies, utilities, developers, and so forth).

315.05 Documentation

The documents required to be preserved in the Design Documentation Package (DDP) or the Project File (PF) is on the following web site:
<http://www.wsdot.wa.gov/eesc/design/projectdev>

1. Selection Phase 315.04(1)	Select the right projects, timing, team, and project processes and elements.
2. Investigation Phase	Investigate the background information, technical input reports, field data, function analysis, and team focus and objectives.
3. Speculation Phase	Be creative and brainstorm alternative proposals and solutions.
4. Evaluation Phase	Analyze design alternatives, technical processes, life cycle costs, documentation of logic, and rationale.
5. Development Phase	Develop technical and economic supporting data to prove the feasibility of the desirable concepts. Develop team recommendations. Recommend long-term as well as interim solutions.
6. Presentation Phase	Present the recommendations of the VE team in an oral presentation, and in a written report and workbook.
7. Implementation Phase 315.04(2)	Evaluate the recommendations. Prepare an implementation plan (VE Decision Document) including the response of the managers and a schedule for accomplishing the decisions based on the recommendations.
8. Audit Phase	Maintain a records system to track the results and accomplishments of the VE program on a statewide basis. Compile appropriate statistical analyses as requested.

Steps 2-6 are performed during the study, see *Introduction To Value Engineering Principles and Practices* for procedures during these steps.

Eight-Phase Job Plan for VE Studies
Figure 315-1

Project Title:					
SR No.	MP	to	MP	Length	Subprogram
PIN			WIN		
Assigned Project Engineer					
Proposed Advertising Date					
Estimated Right of Way Costs			Estimated Construction Costs		
Design Speed			Projected ADT		
Route Conditions/Geometry:					
Adjacent Segments					
Overall Route					
Major Project Elements					
Environmental Issues					
Construction Issues					
Suggested Value Team Composition:					
Architecture		Hydraulics			
Bridge		Landscape Architecture			
Construction		Maintenance			
Design		Planning/Programming			
Environmental		Traffic			
Other _____		Real Estate Services			
Region Contact Person			Dates requested for VE study		

Request for Value Engineering Study
Figure 315-2

Project-Related Input* (Study Package)	Study-Related Facilities and Equipment
Design File	Room w/large table
Quantities	Phone
Estimates	Photo/Video log access/SRView
R/W Plans	Van for Field Trip **
<u>Geotechnical Reports</u>	Easel(s)
Plan Sheets	Large Tablet Paper (2x2 squares)
Environmental Documents	Colored Marking Pens
X-sections and Profiles	Masking and Clear Adhesive Tape
Land Use Maps	Workbook(s)
Contour Maps	Polaroid Camera
Quadrant Maps	Design Manual
Accident Data	"Green Book"
Traffic Data	Standard Plans
Up-to-Date Large-Scale Aerial Photographs	Standard Specifications
Vicinity Map	M.P. Log
Hydraulics Report	Bridge List
Aerial Photos	WSDOT Phone Book
Existing As-Built Plans	Scales and Straight Edge
	Red Book - Field Tables
	Unit Bid Prices
	Calculators
	Scissors

- * Not all information listed may be available to the team depending on the stage of the project.
- ** If field trip is not possible, provide video of project.

VE Study Team Tools
Figure 315-3

Chapter 330

Design Documentation, Approval, and Process Review

- 330.01 General
- 330.02 References
- 330.03 Definitions
- 330.04 Design Documentation
- 330.05 Project Development
- 330.06 Scoping Phase
- 330.07 FHWA Approval
- 330.08 Design Approval
- 330.09 Process Review

330.01 General

The project file contains the documentation of planning, scoping, programming, design, approvals, contract assembly, utility relocation, needed right of way, advertisement, award, construction, and maintenance review comments for a project. A project file is completed for all projects and is retained by the region office responsible for the project. Responsibility for the project will shift from one office to another during the life of a project. The project file follows the project, as the project responsibility shifts from office to office. Portions of the project file that are not designated as components of the Design Documentation Package may be purged when retention of the construction records is no longer necessary.

The Design Documentation Package is a part of the project file. It documents and justifies design decisions and the design process followed. The Design Documentation Package is retained in a permanent, retrievable file for a period of 75 years, in accordance with WSDOT records retention policy.

For operational changes and developer projects, design documentation is required and is retained by the region office responsible for the project, in accordance with WSDOT records retention policy. All participants in the design process must provide the appropriate documentation for their decisions.

330.02 References

Code of Federal Regulations (CFR) 23 CFR 635.111 "Tied bids"

23 CFR 635.411 "Material or product selection"

Revised Code of Washington (RCW) 47.28.030
Contracts -- State forces -- Monetary limits
-- Small businesses, minority, and women
contractors -- Rules.

RCW 47.28.035 Cost of project, defined.

Washington Federal-Aid Stewardship
Agreement, as implemented in the
design matrices (Chapter 325)

Executive Order E 1010.00, "Certification of
Documents by Licensed Professionals," WSDOT

Directional Documents Index, D 00-00, WSDOT

Advertisement and Award Manual, M 27-02,
WSDOT

Hydraulics Manual, M 23-03, WSDOT

Master Plan for Limited Access Highways,
WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Route Development Plan, WSDOT

Washington State Highway System Plan, WSDOT

330.03 Definitions

Design Approval Documented approval of the Design Documentation Package through signature of a designated representative of the approving organization as shown in Figures 330-2a and 330-2b. This documentation becomes part of the Design Documentation Package. If federal funds are involved, Design Approval is required in order to begin right of way acquisition.

Design Concurrence An incremental Design Approval by the designated representative of the approving organization shown in Figures 330-2a and 330-2b. The Project Summary documents must be submitted to the designated approval authority before Design Concurrence can be granted. The primary purpose of Design Concurrence is for work order authorization to establish funding for preliminary engineering.

DE A design exception. Preauthorization to omit correction of an existing design element for various types of projects, as designated in the design matrices. See Chapter 325. A DE designation indicates that the design element is normally outside the scope of the Project Type. See Figure 330-1.

design variance A recorded decision to differ from the design level specified in the *Design Manual*, such as an Evaluate Upgrade (EU) not upgraded, a DE, or a deviation. EUs leading to an upgrade are documented but are not considered to be variances. A project or corridor analysis may also constitute a design variance if that analysis leads to a decision to use a design level or design classification that differs from what the *Design Manual* specifies for the project type.

Design Variance Inventory (DVI) A list of design elements that will not be improved in accordance with the *Design Manual* criteria designated for the project.

Design Variance Inventory System (DVIS)
A database application developed to generate the DVI form. The DVIS also provides query functions providing designers an opportunity to search for previously granted variances. The DVIS application can be accessed at:
<http://www.wsdot.wa.gov/eesc/design/projectdev/>

deviation A documented decision granting approval at project specific locations to differ from the design level specified in the *Design Manual*. See Figure 330-1.

environmental documents:

NEPA National Environmental Policy Act

SEPA [Washington] State Environmental Policy Act

CE NEPA: Categorical Exclusion

CE SEPA: Categorical Exception

EA Environmental Assessment

ECS Environmental Classification Summary

EIS Environmental Impact Statement

ERS Environmental Review Summary

FONSI Finding Of No Significant Impact

ROD Record of Decision

EU An evaluate upgrade. A decision making process, requiring evaluation and documentation of whether or not to correct an existing design element as designated in the design matrices. See Figure 330-1.

FHWA Federal Highway Administration

HQ The Washington State Department of Transportation headquarters organization

Project Control Form A form used to document and approve revisions to project scope, schedule, or budget, from a previously approved Project Definition. There are two versions of the Project Control Form. One version of the form is specifically for projects included in the Nickel Funding Package enacted by the 2003 legislature. The other version of the form is for projects that are not included in the Nickel Funding Package. The form is available at:
<http://www.wsdot.wa.gov/ppsc/pgmmgt/dpsb/>

project file A file containing all documentation and data for all activities related to a project. See 330.01 and 330.04.

Design Documentation Package (DDP)

The portion of the project file, including required project approvals, that will be retained long-term, in accordance with the WSDOT document retention policies. Depending on the scope of the project, it contains the Project Summary and some or all of the other documents discussed in this chapter plus technical reports, calculations (quantity calculations are part of the project file, but are not designated as components of the DDP), estimates, justifications for decisions made, and any applicable documents listed in the Design Documentation Check List on the web.

See 330.04(2). The Design Documentation Package explains how and why the design was chosen, and documents approvals. See 330.01.

Project Summary A set of electronic documents consisting of the Environmental Review Summary (ERS), Design Decisions Summary (DDS), and Project Definition (PD). The Project Summary is part of the design documentation required to obtain Design Concurrence and ultimately is part of the design documentation required for Design Approval. See 330.06.

Environmental Review Summary (ERS)

An electronic document that records the environmental requirements and considerations for a specific project.

Design Decisions Summary (DDS)

An electronic document that records major design decisions regarding roadway geometrics, roadway and roadside features, and other issues that influence the project scope and budget.

Project Definition (PD) An electronic document that records the purpose and need of the project, along with program level and design constraints.

scoping phase The first phase of project development for a specific project. It follows identification of the need for a project and precedes detailed project design. This is the process of identifying the work to be done and developing a cost estimate for completing the design and construction. The Project Summary, engineering and construction estimates, and several technical reports (such as geotechnical, surfacing, bridge condition, etc.) are developed during this phase.

330.04 Design Documentation

(1) Purpose

Design documentation is prepared to record the evaluations by the various disciplines that result in design recommendations. Design assumptions and decisions made prior to and during the

scoping phase are included. Changes that occur throughout project development are documented. Justifications and approvals, if required, are also included.

The Design Documentation Package identifies the purpose and need of the project and documents how the project addresses the purpose and need. The required content of the Design Documentation Package is identified in the Design Documentation Check List at:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

(2) Design Documents

The Design Documentation Package portion of the project file preserves the decision documents generated during the design process. In each package, a summary (list) of the documents is recommended.

The design documents commonly included in the project file and Design Documentation Package for all but the simplest projects are listed in Figure 330-5. For project-specific components, provide documentation in the project file and Design Documentation Package as detailed in the Design Documentation Check List at:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

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

The Design Variance Inventory is required for all projects on NHS highways having design variances and is recommended for all projects having design variances. This form lists all evaluate upgrades (EU) not upgraded to the applicable design level, design exceptions (DE), and deviations as indicated by the design matrices. Also, record variances resulting from a project or corridor analysis in the DVI. Use the Design Variance Inventory System (DVIS) database application to record and manage design variances. The DVIS is available at:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

The Project Definition (PD) and Environmental Review Summary (ERS) are required for most projects. Exceptions will be identified by the Project Control and Reporting office.

The Design Decisions Summary (DDS) is not required for the following project types unless they involve reconstructing the lanes, shoulders, or fill slopes. Since these and some other 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 NHS routes. Include, in the evaluation, only those design elements specifically impacted by the project. Although the following list illustrates some of the project types that do not require a DDS, the list is not intended to be a complete accounting of all such projects. Consult with the Project Control and Reporting office for projects not included in the list.

- Bridge painting
- Crushing and stockpiling
- Pit site reclamation
- Lane marker replacement
- Guide post replacement
- Signal rephasing
- Signal upgrade
- Seismic retrofit
- Bridge joint repair
- Navigation light replacement
- Signing upgrade
- Illumination upgrade
- Rumble strips
- Electrical upgrades
- Major drainage
- Bridge scour
- Fish passage
- Other projects as approved by the HQ Design Office

(3) Certification of Documents by Licensed Professionals

All original technical documents must bear the certification of the responsible licensee. See Executive Order E 1010.00.

(4) Design Exception, Evaluate Upgrade, and Deviation Documentation

See Figure 330-1 for design matrices documentation requirements.

In special cases, projects may need to address design elements, which are shown as blank cells in a design matrix. These special cases must be coordinated with the appropriate Assistant State Design Engineer, and the HQ Project Control and Reporting office. When this is necessary, document the reasons for inclusion of that work in your project.

When the design matrices specify a DE for a design element, the DE documentation must specify the matrix and row, the design element, and the limits of the exception. When a Design Variance Inventory is required for the project, the DE locations must be recorded in the inventory.

All EU decisions must be documented. The EU process determines if an item of work will or will not be done, through analysis of factors such as benefit/cost, route continuity, accident reduction potential, environmental impact, and economic development. Documentation requirements for an EU decision are similar to, but less demanding than, documentation requirements for a deviation. The cost of the improvement must always be considered when making EU decisions. EU examples on the Internet can serve as models for development of EU documentation. The appropriate approval authority for EUs is designated in Figures 330-2a and 330-2b.

Deviation requests are stand-alone documents requiring enough information and project description for an approving authority to make an informed decision of approval or denial. Documentation of a deviation must contain justification and must be approved at the appropriate administrative level as shown in Figures 330-2a and 330-2b. Submit the request as early as possible because approved deviations are needed prior to Design Approval or Intersection/Interchange Plan approval.

Matrix Cell Content	Project corrects design elements that do not conform to specified design level	Document to file [1]	Record in DVIS [2]
Blank cell in design matrix		No	No
Blank cell in design matrix ^[3]		DDP	No
Cell Entry			
Full (F), Modified (M), Basic (B) (with no DE or EU qualifiers)	Yes	No	No
	No ^[4]	Yes ^[5]	Yes
Design Exception (DE)	Yes ^[3]	DDP	No
	No	DDP	Yes
Evaluate Upgrade (EU) ^[5]	Yes	DDP	No
	No	DDP	Yes

DDP = Document to Design Documentation Package

Notes:

- [1] See 330.04(3)
- [2] See 330.04(2)
- [3] May be included in the project in special cases, if identified in the Project Summary or Project Control Form
- [4] Nonconformance with specified design level (Chapter 325) requires an approved deviation
- [5] Requires supporting justification (See 330-04(4).)

Design Matrix Documentation Requirements

Figure 330-1

When applying for deviation approval, it is necessary to provide two explanations. The first identifies the design element and explains why the design level specified in the design matrices was not or cannot be used. The second provides the justification for the design that is proposed. Justification for a deviation must be supported by at least two of the following:

- Accident history and accident analysis
- Benefit/cost analysis
- Engineering judgment
- Environmental issues
- Route continuity

An element of engineering judgment might be a reference to another publication, with an explanation of why that reference is applicable to the situation encountered on the project.

If the element you wish to deviate from, meets the AASHTO *Policy on Geometric Design of Highways and Streets*, but not the *Design Manual* criteria, the only documentation and justification required to support the deviation request is to;

- Identify the design element
- Explain why the design level specified in the design matrices was not used
- Explain which reference to the AASHTO *Policy on Geometric Design of Highways and Streets* was used (including the publication date, chapter, and page number of the policy)

Approval is at the appropriate administrative level, as shown in Figures 330-2a and 330-2b.

Reference a corridor or project analysis as supporting justification for design deviations dealing with route continuity issues. See Chapter 325.

Once a deviation is approved, it applies to that project only. When a new project is programmed at the same location, the subject design element must be reevaluated and either (1) the subject design element is rebuilt to conform with the applicable design level, or (2) a new deviation is developed, approved, and preserved in the Design Documentation Package for the new project. Check the Design Variance Inventory System for help in identifying previously granted deviations.

A change in a design level resulting from an approved Route Development Plan or corridor or project analysis, as specified in design matrix notes, is documented similar to an EU. Design elements that do not comply with the design level specified in an approved corridor or project analysis are documented as deviations.

To prepare a deviation request, or to document an EU decision, use the list in Figure 330-6 as a general guide for the sequence of the content. The list is not all-inclusive of potential content and it might include suggested topics that do not apply to a particular project. Design deviation examples are on the Internet at: <http://www.wsdot.wa.gov/eesc/design/projectdev/>

330.05 Project Development

In general, the region initiates the development of a specific project by preparing the Project Summary. Some project types may be initiated by other WSDOT groups such as the Bridge Office or the Traffic Office, rather than the region. The project coordination with other disciplines (such as Real Estate Services, Utilities, and Environmental) is started in the project scoping phase and continues throughout the project's development. The region coordinates with state and federal resource agencies and local governments to provide and obtain information to assist in developing the project.

The project is developed in accordance with all applicable Directives, Instructional Letters, Supplements, and manuals as listed in D 00-00; the Master Plan for Limited Access Highways; *Washington State Highway System Plan*; *Route Development Plan*; Washington Federal-Aid Stewardship Agreement as implemented in the design matrices (Chapter 325); and the Project Summary.

The region develops and maintains documentation for each project. The project file includes documentation of project work including planning, scoping, public involvement, environmental action, design decisions, right of way acquisition, PS&E development, project advertisement, and construction. Refer to the *Plans Preparation Manual* for PS&E documentation.

All projects involving FHWA action require NEPA clearance. Environmental action is determined through the Environmental Classification Summary (ECS) form. The environmental approval levels are shown in Figures 330-3a and 3b.

Upon receipt of the ECS approval, for projects requiring an EA or EIS under NEPA, the region proceeds with environmental documentation, including instituting public involvement methods that are appropriate to the magnitude and type of the project. (See Chapter 210.)

The Assistant State Design Engineers work with the regions on project development and conduct process reviews on projects as described in 330.09.

330.06 Scoping Phase

Development of the project scope is the initial phase of project development for a specific project. This effort is prompted by the *Washington State Highway System Plan*. The project scoping phase consists of determining a project description, schedule, and cost estimate. The intent is to make design decisions early in the project development process that focus the scope of the project. During the project scoping phase, the Project Summary documents are produced.

Project Summary provides information on the results of the scoping phase; links the project to the *Washington State Highway System Plan* and the *Capital Improvement and Preservation Program (CIPP)*; and documents the design decisions, the environmental classification, and agency coordination. The Project Summary is developed and Design Concurrence is granted before the project is funded for design and construction. The Project Summary consists of ERS, DDS, and PD documents, which are

electronic forms. Specific on-line instructions for filling them out are contained in the Project Summary database.

Environmental Review Summary (ERS) lists the environmental permits and approvals that will be required, environmental classifications, and environmental considerations. This form lists requirements by environmental and permitting agencies. If there is a change in the Project Summary, the information in the ERS must be reviewed and revised to match the new Project Summary. The ERS is prepared during the scoping phase and is approved by the region.

Design Decisions Summary (DDS) states the design matrix used to develop the project, the roadway geometrics, design deviations, evaluate upgrades (EUs), other roadway features, and any design decisions made during scoping of a project. The information contained in this form is compiled from various databases of departmental information, field data collection, and evaluations made in development of the Project Definition and the ERS. Design decisions may be revised throughout the project development process based on continuing evaluations.

The DDS is approved by the appropriate Assistant State Design Engineer for new construction and reconstruction projects on the Interstate System before submittal to FHWA. See 330.07. The regional design authority approves the DDS for all other types of projects. To approve the Design Decisions Summary, the region must be comfortable that there will be no significant change in the Project Definition or estimated cost. If, however, there is a change to the PD or a significant change in the cost estimate, the DDS is to be revised or supplemented and reapproved. Significant cost changes require a Project Control Form to be submitted and approved by the appropriate designee.

Project Definition (PD) identifies the various disciplines and design elements that will be encountered in project development. The PD states the needs, the purpose of the project, program categories, and the recommendations for project phasing. This information determines the level of documentation and evaluation that is needed for Design Approval.

The PD is completed early in the scoping phase to provide a basis for full development of the ERS, DDS, schedule, and estimate. If circumstances necessitate a change to an approved PD, process a Project Control Form for approval by the appropriate designee, revise the original PD form, and obtain approval of the revisions.

330.07 FHWA Approval

For all NHS projects, the level of FHWA oversight varies according to the type of project, the agency doing the work, and the funding source as shown in Figures 330-2a and 330-2b. Oversight and funding do not affect the level of design documentation required for a project.

An FHWA determination of engineering and operational acceptance is required for any new or revised access point (including interchanges, temporary access breaks, and locked gate access points) on the Interstate System, regardless of funding. (See Chapter 1425.)

Documents for projects requiring FHWA review and Design Approval are submitted through the Headquarters (HQ) Design Office. Include applicable project documents as specified in Figure 330-5.

330.08 Design Approval

When the Project Summary documents are complete, and the region is confident that the proposed design adequately addresses the purpose and need for the project, a Design Concurrence may be entered into the Project File. (See Design Concurrence definition for purpose.)

When the Design Documentation Package is complete, Design Approval is granted by the approval authority designated in Figures 330-2a and 330-2b. The Design Approval becomes part of the DDP. See 330.04 and Figure 330-5 for design documents that may lead to Design Approval. Figures 330-2a through 330-4 present approval levels for project design and PS&E documents.

The following items must be approved prior to Design Approval:

- Required Environmental Documents
- Project Summary Documents
- Design Variance Inventory as required
- Cost Estimate

At the time of Design Approval, the Design Documentation Package addresses all guidance currently implemented in the *Design Manual*. If a project is delayed but is advertised within three years of the Design Approval, discuss *Design Manual* revisions with your Project Development Engineer, who will discuss the revisions with the appropriate Assistant State Design Engineer (ASDE) to determine if there is a need to redesign any portion of the project. If the ASDE determines that a redesign is not necessary, the ASDE will confirm with an e-mail. Place a copy of the e-mail confirmation in the Design Documentation Package to document that the current design criteria was evaluated and the ASDE agreed that a redesign is unnecessary.

Address new design policy for projects to be advertised more than three years after Design Approval, redesign as appropriate, and update the Design Documentation Package and the Design Approval to reflect the revisions. For an overview of design policy changes, consult the Detailed Chronology of Design Policy Changes Affecting Shelved Projects at:

<http://www.wsdot.wa.gov/eesc/design/policy/designpolicy.htm>

330.09 Process Review

The process review is done to provide reasonable assurance that projects are prepared in compliance with established policies and procedures and that adequate records exist to show compliance with state and federal requirements. Process reviews are conducted by WSDOT, FHWA, or a combination of both.

The design and PS&E process review is performed in each region at least once each year by the HQ Project Development Branch. The documents used in the review process are: the Design Documentation Check List, PS&E Review Check List, 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.

HQ Design Office, Project Development Branch maintains current copies on the Internet at: <http://www.wsdot.wa.gov/eesc/design/projectdev/>

Each project selected for review is examined completely and systematically beginning with the scoping phase (including planning documents) and continuing through contract plans and (when available) construction records and change orders. Projects are normally selected after contract award. For projects having major traffic design elements, the Maintenance and Operations Programs' Traffic Operations personnel are involved in the review. The WSDOT process reviews may be held in conjunction with FHWA process reviews.

The HQ Project Development Branch schedules the process review and coordinates it with the region and FHWA.

A process review follows this general agenda:

1. Review team meets with regional personnel to discuss the object of the review.
2. Review team reviews the design and PS&E documents, and the construction documents and change orders if available, using the check lists.
3. Review team meets with regional personnel to ask questions and clarify issues of concern.
4. Review team meets with regional personnel to discuss findings.
5. Review team submits a draft report to the region for comments and input.
6. If the review of a project shows a serious discrepancy, the regional design authority is asked to report the steps that will be taken to correct the deficiency.
7. The process review summary forms are completed.
8. The summary forms and check lists are evaluated by the State Design Engineer.
9. The findings and recommendations of the State Design Engineer are forwarded to the regional design authority, for action and/or information, within 30 days of the review.

Project Design	FHWA Oversight Level	Deviation and Corridor/Project Approval(a)(b)	EU Approval(b)	Design Approval
Interstate				
New/Reconstruction ^(c) <ul style="list-style-type: none"> Federal funds No federal funds 	(d) (e)	FHWA	Region	FHWA
Intelligent Transportation Systems (ITS) over \$1 million	(f)	HQ Design	Region	HQ Design
All Other ^(g) <ul style="list-style-type: none"> Federal funds State funds Local agency funds 	(f) (f) (e)	HQ Design	Region	Region
National Highway System (NHS)				
Managed access highway outside incorporated cities and towns, or inside unincorporated cities and towns, or on a limited access highway	(f)	HQ Design	Region	Region
Managed access highway within incorporated cities and towns ^(h) <ul style="list-style-type: none"> Inside curb or EPS⁽ⁱ⁾ Outside curb or EPS 	(f) (f)	HQ Design HQ H&LP	Region N/A	Region City/Town

FHWA = Federal Highway Administration
 HQ = WSDOT Headquarters
 H&LP = WSDOT Highways and Local Programs Office
 EPS = Edge of paved shoulder where curbs do not exist

- (a) These approval levels also apply to deviation processing for local agency work on a state highway.
- (b) See 330.04(4).
- (c) See Chapter 325 for definition.
- (d) Requires FHWA review and approval (full oversight) of design and PS&E submitted by HQ Design.
- (e) To determine the appropriate oversight level, FHWA reviews the Project Summary (or other programming document) submitted by HQ Design, or by WSDOT Highways and Local Programs through HQ Design.
- (f) FHWA oversight is accomplished by process review. (See 330.09)
- (g) Reduction of through lane or shoulder widths (regardless of funding) requires FHWA review and approval of the proposal.
- (h) Applies to the area within the incorporated limits of cities and towns.
- (i) Includes raised medians.

Design Approval Level
Figure 330-2a

Project Design	FHWA Oversight Level	Deviation and Corridor/Project Approval ^{(a)(b)}	EU Approval ^(b)	Design Approval
Non-National Highway System (Non-NHS)				
Improvement project on managed access highway outside incorporated cities and towns, or within unincorporated cities and towns, or on a limited access highway, (Matrix lines 5-8 through 5-26)	N/A	HQ Design	Region	Region
Improvement project on managed access highway within incorporated cities and towns ^(h) <ul style="list-style-type: none"> • Inside curb or EPS⁽ⁱ⁾ • Outside curb or EPS (Matrix lines 5-8 through 5-26)	N/A N/A	HQ Design HQ H&LP	Region N/A	Region City/Town
Preservation project on managed access highway outside incorporated cities and towns, or within unincorporated cities and towns, or on a limited access highway ^(j) (Matrix lines 5-1 through 5-7)	N/A	Region ^(k)	Region	Region
Preservation project on managed access highway within incorporated cities and towns ^{(h)(j)} <ul style="list-style-type: none"> • Inside curb or EPS⁽ⁱ⁾ • Outside curb or EPS (Matrix lines 5-1 through 5-7)	N/A N/A	Region HQ H&LP	Region N/A	Region City/Town

FHWA = Federal Highway Administration
HQ = WSDOT Headquarters
H&LP = WSDOT Highways and Local Programs Office
EPS = Edge of paved shoulder where curbs do not exist

- (a) These approval levels also apply to deviation processing for local agency work on a state highway.
- (b) See 330.04(4).
- (h) Applies to the area within the incorporated limits of cities and towns.
- (i) Includes raised medians.
- (j) For Bridge Replacement projects in the preservation program, follow the approval level specified for improvement projects.
- (k) See Chapters 1430 and 1435 for guidance on access deviations.

Design Approval Level
Figure 330-2b

Item	Approval Authority		
	Region	HQ	FHWA
Program Development			
Work Order Authorization		X	X [1]
Public Hearings			
Corridor Hearing Summary		X [2]	
Design Summary		X [3]	
Access Hearing Plan		X [4]	
Access Findings and Order		X [5]	
Environmental By Classification			
Summary (ECS) NEPA			X
Class I NEPA (EIS)		[7]	X
Class I SEPA (EIS)		X	
Class II NEPA *Programmatical Categorical Exclusion (CE)	X		
Class II NEPA — Documented Categorical Exclusion (CE)	[6]		X
Class II SEPA — Categorical Exemption (CE)	X		
Class III NEPA — Environmental Assessment (EA)		[7]	X
SEPA Check List	X		
Design			
Design Deviations	[8]	[8]	[8]
Experimental Features		X	X [9]
Environmental Review Summary	X		
Final Design Decisions Summary	X	X [3]	
Final Project Definition		X [10]	
Access Point Decision Report		[7]	X
Non-Interstate Interchange Access Point Report		X	
Interchange Plans	X [11]	X [9][11]	
Intersection Plans	X [11]	X [9][11]	
Right of Way Plans	[12]	X	
Monumentation Map	X		
Materials Source Report		X [13]	
Pavement Determination Report		X [13]	
Project Design Approval	[8]	[8]	[8]

Approvals
Figure 330-3a

Item	Approval Authority		
	Region	HQ	FHWA
Design			
Resurfacing Report		X ^[13]	
Signal Permits	X ^[14]		
Geotechnical Report		X ^[13]	
Tied Bids	X ^[15]		X ^{[9][15]}
Bridge Design Plans (Bridge Layout)	X	X	
Hydraulic Report	X ^[16]	X ^{[16][17]}	
Preliminary Signalization Plans		X ^[6]	
Rest Area Plans		X	
Roadside Restoration Plans	X ^[18]	X ^[19]	
Structures Requiring TS&L's		X	X
Wetland Mitigation Plans	X	X	
Wetland Mitigation Planting Plans	X ^[18]	X ^[19]	
Grading Plans	X ^[18]	X ^[19]	
Continuous Illumination – Main Line		X ^[20]	
Project Control Form	X ^[21]	X ^[21]	

X Normal procedure

* If on the preapproved list

Notes:

- [1] Federal aid projects only.
- [2] Environmental and Engineering Programs Director approval.
- [3] State Design Engineer approval.
- [4] Right of Way Plans Engineer approval.
- [5] Refer to Chapter 210 for approval requirements.
- [6] Final review & concurrence required at the region prior to submittal to approving authority.
- [7] Final review & concurrence required at HQ prior to submittal to approving authority.
- [8] Refer to Figures 330-2a & 330-2b for design approval level.
- [9] Applies to new/reconstruction projects on Interstate routes.
- [10] HQ Project Control & Reporting approval.
- [11] Include channelization details.
- [12] Certified by the responsible professional licensee.
- [13] Submit to HQ Materials Branch for review and approval.
- [14] Approved by region's Administrator.
- [15] See 23 CFR 635.111.
- [16] See M 23-03, *Hydraulics Manual* for additional guidance.
- [17] Region to submit Hydraulic Report. Refer to *Hydraulics Manual*.
- [18] Applies only to regions with a Landscape Architect.
- [19] Applies only to regions without a Landscape Architect.
- [20] Approved by State Traffic Engineer.
- [21] Consult HQ Project Control & Reporting for clarification on approval authority.

Approvals
Figure 330-3b

Item	New/ Reconstruction (Interstate only)	NHS and Non-NHS
DBE/training goals* **	(a)	(a)
Right of way certification for federal aid projects	FHWA ^(b)	FHWA ^(b)
Right of way certification for state funded projects	Region ^(b)	Region ^(b)
Railroad agreements	(c)	(c)
Work performed for public or private entities*	[1][2]	Region ^{[1][2]}
State force work*	FHWA ^{[3](d)}	[3](c)(d)
Use of state furnished stockpiled materials*	FHWA ^[4]	Region ^[4]
Stockpiling materials for future projects*	FHWA ^[4]	Region ^[4]
Work order authorization	[5](d)	[5](d)
Ultimate reclamation plan approval through DNR	Region	Region
Proprietary item use*	FHWA ^[4]	[4](c)
Mandatory material sources and/or waste sites*	FHWA ^[4]	Region ^[4]
Nonstandard bid item use*	Region	Region
Incentive provisions	FHWA	(e)
Nonstandard time for completion liquidated damages*	FHWA ^(e)	(e)
Interim liquidated damages*	(f)	(f)

Notes:

- [1] This work requires a written agreement.
- [2] Region approval subject to \$250,000 limitation.
- [3] Use of state forces is subject to \$50,000 limitation as stipulated in RCWs 47.28.030 and 47.28.035.
- [4] Applies only to federal aid projects. However, document for all projects.
- [5] Prior FHWA funding approval required for federal aid projects.

Regional or Headquarters approval authority:

- (a) Office of Equal Opportunity
- (b) Real Estate Services
- (c) Design Office
- (d) Project Control & Reporting Office
- (e) Construction Office
- (f) Transportation Data Office

References:

- ***Advertisement and Award Manual*
- **Plans Preparation Manual*

PS&E Process Approvals
Figure 330-4

Document ^[1]	Required for FHWA Oversight
Project Definition	X
Design Decisions Summary	X
Environmental Review Summary	X
Design Variance Inventory (and supporting information for DEs, EUs not upgraded, and deviations) ^[2]	X
Cost Estimate	X
SEPA & NEPA documentation	X
Design Clear Zone Inventory (see Chapter 700)	X
Interchange plans, profiles, roadway sections	X
Access Point Decision Report (if requesting new or revised access points)	X
Corridor or Project analysis (see Chapter 325)	X
Traffic projections and analysis	
Accident analysis	
Right of Way plans	
Work zone traffic control strategy	
Record of Survey or Monumentation Map	
Documentation of decisions to differ from WSDOT design guidance	
Documentation of decisions for project components for which there is no WSDOT design guidance	
<u>Paths and Trails Calculations</u> ^[3]	

Notes:

- [1] See Design Documentation Check List at <http://www.wsdot.wa.gov/eesc/design/projectdev/> for a complete list of project documentation requirements.
- [2] Required for NHS highways, recommended for all highways.
- [3] See *Plans Preparation Manual*.

Common Components of Design Documentation Package
Figure 330-5

1. Overview
 - (a) The safety or improvement need that the project is to meet
 - (b) Description of the project as a whole
 - (c) Highway classification and applicable design matrix
 - (d) Funding sources
 - (e) Evidence of deviations approved for previous projects (same location)
2. Design Alternatives in Question
 - (a) Existing Conditions and Design Data
 - Location in question
 - Rural, urban, or developing
 - Route development plan
 - Environmental issues
 - Right of way issues
 - Number of lanes and existing geometrics
 - Present and 20 year projected ADT
 - Design speed, posted speed and operating speed
 - Percentage of trucks
 - Terrain designation
 - Managed Access or Limited Access
 - (b) Accident Summary and Analysis
 - (c) Design Using the *Design Manual* criteria
 - Description
 - Cost estimate
 - B/C ratio
 - Advantages and disadvantages
 - Reasons for considering other designs
 - (d) Other Alternatives (may include “No-build” alternative)
 - Description
 - Cost estimate
 - B/C ratio
 - Advantages and disadvantages
 - Reasons for rejection
 - (e) Selected design requiring justification or documentation to file
 - Description
 - Cost estimate
 - B/C ratio
 - Advantages and disadvantages
3. Concurrences, Approvals, and Professional Seals

Deviation and Evaluate Upgrade Request/Documentation Content List
Figure 330-6

- 410.01 General
- 410.02 Required Basic Safety Items of Work
- 410.03 Minor Safety and Minor Preservation Work

410.01 General

Basic design level (B) preserves pavement structures, extends pavement service life, and maintains safe operations of the highway. The basic design level includes restoring the roadway for safe operations and, where needed, may include safety enhancement. Flexibility is provided so that other conditions can be enhanced while remaining within the scope of pavement preservation work.

The required safety items of work listed below may be programmed under a separate project from the paving project as long as there is some benefit to the delay, the safety features remain functional, and the work is completed within two years after the completion of the paving project. If some of the required items are separated from the paving project, maintain a separate documentation file that addresses the separation of work during the two-year time period.

For bituminous surface treatment projects on non-NHS routes, the separation of required safety items is not limited to the two years stated above. The safety work can be accomplished separately using a corridor-by-corridor approach.

410.02 Required Basic Safety Items of Work

For basic design level (B), the following items of work are required:

- Install and replace delineation in accordance with Chapter 830
- Install and replace rumble strips in accordance with the matrices and Chapter 700
- Adjust existing features that are affected by resurfacing, such as monuments, catch basins, and access covers
- Adjust guardrail height in accordance with Chapter 710
- Replace deficient signing, as needed, using current standards. This does not include replacement of sign bridges or cantilever supports
- Relocate, protect, or provide breakaway features for sign supports, luminaires, and WSDOT electrical service poles inside the design clear zone
- Restore sight distance at public road intersections and the inside of curves through low cost measures if they are available such as removal or relocation of signs and other obstructions, and cutting of vegetative matter
- Upgrade nonstandard bridge rail in accordance with the matrices and Chapter 710
- Upgrade barrier terminals and bridge end protection, including transitions, in accordance with Chapter 710
- Restore the cross slope to 1.5 percent when the existing cross slope is flatter than 1.5 percent and, in the engineer's judgment, the steeper slope is needed to solve highway runoff problems in areas of intense rainfall

410.03 Minor Safety and Minor Preservation Work

Consider the following items, where appropriate, within the limits of a pavement preservation project:

- Spot safety enhancements. These are modifications to isolated roadway or roadside features that, in the engineer's judgment, reduce potential accident frequency or severity
- When recommended by the region Traffic Engineer, additional or improved channelization to address intersection related accident concerns, where sufficient pavement width and structural adequacy exist or can be obtained. With justification, channelization improvements may be implemented, with lane and shoulder widths no less than the

design criteria specified in the “Rechannelize Existing Pavement” projects presented in Chapter 340. Consider the impacts to all roadways users. Consider illumination of these improvements. Document decisions when full illumination is not provided, including an analysis of the frequency and severity of nighttime accidents.

- Roadside safety hardware (such as guardrail, signposts, impact attenuators)
- Addressing Location 1 Utility Objects in accordance with the *Utilities Accommodation Policy*, M 22-86

Consider the following items when restoration, replacement, or completion is necessary to assure that an existing system can function as intended:

- Right of way fencing
- Drainage
- Illumination
- Electrical
- Pedestrian and bicycle use

Examples of the above include, but are not limited to, the following: installing short sections of fence needed to control access, replacing grates that are a hazard to bicycles, upgrading electrical system components that require excessive maintenance, and beveling culverts.

- 430.01 General
- 430.02 Design Speed
- 430.03 Alignment
- 430.04 Roadway Widths
- 430.05 Cross Slope
- 430.06 Side Slopes
- 430.07 Bike and Pedestrian
- 430.08 Bridges
- 430.09 Intersections
- 430.10 Documentation

430.01 General

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

The modified design level design criteria have been developed to apply to all applicable functional classes. As a result, for the lower volumes and urban highways modified design level design criteria might exceed full level design criteria. In these cases, full level design criteria may be used.

Projects developed to correct a deficiency, must address all design elements contributing to that deficiency, even when those elements meet modified design level design criteria

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

- Lane Transitions, Chapter 620
- On and off connections, Chapter 940
- Access control, Chapter 1420
- Clear zone, Chapter 700
- Signing, delineation, and illumination, Chapters 820, 830, and 840
- Basic safety, Chapter 410
- Structural capacity, Chapter 1120
- Vertical clearance, Chapter 1120
- Intersection sight distance, Chapter 910
- Traffic Barriers, Chapter 710

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. The desirable design speed for modified design level is given in Figure 430-1. The minimum design speed is not less than the posted speed, or the proposed posted speed. (See Chapter 440 for additional information on design speed.) Document which speed was used, include any supporting studies and data.

Route Type	Posted Speed	Desirable Design Speed
Freeways	All	10 mph over the posted speed
non-Freeways	45 mph or less	Not less than the posted speed
	Over 45 mph	5 mph over posted speed

Desirable Design Speed

Figure 430-1

When the posted speed exceeds the design speed for existing geometric features that are to remain in place (curve radius, superelevation, sight distance, or other elements that the design speed controls) one of two choices must be made:

- When appropriate, work with the region Traffic Office to lower the posted speed to be consistent with the existing design speeds for the geometric features on the facility.
- A corridor analysis can be completed in order to leave the posted speed unchanged and identify all design elements that do not meet the criteria for the existing posted speed. Identify each appropriate location for cautionary signing (including road approach sight distance) and work with the region Traffic Office to install the cautionary signing as provided for in the MUTCD (either by contract or region sign personnel). Consult with and obtain guidance from Region Project Development leadership prior to progressing with the corridor analysis and the design.

430.03 Alignment

(1) Horizontal Alignment

Consideration of horizontal alignment for modified design level is normally limited to curves. Curve design is controlled by the design speed [430.02], superelevation [430.03(4)], and stopping sight distance [430.03(3)].

Identify major modifications to horizontal alignment in the Project Summary. Total removal of pavement and reconstruction of the subgrade are examples of major modifications.

(2) Vertical Alignment

Vertical alignment consists of a series of profile grades connected by vertical curves.

(a) **Vertical curves.** Stopping sight distance controls crest vertical curves. Figure 430-8 gives the minimum curve length for crest vertical curves to remain in place for modified design level stopping sight distance. See 430.03(3) for additional information on modified design level stopping sight distance.

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

When either a crest or a sag vertical curve is to be reconstructed, use full design level design criteria (see Chapters 630 and 650).

(b) **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 vertical alignment in the Project Summary. Total removal of pavement and reconstruction of the subgrade are examples of major modifications. When changing the profile grade, see Chapter 440 for the maximum grade for the functional class of the route.

(3) Stopping Sight Distance

Stopping sight distance is a controlling factor for both vertical and horizontal alignment. A 2-foot object height is used for modified design level stopping sight distance evaluation. Figure 430-2 gives the minimum stopping sight distances allowed to remain in place.

Design Speed (mph)	Design Stopping Sight Distance (ft)
40 or less	155
45	200
50	250
55	305
60	360
65	425
70	495
75	570
80	645

**Stopping Sight Distance,
Modified Design Level**

Figure 430-2

(a) **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 430-9a. When reconstructing a horizontal curve, apply full design level criteria for sight distance. (See Chapter 650.)

For Figure 430-9a, an obstruction is any object with a height of greater than 2.75 feet 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. Objects between 2.75 feet and 2.00 feet above the roadway surface within the M distance might be a sight obstruction, depending on the distance from the roadway. See Figure 430-9b for guidance on determining if an object between 2.75 feet and 2.00 feet above the roadway surface is a sight obstruction.

(b) **Stopping Sight Distance for Vertical Curves.** For existing crest vertical curves use the algebraic difference in grades and the length of curve to compare the existing condition to the stopping sight distance requirements from Figure 430-2. Use the equations in Figure 430-3 or use Figure 430-8 to evaluate the existing curve.

When a crest vertical curve is lengthened, the minimum sight distance is increased; however, the length of the roadway that has the minimum sight distance is also increased. This results in a questionable benefit when the new sight distance is less than for full design level. Therefore, when the existing roadway is reconstructed to improve stopping sight distance, apply full design level criteria. (See Chapter 650.)

<p>When s is less than L:</p> $L = \frac{As^2}{2158}$
<p>When s is greater than L:</p> $L = 2s - \frac{2158}{A}$
<p>Where: L = Length of vertical curve, ft s = Sight distance, ft (Figure 430-2) A = Absolute value of the algebraic difference in grades, %</p>

**Minimum Crest Vertical Curve Length,
Modified Design Level
Figure 430-3**

(4) Superelevation

Evaluate existing superelevation using the equation in Figure 430-4. When the existing superelevation equals or exceeds the value from the equation, the modified design level design criteria is met.

When modifying the superelevation of an existing curve where the existing pavement is to remain in place, use the equation in Figure 430-4 to determine the required superelevation.

For curves on realigned roadways or where the roadway is to be rebuilt, provide full design level superelevation (See Chapter 642).

$e = \left(\frac{6.69V^2}{R} \right) - f$
<p>Where: R = Existing curve radius in ft. V = Design speed in mph from 430.02. e = Superelevation rate in %. f = Side friction factor from Figure 430-5.</p>

**Minimum Superelevation,
Modified Design Level
Figure 430-4**

Design Speed (mph)	Side Friction Factor (f)
15	17.5
20	17
25	16.5
30	16
35	15.5
40	15
45	14.5
50	14
55	13
60	12
65	11
70	10
75	9
80	8

**Side Friction Factor
Figure 430-5**

430.04 Roadway Widths

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

(1) Lane and Shoulder Width

Lane and shoulder widths are shown in Figures 430-10 and 11. Consider joint use with other modes of transportation in shoulder design.

Minimum ramp lane and shoulder widths are shown on Figure 430-14. Use full design level lane and shoulder widths (See Chapter 940) for new and rebuilt ramps.

(2) Turning Roadway Widths

It might be necessary to widen the roadway on curves to accommodate large vehicles. The proposed roadway width for a curve shall not be less than that of the adjacent tangent sections.

Widening of the total roadway width of a curve by less than 2-feet is not required for existing two-lane roadways that are to remain in place.

(a) *The two-lane two-way roadway* width of a curve may not be less than that shown in Figure 430-12a or, if the internal angle (delta) is less than 90 degrees, Figure 430-12b. The minimum total roadway width from Figure 430-12a or 12b may include the shoulder. When the shoulder is included, full-depth pavement is required.

(b) *One-way roadway and Ramp* widths on a curve are shown in Figure 430-6 for existing roadways that are to remain in place. Use full design level width (See Chapters 641 and 940) for new and rebuilt ramps.

(3) Median Width

Minimum median widths are given in Figure 430-10.

430.05 Cross Slope

On all tangent sections, the normal cross slopes of the traveled way are 2 percent.

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 cross slope to full design level criteria (See Chapter 640).

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

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-lane two-way roadway — the following conditions are met:

- The algebraic difference is not greater than 4 percent where the ADT is greater than 2,000.
- The algebraic difference is not greater than 5 percent where the ADT is 2,000 or less.
- The algebraic difference is not greater than 6 percent and the road is striped or signed for no passing.

Curve Radius (ft)	One-Lane ⁽¹⁾	Two-Lane ⁽²⁾
Tangent to 1,001	20	24
500	21	25
400	21	25
300	22	25
200	22	26
150	23	26
100	25	28
75	27	29
50	30	31

(1) Includes the shoulder width.
 (2) Add shoulder widths from Figure 430-10 for highways and 10 ft for ramps.

**One-Way Roadway and Ramp
 Turning Roadway Widths,
 Modified Design Level
 Figure 430-6**

For a two-lane two-way roadway, 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. The cross slope of the shoulder may be steepened to maximize curb height and minimize 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. See Chapter 640 for additional information.

430.06 Side Slopes

(1) Fill/Ditch Slopes

Foreslopes (fill slopes and ditch inslopes) and cut slopes are designed as shown in the Fill and Ditch Slope Selection Table on Figure 430-13 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 6H:1V where practical and at least to 4H:1V. 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.

(2) Cut Slopes

Existing stable backslopes (cut slopes) are to remain undisturbed unless disturbed by other work. When changes are required to a cut slope, design them as shown in the Cut Slope Selection Table on Figure 430-13.

430.07 Bike and Pedestrian

Sidewalk ramps must be addressed for Americans with Disabilities Act of 1990 (ADA) compliance on projects that include hot mix asphalt (HMA) or Portland cement concrete pavement (PCCP) overlays or inlays. Evaluate existing sidewalk ramps for compliance. Construct ADA compliant sidewalk ramps as required.

On Interstate Pavement Rehab./Resurface projects (See Chapter 325) that include HMA or PCCP overlays, or inlays on ramps or crossroads, sidewalk ramps must be addressed for ADA compliance. Other bicycle or pedestrian elements are design exceptions on HMA or PCCP overlays or inlays on Interstate ramps or crossroads.

Projects that widen the roadway, or change the traffic configuration by reducing the shoulders to add turn lanes are considered alterations of the roadway. Such alterations include a requirement to address ADA compliance for sidewalk ramps.

See Chapter 1025 for guidance on pedestrian facilities.

430.08 Bridges

Design all new and replacement bridges to full design level (See Chapter 440) unless a corridor or project analysis justifies the use of modified design level lane and shoulder widths. Evaluate bridges to remain in place using Figures 430-10 and 11. 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 Chapters 1020, 1025, 1050, and 1060.

430.09 Intersections

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

(1) Turn Radii

The intersection turn radii (or right-turn corners) are controlled by the design vehicle. Figure 430-7 is a guide for determining the design vehicle for modified design level. Perform a field review to determine intersection type, types of vehicles that use the intersection, and adequacy of the existing geometrics. When the crossroad is a city street or county road, consider the requirements of the city or county when selecting a design vehicle.

Design right turn corners to meet the requirements of Chapter 910 using the design vehicle selected from Figure 430-7 or from the field review.

(2) Angle

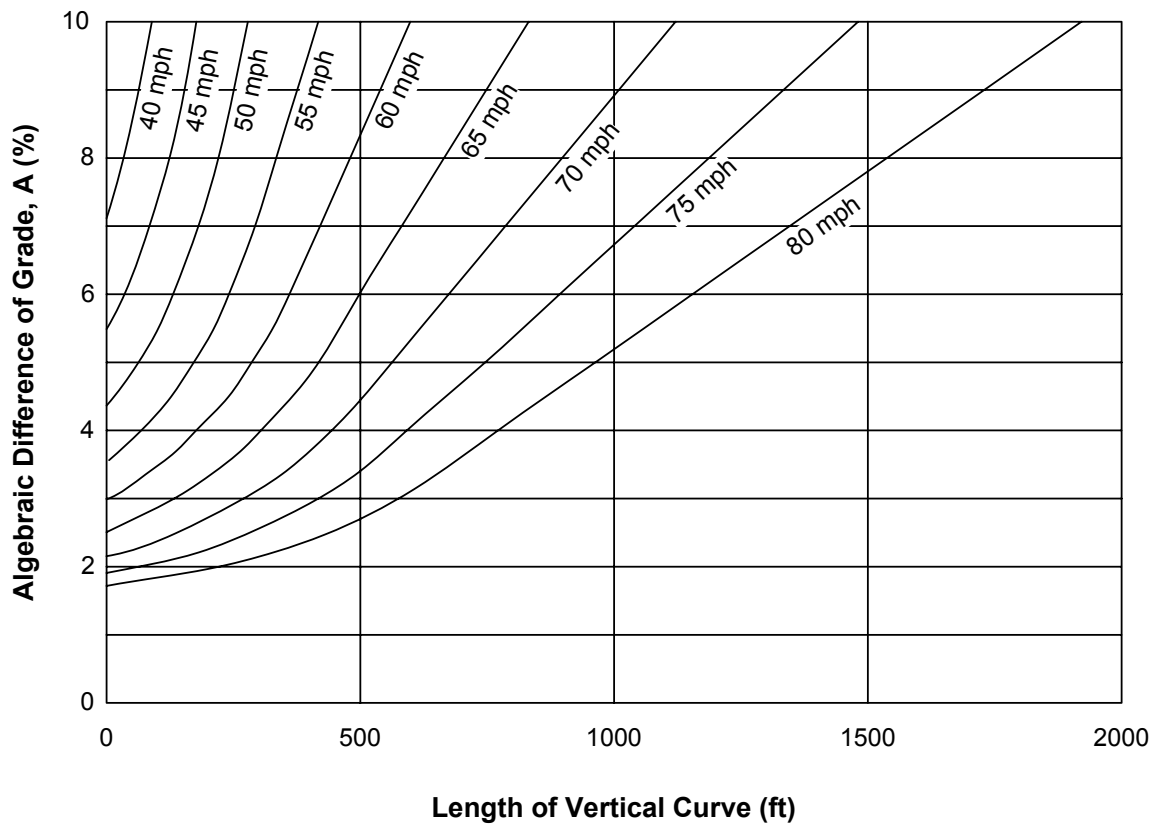
The allowable angle between any two respective legs is between 60° and 120°. When realignment is required to meet this angle requirement, consider realigning to an angle between 75° and 105°.

Intersection Type	Design Vehicle
Junction of Major Truck Routes	WB-67
Junction of State Routes	WB-40
Ramp Terminals	WB-40
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 430-7

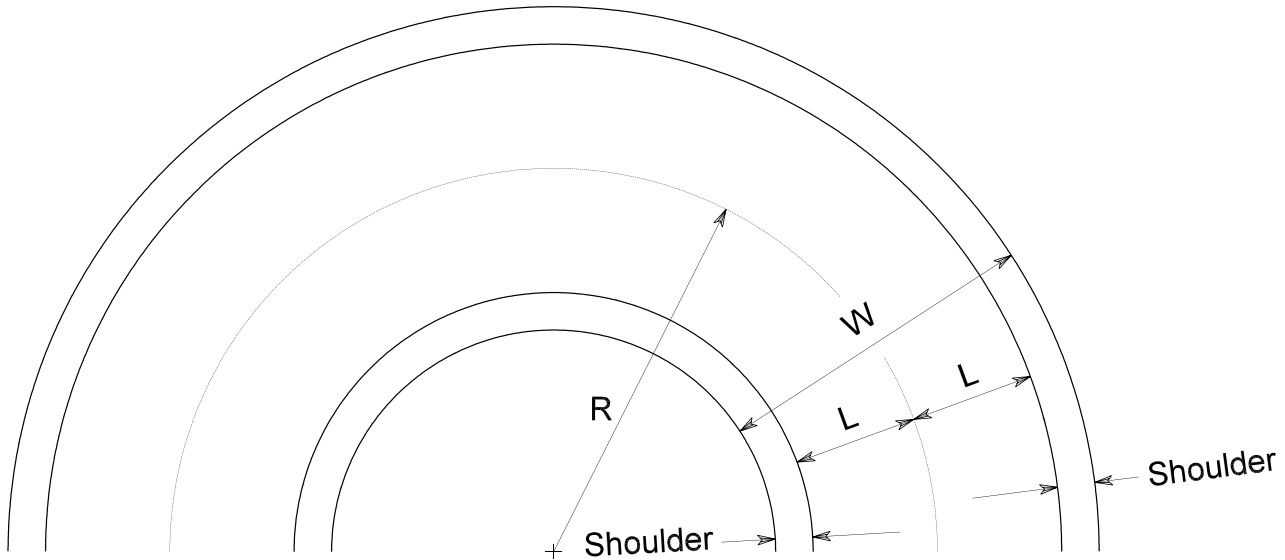
430.10 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site:
<http://www.wsdot.wa.gov/eesc/design/projectdev/>

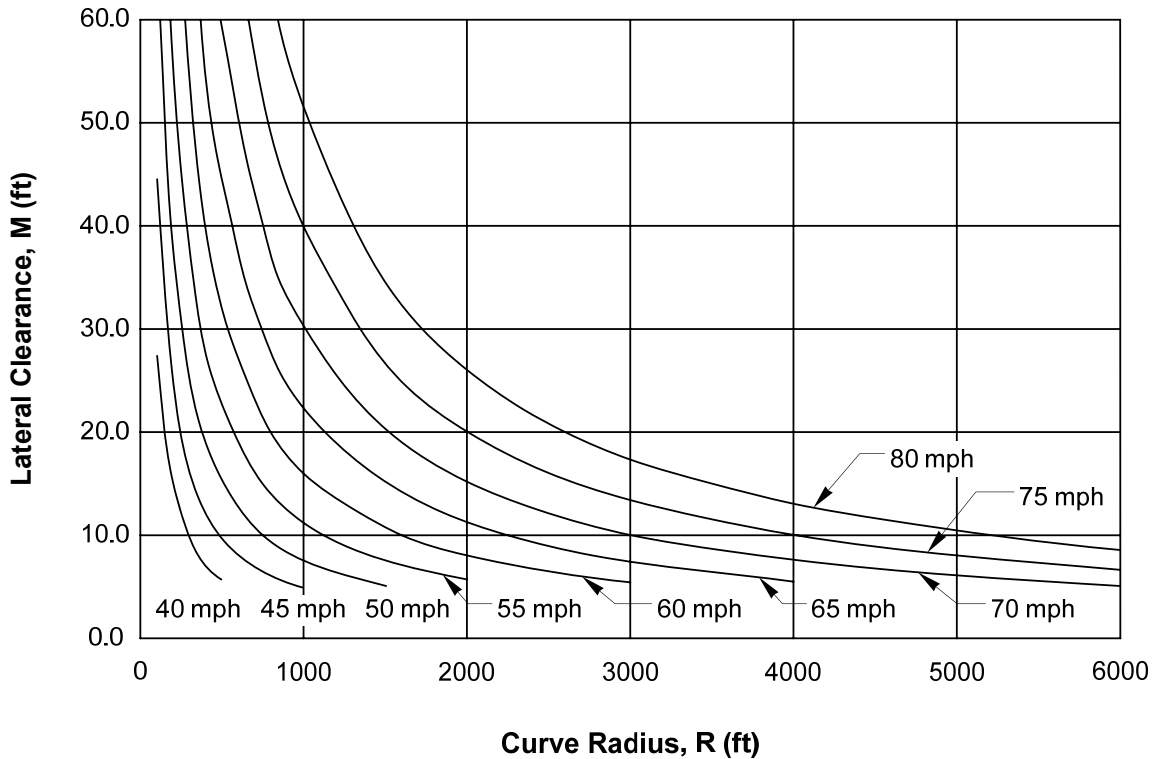


When the intersection of the algebraic difference of grade with the length of vertical curve is below the selected design speed line, modified design level design criteria is met.

**Evaluation for Stopping Sight Distance for Crest Vertical Curves,
Modified Design Level**
Figure 430-8



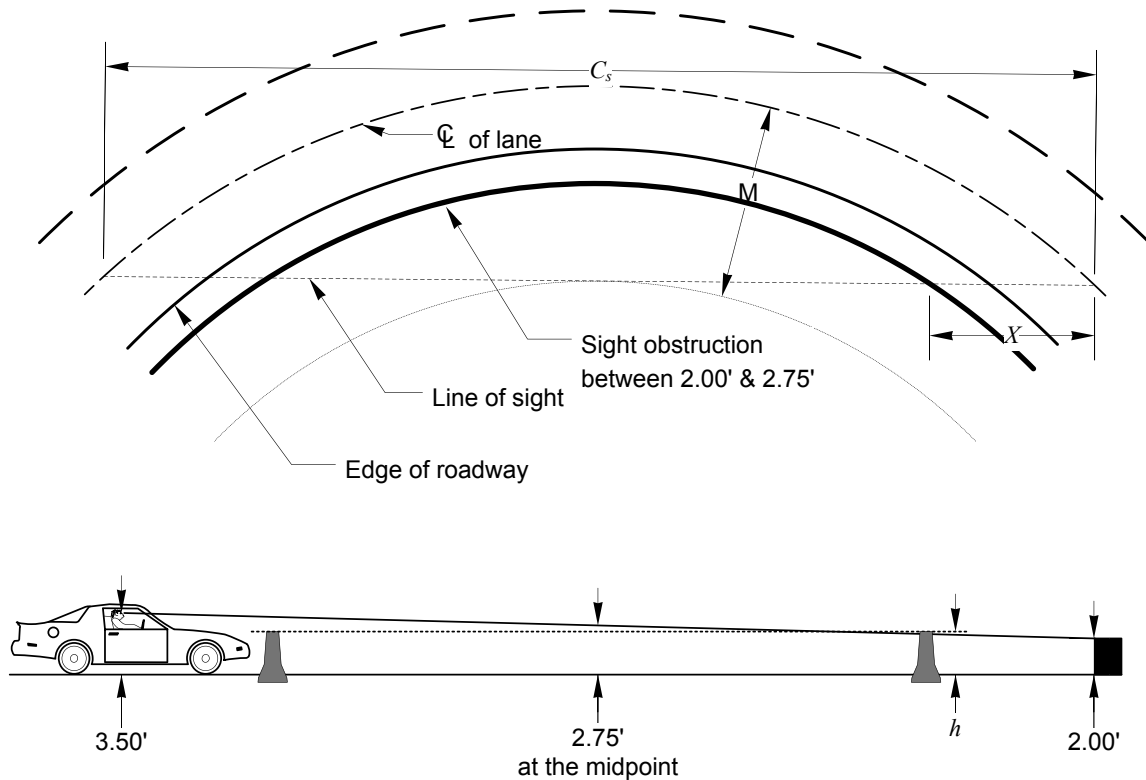
M is the distance in feet from the center line of the inside lane to the obstruction. Obstruction is a cut slope or other object 2.75 ft or more above the inside lane. Objects between 2.75 ft and 2.00 ft above the roadway surface within the M distance might be a sight obstruction, depending on the distance from the roadway. See Figure 430-9b.



When the intersection of the lateral clearance (M) with the curve radius (R) falls above the curve for the selected design speed, modified design criteria is met.

**Evaluation for Stopping Sight Distance for Horizontal Curves,
Modified Design Level**

Figure 430-9a



When $h \leq \left(2 + \frac{1.5X}{C_s} \right)$ modified design criteria is met.

Where:

- M = Lateral clearance for sight distance (ft) See Figure 430-9a
- C_s = Stopping sight distance chord (ft)
- X = Distance from the sight obstruction to the end of the sight distance chord (ft)
- h = Height of sight obstruction above the inside lane.

**Evaluation for Stopping Sight Distance Obstruction for Horizontal Curves,
Modified Design Level**
Figure 430-9b

	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	See Figure 430-1							
Traffic Lanes Number Width	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft
Parking Lanes Urban	None	None	None	None	8 ft	8 ft ⁽²⁾	8 ft	8 ft ⁽²⁾
Median Width Rural Urban	Existing Existing	Existing Existing	Existing Existing	Existing Existing	2 ft 2 ft	4 ft 2 ft	4 ft 2 ft	4 ft 2 ft
Shoulder Width Right ⁽³⁾ Left ⁽⁴⁾	4 ft 2 ft	6 ft 2 ft	4 ft 2 ft	6 ft 2 ft	4 ft	6 ft ⁽⁵⁾	4 ft	6 ft ⁽⁵⁾
Minimum Width for Bridges to Remain in Place ^{(6) (7) (8)}	24 ft ⁽⁹⁾	26 ft ⁽⁹⁾	24 ft ⁽⁹⁾	26 ft ⁽¹⁰⁾	48 ft ⁽⁹⁾	50 ft ⁽⁹⁾ ⁽¹¹⁾	50 ft ⁽⁹⁾ ⁽¹¹⁾	54 ft ⁽¹⁰⁾ ⁽¹¹⁾
Minimum Width for Rehabilitation of Bridges to Remain in Place ^{(6) (8) (12)}	28 ft ⁽⁹⁾	30 ft ⁽⁹⁾	28 ft ⁽⁹⁾	32 ft ⁽¹⁰⁾	54 ft ⁽⁹⁾	60 ft ⁽⁹⁾ ^{(11) (13)}	56 ft ⁽⁹⁾ ⁽¹¹⁾	64 ft ⁽¹⁰⁾ ^{(11) (13)}
Minimum Width for Replacement Bridges	Full Design Level Applies ⁽¹⁴⁾							
Access Control	See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Access Management Classification Report							

Notes:

- (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) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 feet. In urban areas, see Chapter 440. On a route identified as a local, state, or regional significant bicycle route the minimum shoulder width is 4 feet (See Chapter 1020).
- (4) When a curb section is used, the minimum shoulder width from the edge of traveled way to the face of the curb is 1 foot on the left.
- (5) May be reduced by 2 feet 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 25 feet or less, see Chapter 1120.
- (9) Add 11 feet for each additional lane.
- (10) Add 12 feet for each additional lane.
- (11) Includes a 4-foot median, which may be reduced by 2 feet 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 6-foot shoulders — may be reduced by 2 feet 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.

**Multilane Highways and Bridges,
Modified Design Level
Figure 430-10**

	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	See Figure 430-1					
Traffic Lane Width ⁽²⁾	11 ft	11 ft	11 ft	11 ft	11 ft	12 ft
Parking Lanes Urban	8 ft	8 ft	8 ft ⁽³⁾	8 ft	8 ft	8 ft ⁽³⁾
Shoulder Width ⁽⁴⁾	2 ft	3 ft ⁽⁵⁾	4 ft	2 ft	3 ft ⁽⁵⁾	4 ft
Minimum Width for Bridges to Remain in Place ⁽⁶⁾⁽⁷⁾	22 ft ⁽⁸⁾	24 ft	28 ft	22 ft ⁽⁸⁾	24 ft	28 ft
Minimum Width for Rehabilitation of Bridges to Remain in Place ⁽⁷⁾⁽⁹⁾	28 ft ⁽¹⁰⁾	32 ft	32 ft	28 ft ⁽¹⁰⁾	32 ft	32 ft
Minimum Width for Replacement Bridges	Full Design Level Applies ⁽¹¹⁾					
Access Control	See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Management Classification Report.					

Notes:

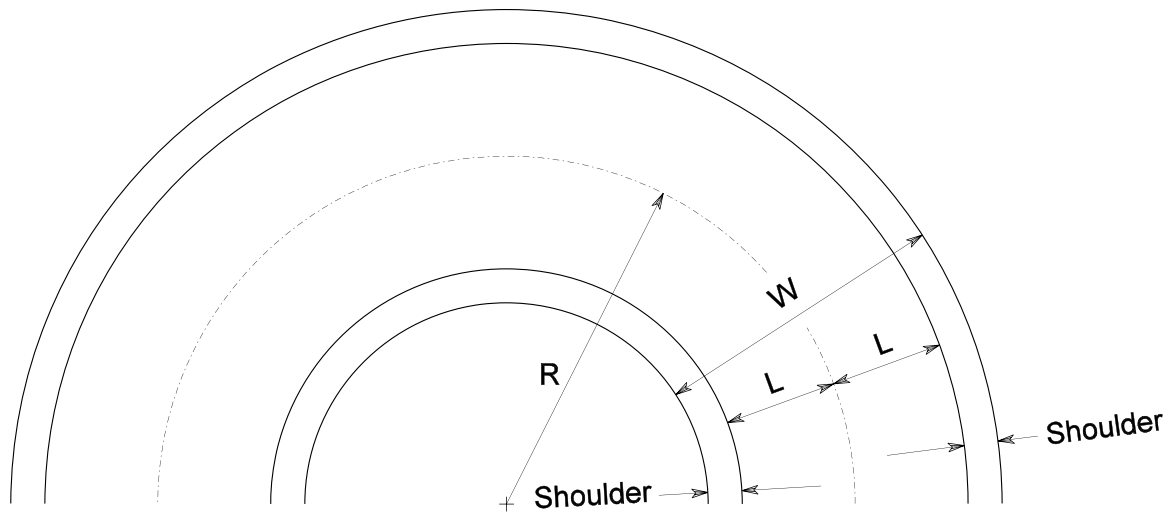
- (1) If current ADT is approaching a borderline condition, consider designing for the higher classification.
- (2) See Figures 430-12a and 12b for turning roadways.
- (3) Parking restriction recommended when ADT exceeds 7,500.
- (4) When a curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 feet. In urban areas, see Chapter 440. On a route identified as a local, state, or regional significant bicycle route the minimum shoulder width is 4 feet (See Chapter 1020).
- (5) For design speeds of 50 mph or less on roads of 2,000 ADT or less, width may be reduced by 1 foot, 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) 20 feet 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) 26 feet when ADT 250 or less.
- (11) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

**Two-Lane Highways and Bridges,
Modified Design Level**
Figure 430-11

Radius of Center Line R (ft)	Minimum Total Roadway Width W (ft)	Minimum Lane Width L (ft)
Tangent	26	11
900	26	11
800	27	12
700	27	12
600	28	12
500	28	12
400	29	12
350	30	12
300	31	12
250	33	13
200	35	13
150	39	13

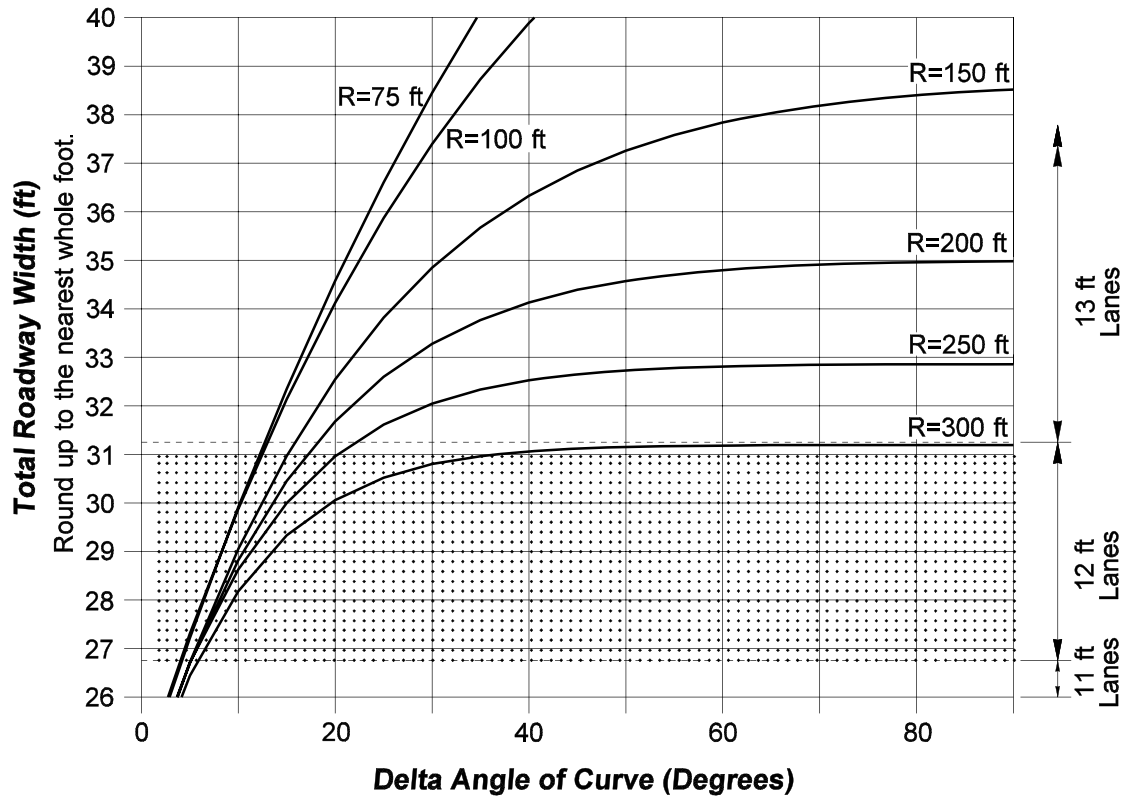
Note:

Also see minimums from Figure 430-11. 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 Two-Way Highway Curves,
Modified Design Level**

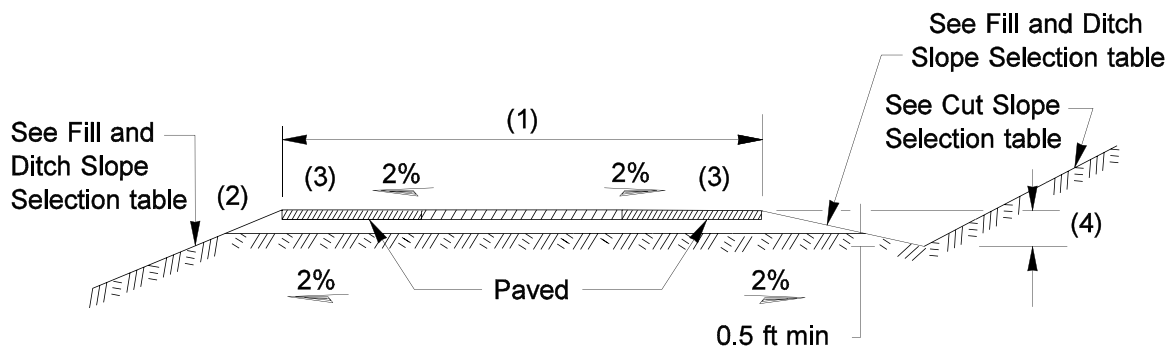
Figure 430-12a



Notes:

May be used when the internal angle (delta) is less than 90 degrees.
 If result is less than the total roadway width from Figure 430-11, use the greater.

**Minimum Total Roadway Widths for Two-Lane Two-Way Highway Curves,
 Modified Design Level**
Figure 430-12b



Height of Cut (ft)	Slope not Steeper than ⁽⁵⁾
0 - 5	4H:1V
5 - 20	3H:1V
over 20	2H:1V

Cut Slope Selection Table

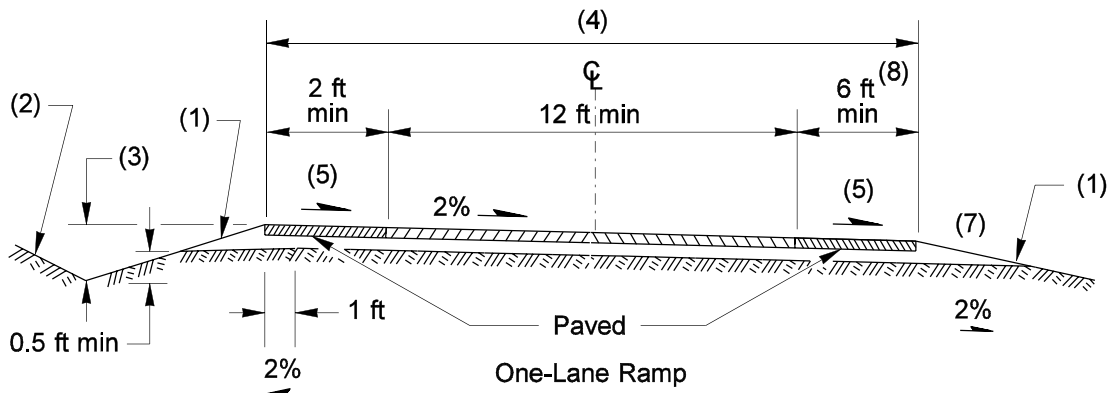
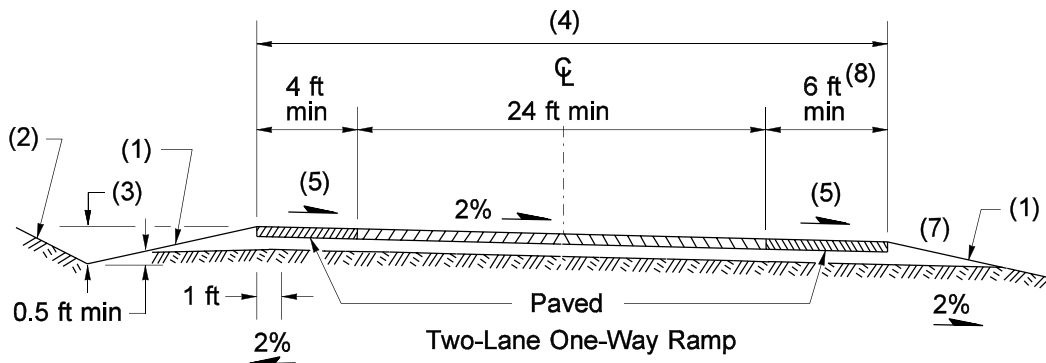
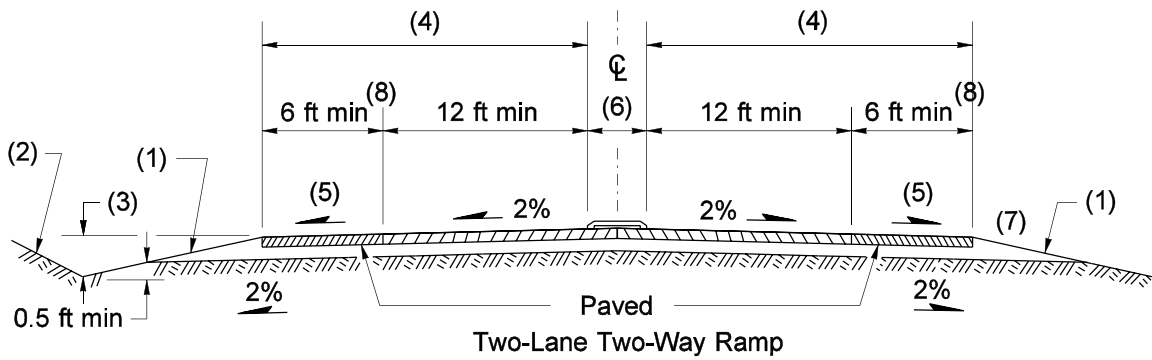
Height of Fill/Depth of Ditch (ft)	Slope not Steeper than
0 - 20	4H:1V
20 - 30	3H:1V
over 30	2H:1V ⁽⁶⁾⁽⁷⁾

Fill and Ditch Slope Selection Table

Notes:

- (1) See Figures 430-10 and 11 for minimum roadway widths and Figures 430-12a and 12b for turning roadway widths.
- (2) Widen and round embankments steeper than 4H:1V.
- (3) See Chapter 640 for shoulder slope requirements.
- (4) Minimum ditch depth is 2 feet for design speeds over 40 mph and 1.5 feet for design speeds 40 mph or less.
- (5) Or as recommended by the soils or geotechnical report. Refer to Chapter 700 for clear zone and barrier requirements
- (6) Where practical, provide flatter slopes for the greater fill heights and ditch depths.
- (7) Fill slopes up to 1 1/2H:1V may be used where favorable soil conditions exist. Refer to Chapter 640 for additional details and Chapter 700 for clear zone and barrier requirements.

**Main Line Roadway Sections,
Modified Design Level
Figure 430-13**



Notes:

- (1) See Fill and Ditch Slope Selection Table on Figure 430-13.
- (2) See Cut Slope Selection Table on Figure 430-13
- (3) Minimum ditch depth is 2 feet for design speeds over 40 mph and 1.5 feet for design speeds at and under 40 mph.
- (4) See 430.04(2)(b) and Figure 430-6 for minimum ramp width.
- (5) See Chapter 640 for shoulder slope requirements.
- (6) The median width of a two-lane two-way ramp shall not be less than that required for traffic control devices and their required shy distances.
- (7) Widen and round embankments steeper than 4H:1V.
- (8) Existing 6 feet may remain. When the roadway is to be widened, 8 feet is preferred.

**Ramp Roadway Sections,
Modified Design Level**
Figure 430-14

- 520.01 Introduction
- 520.02 Estimating Tables

520.01 Introduction

Detailed criteria and methods that govern pavement design are in the following:

WSDOT Pavement Guide – Interactive issued only on CD ROM.

Pavement Type Selection Protocol (PTSP) including the Dowel Bar Type Selection Protocol (DBTSP) located online at:
<http://www.wsdot.wa.gov/biz/mats/>

520.02 Estimating Tables

Figures 520-1 through 520-5h are to be used when detailed estimates are required. They are for pavement sections, shoulder sections, stockpiles, and asphalt distribution. Prime coats and fog seal are in Figure 520-2a.

Unit Dry Weight				
Type of Material	Truck Measure		Compacted on Roadway	
	lb/cy	T/cy	lb/cy	T/cy
Ballast	3100	1.55	3900	1.95
Crushed Surfacing Top Course	2850	1.43	3700	1.85
Crushed Surfacing Base Course	2950	1.48	3700	1.85
Screened Gravel Surfacing			3700	1.85
**Gravel Base			3400 – 3800	1.70 – 1.90
Shoulder Ballast			2800	1.40
Maintenance Sand 3/8" – 0	2900	1.45		
Mineral Aggregate 2" – 1"	2600	1.30		
Mineral Aggregate 1 3/4" – 3/4"	2600	1.30		
Mineral Aggregate 1 1/2" – 3/4"	2550	1.28		
Mineral Aggregate 1" – 3/4"	2500	1.25		
Mineral Aggregate 3/4" – 1/2"	2400	1.20		
Mineral Aggregate 1 1/4" – 1/4"	2600	1.30		
Mineral Aggregate 1" – 1/4"	2600	1.30		
Mineral Aggregate 7/8" – 1/4"	2550	1.28		
Mineral Aggregate 3/4" – 1/4"	2500	1.25		
Mineral Aggregate 5/8" – 1/4"	2650	1.33		
Mineral Aggregate 1/2" – 1/4" or #4	2600	1.30		
Mineral Aggregate 1/4" or #4 – 0	2900	1.45		
Concrete Aggr. No. 2 (1 1/4" - #4)	3000	1.50		
Concrete Sand (Fine Aggregate)	2900	1.45		
Crushed Cover Stone	2850	1.43		
** 3,700 lb/cy (1.85 tons/cy) is recommended as the most suitable factor; however, if the grading approaches the coarseness of ballast, the factor would approach 3,800 lb/cy (1.90 tons/cy), and if the grading contains more than 45% sand, the factor would decrease, approaching 3,400 lb/cy (1.70 tons/cy) for material that is essentially all sand.				

General Notes:

Weights shown are dry weights and corrections are required for water contents.

The tabulated weights for the materials are reasonably close; however, apply corrections in the following order:

For specific gravity:

$$Wt. = \frac{\text{tabular wt.} \times \text{specific gravity on surface report}}{2.65}$$

For water content:

$$Wt. = \text{tabular wt.} \times (1 + \text{free water \% in decimals})$$

If they are to be stockpiled, increase required quantities by 10 percent to allow for waste.

Direct attention to the inclusion of crushed surfacing top course material that may be required for keystone when estimating quantities for projects having ballast course.

Estimating – Miscellaneous Tables

Figure 520-1

610.01	General
610.02	References
610.03	Design Year
610.04	Definitions
610.05	Travel Forecasting (Transportation Modeling)
610.06	Traffic Analysis
610.07	Scope of Traffic Impact Analysis
610.08	Traffic Data
610.09	Traffic Impact Analysis Methodologies
610.10	Traffic Analysis Software
610.11	Mitigation Measures
610.12	Traffic Impact Analysis Report

610.01 General

It is the Washington State Department of Transportation's (WSDOT's) responsibility to provide for an interconnected transportation system to ensure the mobility of people and goods. In order to achieve these objectives, traffic engineers determine whether the proposed improvements will satisfy future needs by comparing the forecast directional hourly volume with the traffic-handling capacity of an improved facility. Project traffic forecasts and capacity are used to establish the number of through lanes, the length of auxiliary lanes, signal timing, right of way requirements, and other characteristics, so that the facility can operate at an acceptable level of service through the design year.

This chapter provides guidance and general requirements for traffic analyses. Specific requirements for a traffic analysis depend on a variety of factors. These include:

- Project proponents (federal, state, local, and private sector).
- Lead agency.
- Legal requirements (laws, regulations, procedures, and contractual obligations).
- Purpose of the traffic analysis.

Along with these factors, examine capacity and safety needs, look at project benefits and costs, determine development impacts, and identify mitigation requirements.

This *Design Manual* does not cover capacity analysis; see the latest version of the *Highway Capacity Manual* (HCM).

610.02 References

Laws – Federal and state laws and codes that may pertain to this chapter include:

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, Federal Highway Administration (FHWA), National Advisory Committee on Uniform Traffic Control Devices, including the "Washington State Modifications to the MUTCD," Chapter 468-95 Washington Administrative Code (WAC), MUTCD <http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm>

Revised Code of Washington (RCW), Chapter 43.21C, the State Environmental Policy Act (SEPA)

The National Environmental Policy Act (NEPA) of 1969

Design Guidance – Design guidance included by reference within the text includes:

Highway Capacity Manual (HCM), latest edition, Transportation Research Board, National Research Council

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

Sign Fabrication Manual, M 55-05, WSDOT

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

"Trip Generation," Institute of Transportation Engineers (ITE)

Supporting Information – Other resources used or referenced in this chapter include:

NCHRP Synthesis 306, *Long-Term Pavement Practices*, Transportation Research Board

Development Services Manual, 3007.00, WSDOT

Traffic Manual, M51-02, WSDOT

610.03 Design Year

Roadway geometric design must consider projected traffic for the opening year and the design year. The design year for new construction and reconstruction projects is given in Chapter 440. However, the design year for developer projects is often (but not always) the horizon year or build-out year. One early task for the traffic analyst is to determine the correct design year.

610.04 Definitions

annual average daily traffic (AADT) The total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year.

average daily traffic (ADT) The total volume during a given time period (in whole days): greater than one day and less than one year, divided by the number of days in that time period.

capacity The maximum sustainable flow rate at which vehicles or persons can reasonably be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions. Capacity is usually expressed as vehicles per hour (vph), passenger cars per hour (pcph), or persons per hour (pph).

capture trips Trips that do not enter or leave the traveled ways of a project's boundary within a mixed-use development.

design hourly volume (DHV) Computed by taking the annual average daily traffic times the K-factor. It can only be accurately determined in locations where there is a permanent traffic recording device active 365 days of the year. It correlates to the peak hour (see peak hour definition), but it is not equivalent. In some circumstances, it is necessary to use the peak hour data instead of DHV because peak hour can be collected using portable traffic recorders.

directional design hour volume (DDHV) The traffic volume for the design hour in the peak direction of flow, in vehicles per hour. For example, if during the design hour, 60% of the vehicles traveled eastbound and 40% traveled westbound, then the DDHV for the eastbound direction would be the DHV x 0.60.

K-factor The proportion of AADT occurring in the analysis hour is referred to as the K-factor, expressed as a decimal fraction (commonly called "K," "K30," or "K100"). The K30 is the thirtieth (K100 is the one-hundredth) highest peak hour divided by the annual average daily traffic. Normally, the K30 or K100 will be in the range of 0.09 to 0.10 for urban and rural areas. Average design hour factors are available on the web in the Transportation Data Office's Annual Peak Hour Report.

lead agency The public agency that has the principal responsibility for carrying out or approving a project.

level of service (LOS) A qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. Six levels of service are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Each level of service represents a range of operating conditions and the driver's perception of those conditions. Safety is not included in the measures that establish service levels.

"pass-by" trips Pass-by trips are made as intermediate stops between an origin and a primary trip destination (for example, home to work, home to shopping).

peak hour The 60-minute interval that contains the largest volume of traffic during a given time period. If a traffic count covers consecutive days, the peak hour can be an average of the highest hour across all of the days. An A.M. peak is simply the highest hour from the A.M., and the P.M. peak is the highest from the P.M. Peak hour correlates to the DHV, but is not the same. However, it is close enough on items such as intersection plans for approval to be considered equivalent.

project Activities directly undertaken by government, financed by government, or requiring a permit or other approval from government.

“select zone” analysis A traffic model run, where the related project trips are distributed and assigned along a populated highway network. This analysis isolates the anticipated impact on the state highway network created by the project.

610.05 Travel Forecasting (Transportation Modeling)

While regional models are available in most urban areas, they may not be the best tool for reviewing developments. Most regional models are macroscopic in nature and do not do a good job of identifying intersection-level development impacts without further refinement of the model. The task of refining the model can be substantial and is not warranted in many instances. The region makes the determination whether a model or a trend line analysis can be used to take into account historical growth rates and background projects. This decision would be based on numerous factors including the type, scale, and location of the development. The regional model is generally more appropriate for larger projects that generate a substantial number of new trips. The Traffic Impact Analysis (TIA) clearly describes the methodology and process used in developing the forecast in support of the analysis of a proposed project.

610.06 Traffic Analysis

The level of service (LOS) for operating state highway facilities is based upon measures of effectiveness (MOEs), per the latest version of the *Highway Capacity Manual*.

These MOEs (see Figure 610-1) describe the measures best suited for analyzing state highway facilities, such as freeway segments, signalized intersections, on- or off-ramps, and others. Depending on the facility, WSDOT LOS thresholds are LOS C and LOS D on state highway facilities. The LOS threshold for developer projects is set differently. Refer to Chapter 4 of the *Developer Services Manual*.

(1) Trip Generation Thresholds

The following criteria are used as the starting point for determining when a TIA is needed:

- When a project changes local circulation networks that impact a state highway facility involving direct access to the state highway facility; includes a nonstandard highway geometric design feature, and others.
- The potential risk for a traffic incident is significantly increased due to congestion-related collisions, nonstandard sight distance considerations, increases in traffic conflict points, and others.
- When a project affects state highway facilities experiencing significant delay; LOS “C” in rural areas or “D” in urban areas.

Note: A traffic analysis can be as simple as providing a traffic count or as complex as a microscopic simulation. The appropriate level of analysis is determined by the specifics of a project, the prevailing highway conditions, and the forecasted traffic. For developer projects, different thresholds may be used depending on local agency codes or interagency agreements (or both) between WSDOT and local agencies. For more information, refer to Chapter 4 of the *Development Services Manual*.

TYPE OF FACILITY	MEASURE OF EFFECTIVENESS (MOE)
Basic Freeway Segments	Density (pc/mi/ln)
Ramps	Density (pc/mi/ln)
Ramp Terminals	Delay (sec/veh)
Multilane Highways	Density (pc/mi/ln)
Two-Lane Highways	Percent-Time-Spent Following Average Travel Speed (mi/hr)
Signalized Intersections	Control Delay Per Vehicle (sec/veh)
Unsignalized Intersections	Average Control Delay Per Vehicle (sec/veh)
Urban Streets	Average Travel Speed (mi/hr)

Measures of Effectiveness by Facility Type

Figure 610-1

(2) Updating an Existing Traffic Impact Analysis

A TIA may require updating when the amount or character of traffic is significantly different from an earlier analysis. Generally, a TIA requires updating every two years. A TIA might require updating sooner in rapidly developing areas and not as often in slowly developing areas. In these cases, consultation with WSDOT is strongly recommended.

610.07 Scope of Traffic Impact Analysis

Consultation between the lead agency, WSDOT, and those preparing the TIA is recommended before commencing work on the analysis to establish the appropriate scope. At a minimum, the TIA includes the following elements:

(1) Boundaries of the Traffic Impact Analysis

Boundaries are all state highway facilities impacted in accordance with the criteria in 610.06. Traffic impacts of local streets and roads can impact intersections on state highway facilities. In these cases, include an analysis of adjacent local facilities, (driveways, intersections, and interchanges), upstream and downstream of the intersection with the state highway in the TIA. A “lesser analysis” may include obtaining traffic counts, preparing signal warrants, or a focused TIA. For developer projects, the boundaries (such as the city limits) may be determined by the local agency.

(2) Traffic Analysis Scenarios

WSDOT is interested in the effects of plan updates and amendments, as well as the effects of specific project entitlements (including, but not limited to, site plans, conditional use permits, subdivisions, and rezoning) that have the potential to impact a state highway facility. The complexity and/or magnitude of the impacts of a project normally dictate the scenarios necessary to analyze the project. Consultation between the lead agency, WSDOT, and those preparing the TIA is recommended to determine the appropriate scenarios for the analysis and why they should be addressed.

(a) When only a plan amendment or update is being sought in a TIA, the following scenarios are required:

1. Existing Conditions – Current year traffic volumes and peak hour LOS analysis of affected state highway facilities.
2. Proposed Project Only With Select Zone Analysis – Trip generation, distribution, and assignment in the year the project is anticipated to complete construction.
3. Plan Build-Out Only – Trip assignment and peak hour LOS analysis. Include current land uses and other pending plan amendments/anticipated developments.
4. Plan Build-Out Plus Proposed Project – Trip assignment and peak hour LOS analysis. Include proposed project and other pending plan amendments.

(b) When a plan amendment is not proposed and a proposed project is seeking specific entitlements (such as site plans, conditional-use permits, subdivisions, rezoning, and others), the following scenarios are required to be analyzed in the TIAs:

1. Existing Conditions – Current year traffic volumes and peak hour LOS analysis of affected state highway facilities.
2. Proposed Project Only – Trip generation, distribution, and assignment in the year the project is anticipated to complete construction.
3. Cumulative Conditions (Existing Conditions Plus Other Approved and Pending Projects Without Proposed Project) – Trip assignment and peak hour LOS analysis in the year the project is anticipated to complete construction.
4. Cumulative Conditions Plus Proposed Project (Existing Conditions Plus Other Approved and Pending Projects Plus Proposed Project) – Trip assignment and peak hour LOS analysis in the year the project is anticipated to complete construction.
5. Cumulative Conditions Plus Proposed Phases (Interim Years) – Trip assignment and peak hour LOS analysis in the years the project construction phases are anticipated to be completed.

(c) In cases where the circulation element of the plan is not consistent with the land use element or the plan is outdated and not representative of current or future forecasted conditions, all scenarios from 610.07(2)(a) and (b) are to be utilized, with the exception of the duplication of (b)1 and (b)2.

610.08 Traffic Data

Prior to any fieldwork, consultation between the lead agency, WSDOT, and those preparing the TIA is recommended to reach consensus on the data and assumptions necessary for the study. The following elements are a starting point in that consideration:

(1) Trip Generation

For trip generation forecasts, use the latest edition of the Institute of Transportation Engineers' (ITE) publication, "Trip Generation." Local trip generation rates are also acceptable if appropriate validation is provided to support them.

(a) **Trip Generation Rates** – When the land use has a limited number of studies to support the trip generation rates or when the Coefficient of Determination (R²) is below 0.75, consultation between the lead agency, WSDOT, and those preparing the TIA is recommended.

(b) **Pass-by Trips** – Pass-by trips are only considered for retail-oriented development. Reductions greater than 15% require consultation and acceptance by WSDOT. Include the justification for exceeding a 15% reduction in the TIA.

(c) **Captured Trips** – Captured trip reductions greater than 5% require consultation and acceptance by WSDOT. Include the justification for exceeding a 5% reduction in the TIA.

(d) **Transportation Demand Management (TDM)** – Consultation between the lead agency and WSDOT is essential before applying trip reduction for TDM strategies. Note: Reasonable reductions to trip generation rates are considered when adjacent state highway volumes are sufficient (at least 5,000 ADT) to support reductions for the land use.

(2) Traffic Counts

Prior to field traffic counts, consultation between the lead agency, WSDOT, and those preparing the TIA is recommended to determine the level of detail (location, signal timing, travel speeds, turning movements, and so forth) required at each traffic count site. All state highway facilities within the boundaries of the TIA are to be considered. Common rules for counting vehicular traffic include, but are not limited to, the following:

- (a) Conduct vehicle counts to include at least one contiguous 24-hour period on Tuesdays, Wednesdays, or Thursdays during weeks not containing a holiday and in favorable weather conditions.

- (b) Conduct vehicle counts during the appropriate peak hours (see peak hour discussion below).
- (c) Consider seasonal and weekend variations in traffic where appropriate (recreational routes, tourist seasons, harvest season, and others).

(3) Peak Hours

To eliminate unnecessary analysis, consultation between the lead agency, WSDOT, and those preparing the TIA is recommended during the early planning stages of a project. In general, the TIA includes a morning (A.M.) and an evening (P.M.) peak hour analysis. Other peak hours (such as 11:30 A.M. to 1:30 P.M., weekends, and holidays) might also be required to determine the significance of the traffic impacts generated by a project.

(4) Accidents

The following should be included in any discussion of the subject of accidents:

- (a) A listing of the location's 3-year accident history. (For direct access points and/or intersections, the list covers an area 0.1 mile to either side of the main line or crossroad intersection).
- (b) A collision diagram illustrating the 3-year accident history at each location where the number of accidents at the location has been 15 or more in the last 3 years.
- (c) The predominant accident types and their locations, any accident patterns, and an assessment of and mitigation for the development's traffic safety impacts.

Also, include in the discussion the following:

1. Sight distance and any other pertinent roadway geometrics
2. Driver expectancy and accident potential (if necessary)
3. Special signing and illumination needs (if necessary)

610.09 Traffic Impact Analysis Methodologies

Typically, the traffic analysis methodologies for the facility types indicated below are used by WSDOT and will be accepted without prior consultation. When a state highway has saturated flows, the use of a microsimulation model is encouraged for the analysis (note, however, that the microsimulation model must be calibrated and validated for reliable results). Other analysis methods may be accepted; however, consultation between the lead agency, WSDOT, and those preparing the TIA is recommended to agree on the data necessary for the analysis. The methodologies include:

- A. Freeway Segments – *Highway Capacity Manual* (HCM), operational analysis
- B. Weaving Areas – *WSDOT Design Manual* (DM), (HCM), operational analysis
- C. Ramps and Ramp Junctions – HCM, operational analysis or *WSDOT DM, WSDOT Ramp Metering Guidelines* (most recent edition)
- D. Multilane Highways – HCM, operational analysis
- E. Two-Lane Highways – HCM, operational analysis
- F. Signalized Intersections – HCM, *Highway Capacity Software*,** operational analysis, Synchro
- G. Unsignalized Intersections – HCM, (MUTCD), and *WSDOT Design Manual*, Chapter 850.05, for signal warrants if a signal is being considered
- H. Transit – HCM, operational analysis
- I. Pedestrians – HCM
- J. Bicycles – HCM
- K. *WSDOT Criteria/Warrants* – MUTCD (stop signs), *WSDOT Traffic Manual* (school crossings), *WSDOT Design Manual*, Chapter 840 (freeway lighting, conventional highway lighting)

L. Channelization – WSDOT *Design Manual*

M. Roundabouts – WSDOT *Design Manual*

****Note:** WSDOT does not officially advocate the use of any special software. However, consistency with the HCM is advocated in most (but not all) cases. The WSDOT local development review units utilize the software mentioned above. If different software or analytical techniques are used for the TIA, then consultation between the lead agency, WSDOT, and those preparing the TIA is recommended.

Challenge results that are significantly different than those produced with the analytical techniques above. The procedures in the *Highway Capacity Manual* do not explicitly address operations of closely spaced signalized intersections. Under such conditions, several unique characteristics must be considered, including spill-back potential from the downstream intersection to the upstream intersection; effects of downstream queues on upstream saturation flow rates; and unusual platoon dispersion or compression between intersections. An example of such closely spaced operations is signalized ramp terminals at urban interchanges. Queue interactions between closely spaced intersections can seriously distort the procedures in the HCM.

610.10 Traffic Analysis Software

For applications that fall outside the limits of the HCM software, WSDOT makes use of the following software:

(1) TRANSYT-7F

TRANSYT-7F is a traffic signal timing optimization software package for traffic networks, arterial streets, or single intersections having complex or simple conditions.

TRANSYT-7F capabilities other than signal timing programs include:

- Lane-by-lane analysis
- Direct CORSIM optimization
- Multicycle and multiperiod optimization

- Detailed simulation of existing conditions
- Detailed analysis of traffic-actuated control
- Hill-climb and genetic algorithm optimization
- Optimization based on a wide variety of objective functions
- Optimization of cycle length, phasing sequence, splits, and offsets
- Explicit simulation of platoon dispersion, queue spillback, and spillover
- Full flexibility in modeling unusual lane configurations and timing plans

(2) Trafficware – Synchro

Synchro is a software application for optimizing traffic signal timing and performing capacity analyses. The software optimizes splits, offsets, and cycle lengths for individual intersections, an arterial, or a complete network. Synchro performs capacity analyses using both the Intersection Capacity Utilization (ICU) and HCM methods. Synchro provides detailed time space diagrams that can show vehicle paths or bandwidths. Synchro can be used for creating data files for SimTraffic and other third party traffic software packages. SimTraffic models signalized and unsignalized intersections, and freeway sections with cars, trucks, pedestrians, and buses.

Synchro capabilities other than signal timing programs include:

- Lane-by-lane analysis
- Direct CORSIM optimization
- Multicycle and multiperiod optimization
- Detailed simulation of existing conditions
- Detailed analysis of traffic-actuated control
- Hill-climb and genetic algorithm optimization
- Optimization based on a wide variety of objective functions
- Optimization of cycle length, phasing sequence, splits, and offsets
- Explicit simulation of platoon dispersion, queue spillback, and spillover
- Full flexibility in modeling unusual lane configurations and timing plans

(3) aaSIDRA

aaSIDRA is a software product that can analyze signalized and unsignalized intersections, including roundabouts in one package. It is a microanalytical traffic evaluation tool that employs lane-by-lane and vehicle drive cycle models.

aaSIDRA can perform signal timing optimization for actuated and pretimed (fixed-time) signals, with signal phasing schemes from the simplest to the most sophisticated.

aaSIDRA, or aaTraffic SIDRA (Signalized & unsignalized Intersection Design and Research Aid) software is for use as an aid for designing and evaluating of the following intersection types:

- Signalized intersections (fixed-time, pretimed, and actuated)
- Roundabouts
- Two-way stop sign control
- All-way stop sign control
- Yield sign control

(4) PTV America – Vissim

Vissim is a microscopic, behavior-based multi-purpose traffic simulation program, for signal systems, freeway systems, or combined signal and freeway systems having complex or simple conditions.

The program offers a wide variety of urban and highway applications, integrating public and private transportation. Even complex traffic conditions are visualized at an unprecedented level of detail providing realistic traffic models.

Vissim capabilities include:

- Dynamic Vehicle Assignment
- Land use traffic impact studies and access management studies
- Freeway and surface street interchanges
- Signal timing, coordination, and pre-emption
- Freeway weaving sections, lane adds and lane drops
- Bus stations, bus routes, carpools, and taxis
- Ramp metering and HOV lanes

- Unsignalized intersections and signal warrants
- Incident detection and management
- Queuing studies involving turn pockets and queue blockage
- Toll plazas and truck weigh stations
- Origin-destination traffic flow patterns
- Verification and validation of other software
- Surrogate for field data collection
- Public presentation and demonstration

(5) TSIS – Corsim

TSIS is a traffic simulation software package for signal systems, freeway systems, or combined signal and freeway systems having complex or simple conditions. Its strength lies in its ability to simulate traffic conditions at a level of detail beyond other simulation programs.

TSIS capabilities include:

- Land use traffic impact studies and access management studies
- Freeway and surface street interchanges
- Signal timing, coordination, and pre-emption
- Freeway weaving sections, lane adds, and lane drops
- Bus stations, bus routes, carpools, and taxis
- Ramp metering and HOV lanes
- Unsignalized intersections and signal warrants
- Incident detection and management
- Queuing studies involving turn pockets and queue blockage
- Toll plazas and truck weigh stations
- Origin-destination traffic flow patterns
- Verification and validation of other software
- Surrogate for field data collection
- Public presentation and demonstration

Use the most current version of Traffic Analysis Software. Current software licenses may be obtained from the Traffic Analysis Engineer at the HQ Traffic Office: (360) 705-7297.

610.11 Mitigation Measures

Consultation between the lead agency, WSDOT, and those preparing the TIA is recommended to reach consensus on the mitigation measures and who will be responsible. Mitigation measures must be included in the TIA, to determine if a project's impacts can be eliminated or reduced to a level of insignificance. Eliminating or reducing impacts to a level of insignificance is the standard pursuant to SEPA and NEPA. The lead agency is responsible for administering the SEPA review process and has the principal authority for approving a local development proposal or land use change. WSDOT, as a lead agency, is responsible for reviewing the TIA for impacts that pertain to state highway facilities. However, the authority vested in the lead agency under SEPA does not take precedence over other authorities in law.

If the mitigation measures require work in the state highway right of way, an encroachment permit from WSDOT is required. This work is also subject to WSDOT standards and specifications. Consultation between the lead agency, WSDOT, and those preparing the TIA early in the planning process is strongly recommended to expedite the review of local development proposals and to reduce conflicts and misunderstandings in both the local agency SEPA review process as well as the WSDOT encroachment permit process.

Additional mitigation recommendations necessary to help relieve impacts include the following:

- (a) Satisfy local agency guidelines and interlocal agreements
- (b) Correct any LOS deficiencies as per interlocal guidelines
- (c) Donation of right of way/frontage improvements/channelization changes
- (d) Installation of a traffic signal (warrant analysis per MUTCD is required)
- (e) Include current/future state projects (Sunshine Report)

- (f) Clear zone if widening the state highway
- (g) Any proposed changes to state highway channelization require submittal of a complete channelization plan, per channelization plan checklist, for state review and approval
- (h) Possible restrictions of turning movements
- (i) Sight distance
- (j) Traffic mitigation payment (pro-rata share contribution) to a programmed WSDOT project (see Chapter 4 of the *Development Services Manual*)

610.12 Traffic Impact Analysis Report

The minimum contents of a TIA report are listed below. The amount of text required under each element will vary depending upon the scale of the project.

I. EXECUTIVE SUMMARY

II. TABLE OF CONTENTS

- A. List of Figures (Maps)
- B. List of Tables

III. INTRODUCTION

- A. Description of the proposed project
- B. Location of the project
- C. Site plan including all access to state highways (site plan, map)
- D. Circulation network including all access to state highways (vicinity map)
- E. Land use and zoning
- F. Phasing plan including proposed dates of project (phase) completion
- G. Project sponsor and contact person(s)
- H. References to other traffic impact studies

IV. TRAFFIC ANALYSIS

- A. Clearly stated assumptions
- B. Existing and projected traffic volumes (including turning movements), facility geometry (including storage lengths), and traffic controls (including signal phasing and multisignal progression where appropriate), (figure/s)
- C. Project trip generation (including references) (tables)
- D. Project-generated trip distribution and assignment (figure/s)
- E. LOS and warrant analyses—existing conditions, cumulative conditions, and full-build of plan conditions with and without project

V. CONCLUSIONS AND RECOMMENDATIONS

- A. LOS and appropriate MOE quantities of impacted facilities with and without mitigation measures
- B. Mitigation phasing plan including dates of proposed mitigation measures
- C. Define responsibilities for implementing mitigation measures
- D. Cost estimates for mitigation measures and financing plan

VI. APPENDICES

- A. Description of traffic data and how data was collected
- B. Description of methodologies and assumptions used in analyses
- C. Worksheets used in analyses (for example, signal warrant, LOS, traffic count information)

650.01	General
650.02	References
650.03	Definitions
650.04	Stopping Sight Distance
650.05	Passing Sight Distance
650.06	Decision Sight Distance
650.07	Documentation

650.01 General

It is essential that the driver of a vehicle be able to see far enough ahead to assess developing situations and take appropriate action. For purposes of design, the required sight distance is considered in terms of passing sight distance, stopping sight distance, and decision sight distance.

For additional information, see the following chapters:

Chapter	Subject
910	sight distance at intersections at grade
915	sight distance at roundabouts
920	sight distance at road approaches
930	sight distance at railroad crossings
1020	sight distance for paths and trails

650.02 References

Design Guidance Guidance included by reference within the text includes:

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the Washington State Modifications to the MUTCD, Chapter 468-95 WAC, (MUTCD) <http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm>

Supporting Information Other resources used or referenced in this chapter includes:

A Policy on Geometric Design of Highways and Streets, AASHTO, 2001

650.03 Definitions

decision sight distance The distance required for a driver to detect an unexpected or difficult-to-perceive information source or hazard, interpret the information, recognize the hazard, select an appropriate maneuver, and complete it safely and efficiently.

design speed The speed used to determine the various geometric design features of the roadway.

passing sight distance The distance (on a two-lane highway) required for a vehicle to execute a normal passing maneuver based on design conditions and design speed.

roadside That area between the outside shoulder edge and the right of way limits. The median area between the edges the shoulders on a divided highway is also considered roadside.

roadway The portion of a highway, including shoulders, for vehicular use.

rural design area An area that meets none of the conditions to be an urban design area.

sight distance The length of highway visible to the driver.

stopping sight distance The distance required to safely stop a vehicle traveling at design speed.

suburban area A term for the area at the boundary of an urban area. Suburban settings may combine the higher speeds common in rural areas with activities that are more similar to urban settings.

urban area An area designated by WSDOT in cooperation with the Transportation Improvement Board and regional transportation planning organizations, subject to the approval of the FHWA.

urban design area An area where urban design criteria is appropriate, that is defined by one or more of the following:

- An urban area.
- An area within the limits of an incorporated city or town.

- An area characterized by intensive use of the land for the location of structures and receiving such urban services as sewer, water, and other public utilities and services normally associated with an incorporated city or town. This may include an urban growth area defined under the Growth Management Act (Chapter 36.70A RCW Growth management—planning by selected counties and cities), but outside the city limits.
- An area with not more than 25% undeveloped land.

650.04 Stopping Sight Distance

(1) Design Criteria

Stopping sight distance is the sum of two distances: the distance traveled during perception and reaction time and the distance required to stop the vehicle. The perception and reaction time used in design is 2.5 seconds. The stopping distance is calculated using a constant deceleration rate of 11.2 feet/second².

Provide design stopping sight distance (see Figure 650-1) at all points on all highways and on all intersecting roadways, except when evaluating an existing roadway, as provided in 650.04(7).

Available stopping sight distance is calculated for a passenger car using an eye height (h_1) of 3.50 feet and an object height (h_2) of 0.50 foot. Although AASHTO allows a 2-foot object height, a 0.5-foot object height is used because objects with a height between 0.5 foot and 2 feet may be perceived as hazards that would likely result in an erratic maneuver. In urban design areas, with justification, the object height (h_2) may be increased to 2.00 feet. Figure 650-1 gives the design stopping sight distances for grades less than 3%, the minimum curve length for a 1% grade change to provide the sight distance (using $h_2=0.50$ feet) for a crest (K_C) and sag (K_S) vertical curve, and the minimum length of vertical curve for the design speed (VCL_m). (See 650.04(2) for sight distances when the grade is 3% or greater.)

Design Speed (mph)	Design Stopping Sight Distance (ft)	K_C	K_S	VCL_m (ft)
25	155	18	25	75
30	200	30	36	90
35	250	47	49	105
40	305	70	63	120
45	360	98	78	135
50	425	136	96	150
55	495	184	115	165
60	570	244	136	180
65	645	313	157	195
70	730	401	180	210
75	820	506	206	225
80	910	623	231	240

Design Stopping Sight Distance

Figure 650-1

(2) Effects of Grade

The grade of the highway has an effect on the vehicle's stopping sight distance. The stopping distance is increased on downgrades and decreased on upgrades. Figure 650-2 gives the stopping sight distances for grades of 3% and steeper. When evaluating sight distance with a changing grade, use the grade for which the longest sight distance is needed.

Design Speed (mph)	Stopping Sight Distance (ft)					
	Downgrade			Upgrade		
	-3%	-6%	-9%	3%	6%	9%
25	158	165	173	147	143	140
30	205	215	227	190	184	179
35	258	271	288	237	229	222
40	315	333	354	289	278	269
45	378	401	428	345	331	320
50	447	474	508	405	389	375
55	520	553	594	470	450	433
60	599	638	687	539	515	495
65	683	729	786	612	585	561
70	772	826	892	690	658	631
75	867	928	1004	773	736	705
80	966	1037	1123	860	818	782

Design Stopping Sight Distance on Grades

Figure 650-2

For stopping sight distances on grades between those listed, interpolate between the values given or use the equation in Figure 650-3.

$$S = 1.47Vt + \frac{V^2}{30 \left[\left(\frac{a}{32.2} \right) \pm \frac{G}{100} \right]}$$

Where:
 S = Stopping sight distance on grade (ft)
 V = Design speed (mph)
 t = Perception/reaction time (2.5 sec)
 a = Deceleration rate (11.2 ft/sec²)
 G = Grade (%)

Stopping Sight Distance on Grades
 Figure 650-3

(3) Crest Vertical Curves

Use Figure 650-11 or the equations in Figure 650-4 to find the minimum crest vertical curve length to provide stopping sight distance when given the algebraic difference in grades. When using the equations in Figure 650-4, use $h_1=3.50$ feet and $h_2=0.50$ foot. Figure 650-11 does not use the sight distance greater than the length of curve equation. When the sight distance is greater than the length of curve and the length of curve is critical, the $S>L$ equation given in Figure 650-4 may be used to find the minimum curve length.

When a new crest vertical curve is built or an existing one is rebuilt with grades less than 3%, provide Design Stopping Sight Distance from Figure 650-1. When grades are 3% or greater, see 650.04(2) for required sight distance.

In urban design areas, with justification, an object height (h_2) of 2.00 feet may be used with the equations in Figure 650-4.

When evaluating an existing roadway, see 650.04(7).

When $S>L$	
$L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A}$	$S = \frac{L}{2} + \frac{100(\sqrt{h_1} + \sqrt{h_2})^2}{A}$
When $S<L$	
$L = \frac{AS^2}{200(\sqrt{h_1} + \sqrt{h_2})^2}$	$S = \sqrt{\frac{200L(\sqrt{h_1} + \sqrt{h_2})^2}{A}}$
Where: L = Length of vertical curve (ft) S = Sight distance (ft) A = Algebraic difference in grades (%) h_1 = Eye height (3.50 ft) h_2 = Object height—see text (ft)	

Sight Distance, Crest Vertical Curve
 Figure 650-4

(4) Sag Vertical Curves

Sag vertical curves are only a sight restriction during the hours of darkness. Headlight sight distance is used for the sight distance design criteria at sag vertical curves. In some cases, a lesser length may be allowed. (See Chapter 630 for guidance and requirements.)

Use Figure 650-12 or the equations in Figure 650-5 to find the minimum length for a sag vertical curve to provide the headlight stopping sight distance when given the algebraic difference in grades. The sight distance greater than the length of curve equation is not used in Figure 650-12. When the sight distance is greater than the length of curve and the length of curve is critical, the $S>L$ equation given in Figure 650-5 may be used to find the minimum length of curve.

When a new sag vertical curve is built or an existing one is rebuilt with grades less than 3%, provide Design Stopping Sight Distance from Figure 650-1. When grades are 3% or greater, see 650.04(2) for required sight distance.

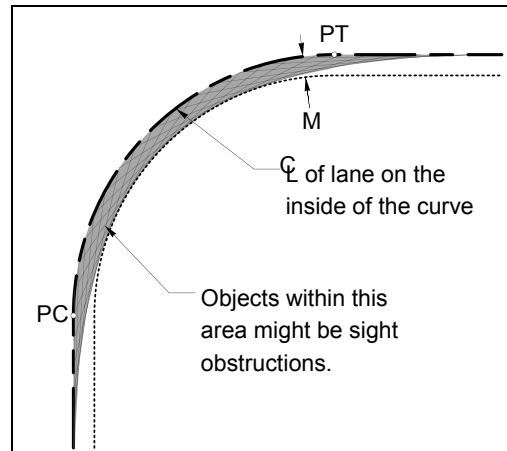
When evaluating an existing roadway, see 650.04(7).

Where $S > L$	
$L = 2S \cdot \frac{400 + 3.5S}{A}$	$S = \frac{LA + 400}{2A - 3.5}$
Where $S < L$	
$L = \frac{AS^2}{400 + 3.5S}$	$S = \frac{3.5L \pm \sqrt{(3.5L)^2 + 1600AL}}{2A}$
Where:	
L = Curve length (ft)	
A = Algebraic grade difference (%)	
S = Sight distance (ft)	

Sight Distance, Sag Vertical Curve
Figure 650-5

(5) Horizontal Curves

Use Figure 650-13a or the equation in Figure 650-7 to check for adequate stopping sight distance where sight obstructions are on the inside of a curve. A stopping sight distance obstruction is any roadside object within the M distance (such as median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings), 2 feet or greater above the roadway surface at the centerline of the lane on the inside of the curve. Figure 650-13a and the equation in Figure 650-7 are for use when the length of curve is greater than the sight distance and the sight restriction is more than half the sight distance from the end of the curve. When the length of curve is less than the stopping sight distance or the sight restriction is near either end of the curve, the desired sight distance may be available with a lesser M distance. (See Figure 650-6.) When this occurs, the sight distance can be checked graphically.



Sight Distance Area on Horizontal Curves
Figure 650-6

When the road grade is less than 3%, provide Design Stopping Sight Distance from Figure 650-1.

When the grade is 3% or greater, see 650.04(2) for required sight distance.

In urban design areas, with justification, a 2.00-foot object height (h_2) may be used. When $h_2=2.00$ feet, roadside objects between 2.00 feet and 2.75 feet might not be a sight obstruction. (See Figure 650-13b for guidance on determining whether a roadside object is a sight obstruction.)

When evaluating an existing roadway, see 650.04(7).

$M = R \left[1 - \cos \left(\frac{28.65 S}{R} \right) \right]$
$S = \frac{R}{28.65} \left[\cos^{-1} \left(\frac{R - M}{R} \right) \right]$
Where:
M = Distance from the centerline of the inside lane of the curve to the sight obstruction (ft)
R = Radius of the curve (ft)
S = Sight distance (ft)

Sight Distance, Horizontal Curves
Figure 650-7

(6) Overlapping Horizontal and Vertical Curves

A vertical curve will affect the height at which a roadside object will become a sight obstruction. A crest vertical curve will raise roadside objects and make them more likely to become sight obstructions. A sag vertical curve will lower roadside objects, making them less likely to be sight obstructions.

(7) Existing Stopping Sight Distance

Existing stopping sight distance is used when the vertical and horizontal alignments are unchanged, the sight obstruction is existing, and there are no problems related to the sight distance. Figure 650-8 gives the values for existing stopping sight distance and the associated K_C and K_S . When evaluating the existing sight distance, use an object height (h_2) of 2.00 feet.

For crest vertical curves where the existing vertical alignment is retained and the existing roadway pavement is not reconstructed, existing stopping sight distance values in Figure 650-8 may be used. The minimum length of an existing crest vertical curve may be found using the equations in Figure 650-4 and $h_2=2.00$ feet, or using the K_C values from Figure 650-8.

For sag vertical curves where the existing vertical alignment is retained and the existing roadway pavement is not being reconstructed, existing stopping sight distance values in Figure 650-8 may be used. The minimum length of an existing sag vertical curve may be found using the equations in Figure 650-5, or using the K_S values from Figure 650-8. In some cases, when continuous illumination is provided, a lesser length may be allowed. (See Chapter 630 for guidance.)

For horizontal curves, existing stopping sight distance values from Figure 650-8 may be used when all of the following are met at the curve:

- The vertical and horizontal alignments are existing
- The roadway pavement will not be reconstructed
- The roadway will not be widened
- The sight obstruction is existing
- Roadside improvements to sight distance do not require additional right of way`

A sight obstruction is any roadside object within the M distance from the equation in Figure 650-7 with a height more than 2.75 feet above the centerline of the inside lane. Roadside objects between 2.00 feet and 2.75 feet might be a sight obstruction. (See Figure 650-13b for guidance on determining whether a roadside object is a sight obstruction.)

Design Speed (mph)	Existing Stopping Sight Distance (ft)	K_C	K_S
20	115	6	16
25	145	10	23
30	180	15	31
35	220	22	41
40	260	31	52
45	305	43	63
50	350	57	75
55	400	74	89
60	455	96	104
65	495	114	115
70	540	135	127
75	585	159	140
80	630	184	152

Existing Stopping Sight Distance
Figure 650-8

650.05 Passing Sight Distance

(1) Design Criteria

Passing sight distance is the sum of four distances:

- The distance traveled by the passing vehicle during perception and reaction time and initial acceleration to the point of encroachment on the opposing lane.
- The distance the passing vehicle travels in the opposing lane.
- The distance that an opposing vehicle travels during two-thirds of the time the passing vehicle is in the opposing lane.
- A clearance distance between the passing vehicle and the opposing vehicle at the end of the passing maneuver.

Sight distance for passing is calculated for a passenger car using an eye height (h_1) of 3.50 feet and an object height (h_2) of 3.50 feet. Figure 650-9 gives the passing sight distances for various design speeds.

Design Speed (mph)	Passing Sight Distance (ft)
20	710
25	900
30	1090
35	1280
40	1470
45	1625
50	1835
55	1985
60	2135
65	2285
70	2480
75	2580
80	2680

Passing Sight Distance
Figure 650-9

On two-lane two-way highways, provide passing opportunities to meet traffic volume demands. This can be accomplished by using numerous sections with safe passing sight distance or by adding passing lanes at critical locations. (See Chapter 1010.)

In the design stage, passing sight distance can be provided by adjusting the alignment either vertically or horizontally to increase passing opportunities.

These considerations also apply to multilane highways where staged construction includes a two-lane two-way operation as an initial stage. Whether auxiliary lanes are provided, however, depends on the time lag proposed between the initial stage and the final stage of construction.

(2) Vertical Curves

Figure 650-14 gives the length of crest vertical curve needed to provide passing sight distance for two-lane highways. The distance from Figure 650-9 and the equations in Figure 650-4, using 3.50 feet for both h_1 and h_2 , may also be used to determine the minimum length of vertical curve to provide the required passing sight distance.

Sag vertical curves are not a restriction to passing sight distance.

(3) Horizontal Curves

Passing sight distance can be restricted on the inside of a horizontal curve by roadside objects that are 3.50 feet or more above the roadway surface. Use the distance from Figure 650-9 and the equation in Figure 650-7 to determine whether the object is close enough to the roadway to be a restriction to passing sight distance. The equation assumes that the curve length is greater than the sight distance. Where the curve length is less than the sight distance, the desired sight distance may be available with a lesser M distance.

(4) No-Passing Zone Markings

Knowledge of the practices used for marking no-passing zones on two-lane roads is helpful in designing a safe highway. The values in Figure 650-9 are the passing sight distances starting at the point the pass begins. The values in the MUTCD are lower than the Figure 650-9 values. They are for no-passing zone marking limits and start at the point the safe pass must be completed.

The MUTCD values are not to be used directly in design, but are discussed for the designer's recognition of locations requiring no-passing pavement markings. Sections of highway providing passing sight distance in the range of values between the distances in Figure 650-9 and MUTCD values require careful review by the designer.

650.06 Decision Sight Distance

Decision sight distance values are greater than stopping sight distance values because they give the driver an additional margin for error and afford sufficient length to maneuver at the same or reduced speed rather than to just stop.

Provide decision sight distance where highway features create the likelihood for error in information reception, decision making, or control actions. Example highway features include interchanges; intersections; changes in cross section (such as at toll plazas and drop lanes); and areas of concentrated demand where sources of information compete (for example, those from roadway elements, traffic, traffic control devices, and advertising signs). If possible, locate these highway features where decision sight distance can be provided. If this is not possible, use suitable traffic control devices and positive guidance to give advanced warning of the conditions.

Use the decision sight distances in Figure 650-10 where highway features require complex driving decisions.

Design Speed (mph)	Decision Sight Distance for Maneuvers (ft)				
	A	B	C	D	E
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445
75	875	1545	1180	1365	1545
80	970	1685	1260	1455	1650

Decision Sight Distance

Figure 650-10

The maneuvers in Figure 650-10 are as follows:

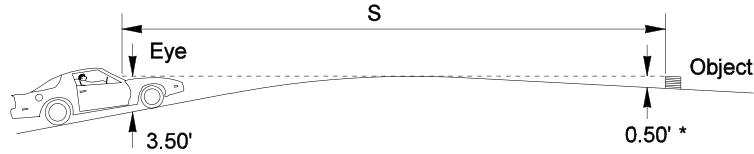
- A. Rural stop
- B. Urban stop
- C. Rural speed/path/direction change
- D. Suburban speed/path/direction change
- E. Urban speed/path/direction change

Decision sight distance is calculated using the same criteria as stopping sight distance: $h_1=3.50$ feet and $h_2=0.50$ foot. Use the equations in Figures 650-4, 5, and 7 to determine the decision sight distance for crest vertical curves, sag vertical curves, and horizontal curves.

650.07 Documentation

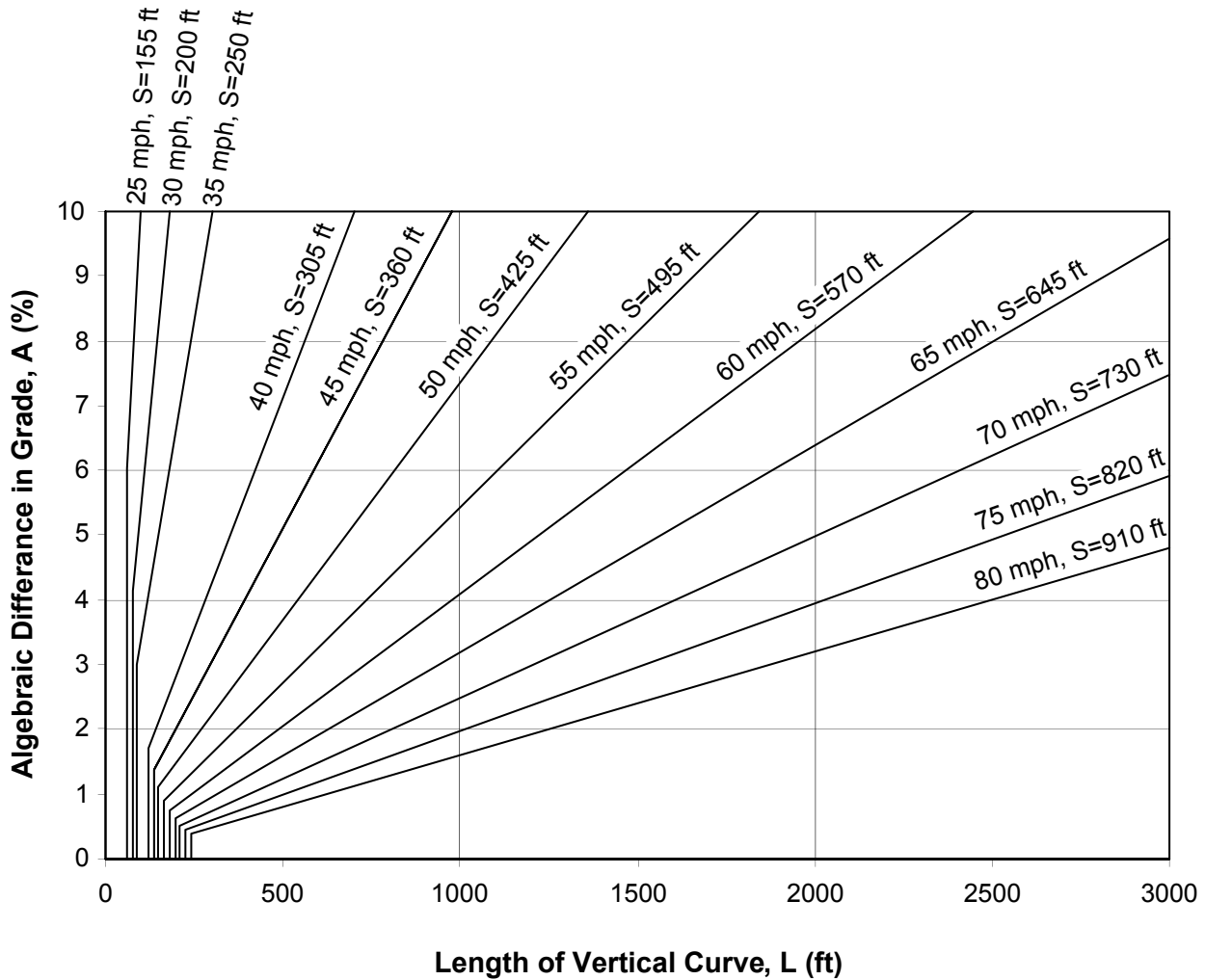
The list of documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

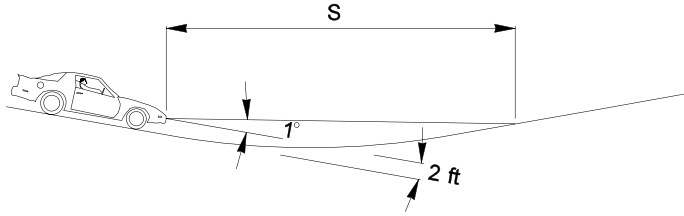


The minimum length can also be determined by multiplying the algebraic difference in grades by the K_C value from Figure 650-1 ($L=K_C \cdot A$). Both the figure and the equation give approximately the same length of curve. Neither use the $S>L$ equation.

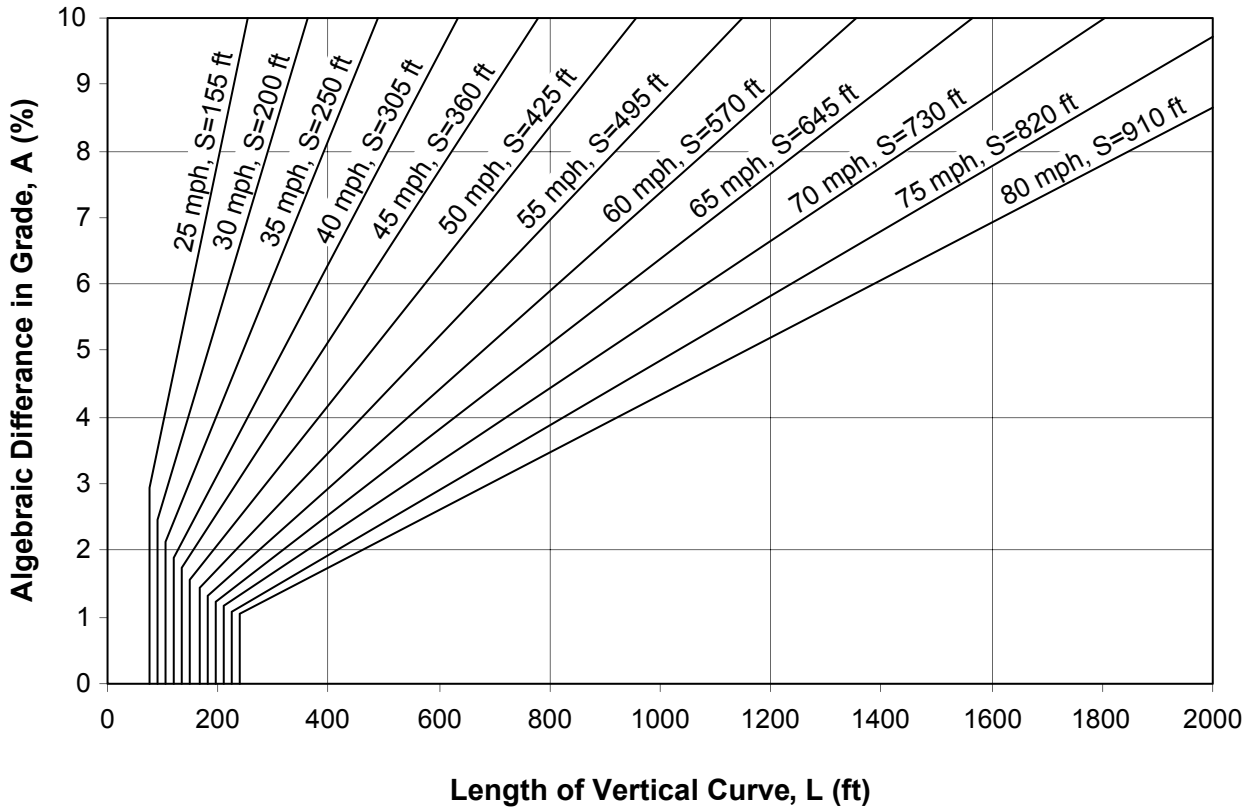
* This chart is based on a 0.50-foot object height. When a higher object height is allowed (see 650.04(3) for guidance), the equations in Figure 650-4 must be used.



Stopping Sight Distance for Crest Vertical Curves
Figure 650-11

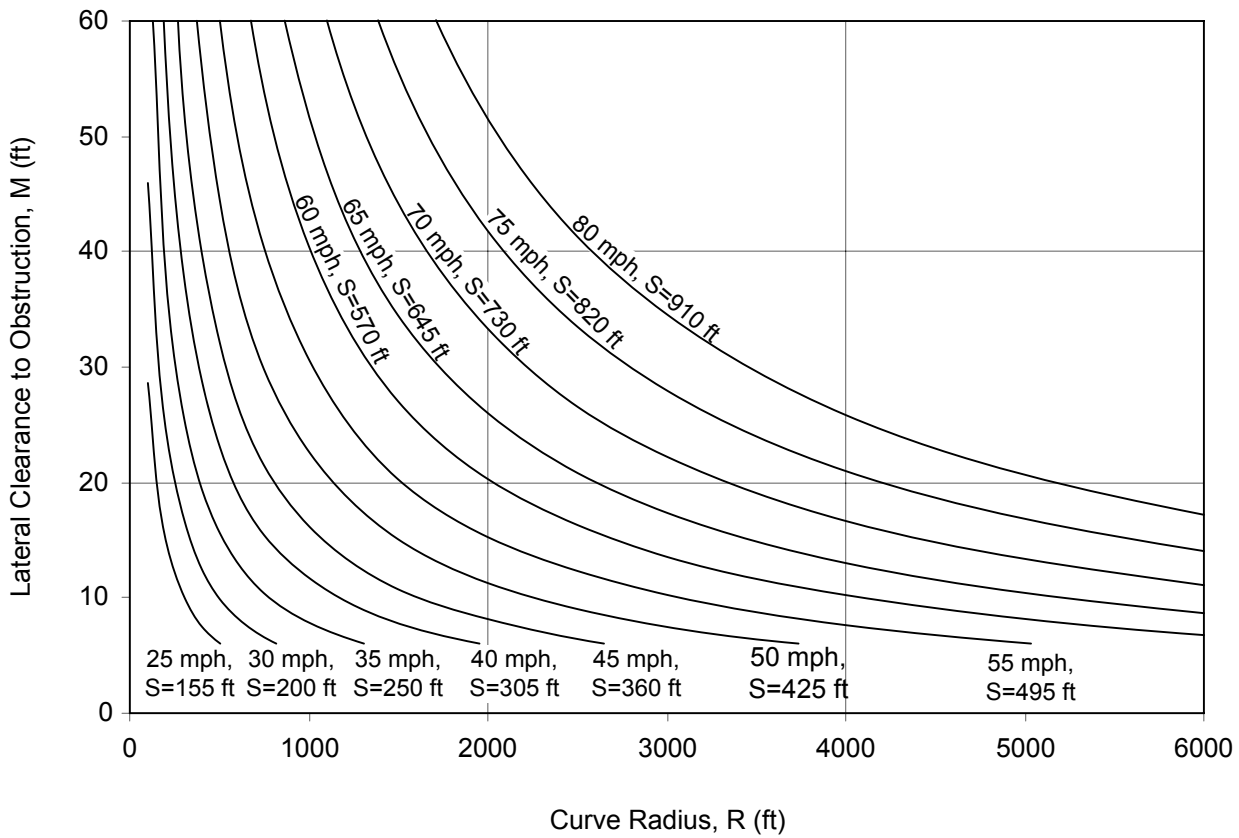
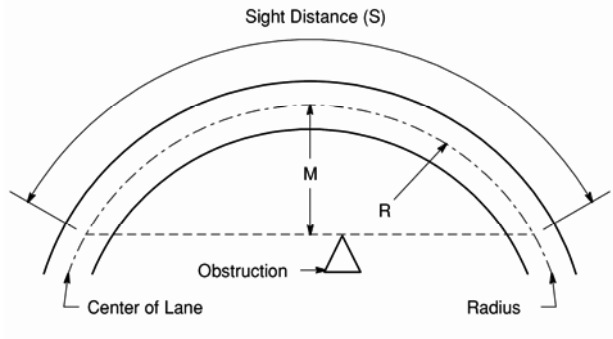


The minimum length can also be determined by multiplying the algebraic difference in grades by the K_S value from Figure 650-1 ($L=K_S \cdot A$). Both the figure and equation give approximately the same length of curve. Neither use the $S>L$ equation.

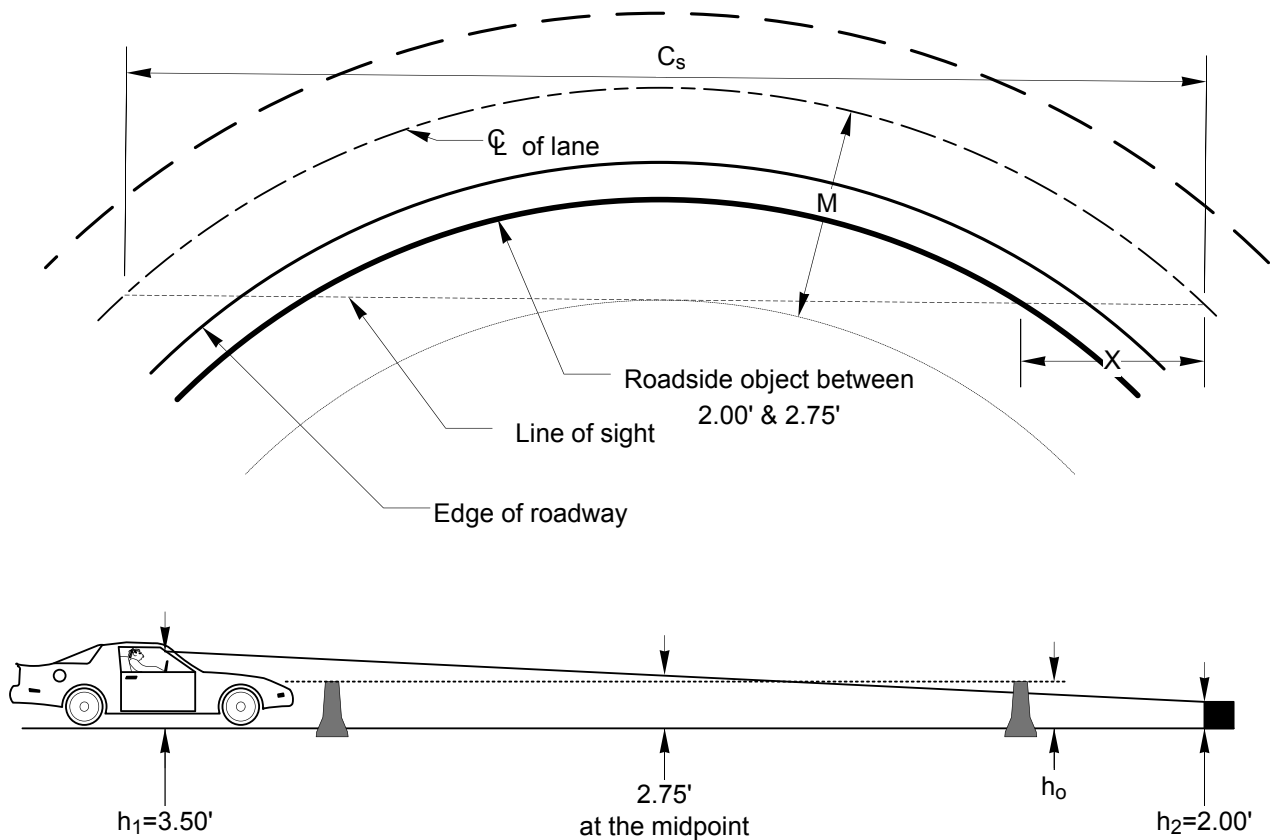


Stopping Sight Distance for Sag Vertical Curves
Figure 650-12

When $h_2=2.00$ ft, objects between 2.00 ft and 2.75 ft above the centerline of the inside lane might be a sight obstruction. (See Figure 650-13b for guidance.)



Horizontal Stopping Sight Distance
Figure 650-13a



When $h_o > \left(2 + \frac{0.75X}{\frac{1}{2}C_s} \right)$, roadside object is a sight obstruction.

Where:

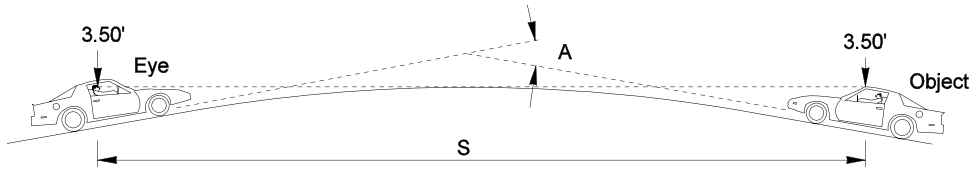
M = Lateral clearance for sight distance (feet) (see Figure 650-7)

C_s = Stopping sight distance chord (feet)

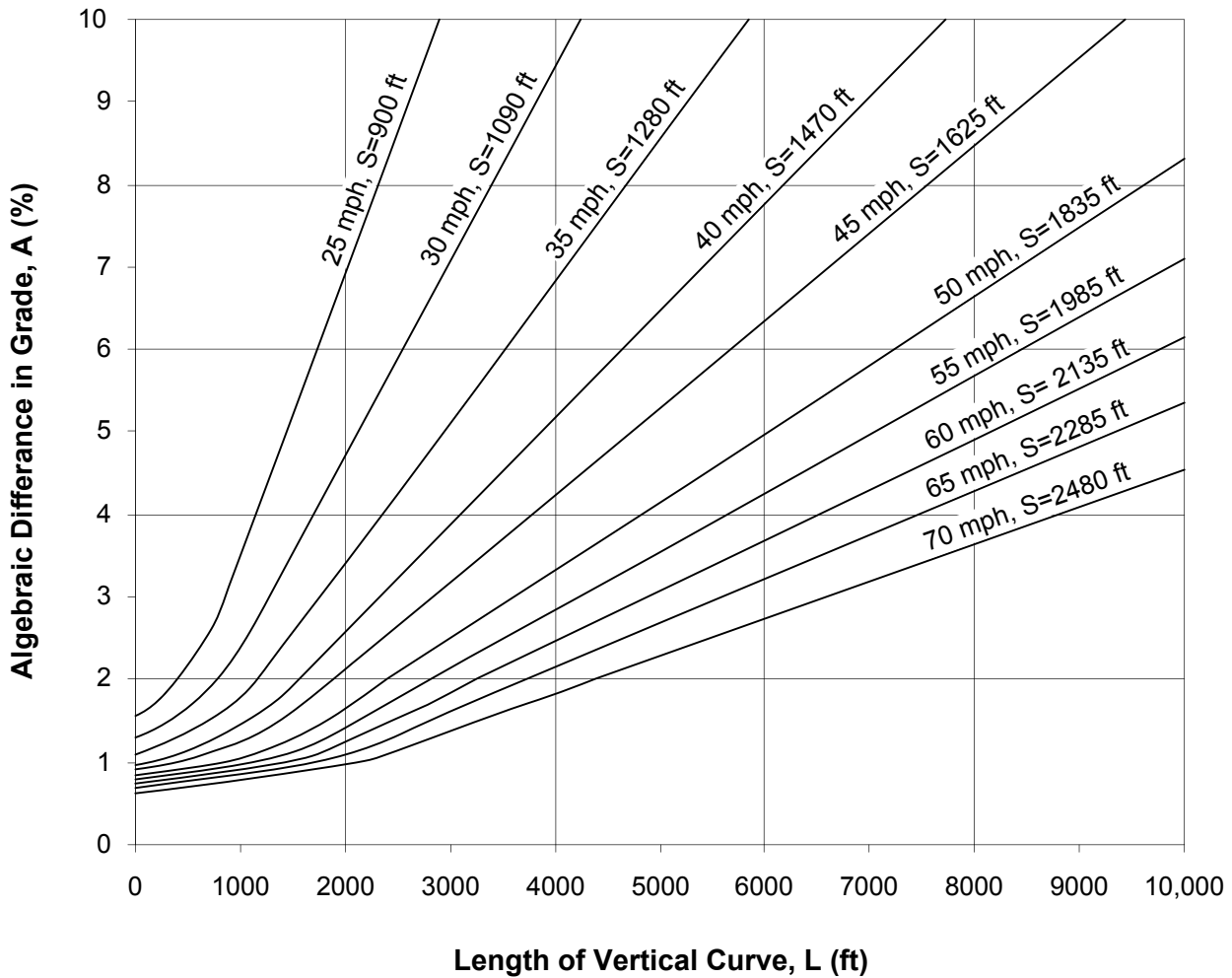
X = Distance from the sight obstruction to the end of the sight distance chord (feet)

h_o = Height of roadside object above the centerline of the inside lane (feet)

Horizontal Stopping Sight Distance
Figure 650-13b



Where $S > L$	
$L = 2S - \frac{2800}{A}$	$S = \frac{L}{2} + \frac{1400}{A}$
Where $S < L$	
$L = \frac{AS^2}{2800}$	$S = \sqrt{\frac{2800L}{A}}$
<p>L = Curve length (ft) A = Algebraic grade difference (percent) S = Sight distance (ft)</p>	



Passing Sight Distance for Crest Vertical Curves
Figure 650-14

- 700.01 General
- 700.02 References
- 700.03 Definitions
- 700.04 Clear Zone
- 700.05 Hazards to Be Considered for Mitigation
- 700.06 Median Considerations
- 700.07 Other Roadside Safety Features
- 700.08 Documentation

700.01 General

Roadside safety addresses the area outside of the roadway and is an important component of total highway design. There are numerous reasons why a vehicle leaves the roadway. Regardless of the reason, a forgiving roadside can reduce the seriousness of the consequences of a roadside encroachment. From a safety perspective, the ideal highway has roadsides and median areas that are flat and unobstructed by hazards.

Elements such as side slopes, fixed objects, and water are potential hazards that a vehicle might encounter when it leaves the roadway. These hazards present varying degrees of danger to the vehicle and its occupants. Unfortunately, geography and economics do not always allow ideal highway conditions. The mitigative measures to be taken depend on the probability of an accident occurring, the likely severity, and the available resources.

In order of preference, mitigative measures are: removal, relocation, reduction of impact severity (using breakaway features or making it traversable), and shielding with a traffic barrier. Consider cost (initial and life cycle costs) and maintenance requirements in addition to accident severity when selecting a mitigative measure. Use traffic barriers only when other measures cannot reasonably be accomplished. See Chapter 710 for additional information on traffic barriers.

700.02 References

- A Policy on Geometric Design of Highways and Streets* (Green Book), AASHTO, 2001
- Revised Code of Washington* (RCW) 47.24.020(2), “Jurisdiction, control”
- RCW 47.32.130, “Dangerous objects and structures as nuisances”
- City and County Design Standards (contained in the *Local Agency Guidelines*, M 36-63), WSDOT
- Roadside Design Guide*, AASHTO, 2002
- Roadside Manual*, M 25-30, WSDOT
- Standard Plans for Road, Bridge, and Municipal Construction* (Standard Plans), M 21-01, WSDOT

700.03 Definitions

ADT The average daily traffic for the design year under consideration.

backslope A sideslope that goes up as the distance increases from the roadway (cut slopes).

clear run-out area The area beyond the toe of a nonrecoverable slope available for safe use by an errant vehicle.

clear zone 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. The clear zone cannot contain a critical fill slope.

critical fill slope A slope on which a vehicle is likely to overturn. Slopes steeper than 3H:1V are considered critical fill slopes.

Design Clear Zone The minimum target value used in highway design.

foreslope A sideslope that goes down as the distance increases from the roadway (fill slopes and ditch inslopes).

hazard A side slope, a fixed object, or water that, when struck, can result in unacceptable impact forces on the vehicle occupants or place the occupants in a hazardous position. A hazard can be either natural or manmade.

nonrecoverable slope A slope on which an errant vehicle will continue until it reaches the bottom, without having the ability to recover control. Fill slopes steeper than 4H:1V, but no steeper than 3H:1V, are considered nonrecoverable.

recoverable slope A slope on which the driver of an errant vehicle can regain control of the vehicle. Slopes of 4H:1V or flatter are considered recoverable.

recovery area The minimum target value used in highway design when a fill slope between 4H:1V and 3H:1V starts within the Design Clear Zone.

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.

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.

700.04 Clear Zone

A clear roadside border area is a primary consideration when analyzing potential roadside and median hazards (as defined in 700.05). The intent is to provide as much clear, traversable area for a vehicle to recover as practical. The Design Clear Zone is used to evaluate the adequacy of the existing clear area and proposed modifications of the roadside. When considering the placement of new objects along the roadside or median, evaluate the potential for impacts and try to select locations with the least likelihood of an impact by an errant vehicle.

(1) Design Clear Zone on All Limited Access State Highways and Other State Highways Outside Incorporated Cities and Towns

Evaluate the Design Clear Zone when the Clear Zone column on the design matrices (see Chapter 325) indicates evaluate upgrade (EU) or Full Design Level (F) or when considering the placement of a new fixed object on the roadside or median. Use the Design Clear Zone Inventory form (Figures 700-2a & 2b) to identify potential hazards and propose corrective actions.

Guidance for establishing the Design Clear Zone for highways outside of incorporated cities is provided in Figure 700-1. This guidance also applies to limited access state highways within the city limits. Providing a clear recovery area that is consistent with this guidance does not require any additional documentation. However, there might be situations where it is not practical to provide these recommended distances. In these situations, document the decision as an evaluate upgrade or deviation as discussed in Chapter 330.

For additional Design Clear Zone guidance relating to roundabouts, see Chapter 915.

While not required, the designer is encouraged to evaluate potential hazards even when they are beyond the Design Clear Zone distances.

For state highways that are in an urban environment but outside of an incorporated city, evaluate both median and roadside clear zones as discussed above using Figure 700-1. However, there might be some flexibility in establishing the Design Clear Zone in urbanized areas adjacent to incorporated cities and towns. To achieve this flexibility, an evaluation of the impacts including safety, aesthetics, the environment, economics, modal needs, and access control can be used to establish the Design Clear Zone. This discussion, analysis, and agreement must take place early in the consideration of the median and roadside designs. An agreement on the responsibility for these median and roadside sections must be formalized with the city and/or county. The justification for the design decision for the selected Design Clear Zone must be documented as part of a project or corridor analysis. (See Chapter 330.)

(2) Design Clear Zone Inside Incorporated Cities and Towns

For managed access state highways within an urban area, it is recognized that in many cases it will not be practical to provide the Design Clear Zone distances shown in Figure 700-1. Roadways within an urban area generally have curbs and sidewalks and might have objects such as trees, poles, benches, trash cans, landscaping, and transit shelters along the roadside.

(a) **Roadside.** For managed access state highways, it is the city's responsibility to establish an appropriate Design Clear Zone in accordance with guidance contained in the City and County Design Standards. Document the Design Clear Zone established by the city in the Design Documentation Package.

(b) **Median.** For managed access state highways with raised medians, the median's Design Clear Zone is evaluated using Figure 700-1. In some instances, a median analysis will show that certain median designs provide significant benefits to overall corridor or project operations. In these cases, flexibility in establishing the Design Clear Zone is appropriate. To achieve this flexibility, an evaluation of the impacts (including safety, aesthetics, the environment, economics, modal needs, and access control) can be used to establish the median clear zone. This discussion, analysis, and agreement must take place early in the consideration of the flexible median design. An agreement on the responsibility for these median sections must be formalized with the city. The justification for the design decision for the selected Design Clear Zone must be documented as part of a project or corridor analysis. (See Chapter 330.)

(3) Design Clear Zone and Calculations

The Design Clear Zone guidance provided in Figure 700-1 is a function of the posted speed, side slope, and traffic volume. There are no distances in the table for 3H:1V fill slopes. Although fill slopes between 4H:1V and 3H:1V are considered traversable if free of fixed objects, these slopes are defined as nonrecoverable slopes. A vehicle might be able to begin recovery on

the shoulder, but will be unable to further this recovery until reaching a flatter area (4H:1V or flatter) at the toe of the slope. Under these conditions, the Design Clear Zone distance is called a recovery area. The method used to calculate the recovery area and an example are shown in Figure 700-3.

For ditch sections, the following criteria determine the Design Clear Zone:

(a) For ditch sections with foreslopes 4H:1V or flatter (see Figure 700-4, Case 1, for an example) the Design Clear Zone distance is the greater of the following:

- The Design Clear Zone distance for a 10H:1V cut section based on speed and the average daily traffic (ADT).
- A horizontal distance of 5 feet beyond the beginning of the backslope.

When a backslope steeper than 3H:1V continues for a horizontal distance of 5 feet beyond the beginning of the backslope, it is not necessary to use the 10H:1V cut slope criteria.

(b) For ditch sections with foreslopes steeper than 4H:1V, and backslopes steeper than 3H:1V the Design Clear Zone distance is 10 feet horizontal beyond the beginning of the backslope. (See Figure 700-4, Case 2, for an example.)

(c) For ditch sections with foreslopes steeper than 4H:1V and backslopes 3H:1V or flatter, the Design Clear Zone distance is the distance established using the recovery area formula (Figure 700-3). (See also Figure 700-4, Case 3, for an example.)

700.05 Hazards to Be Considered for Mitigation

There are three general categories of hazards: side slopes, fixed objects, and water. The following sections provide guidance for determining when these obstacles present a significant hazard to an errant motorist. In addition, several conditions require special consideration:

- Locations with high accident rate histories.
- Locations with pedestrian and bicycle usage. See Chapters 1020, "Bicycle Facilities," and 1025, "Pedestrian Design Considerations."

- Playgrounds, monuments, and other locations with high social or economic value.
- Redirectional land forms, also referred to as earth berms, were installed to mitigate hazards located in depressed medians and at roadsides. They were constructed of materials that provided support for a traversing vehicle. With slopes in the range of 2H:1V to 3H:1V, they were intended to redirect errant vehicles. The use of redirectional land forms has been discontinued as a means for mitigating fixed objects. Where redirectional land forms currently exist as mitigation for a fixed object, ensure that the hazard they were intended to mitigate is removed, relocated, made crashworthy, or shielded with barrier. Landforms may be used to provide a smooth surface at the base of a rock cut slope.

Use of a traffic barrier for hazards other than those described below requires justification in the Design Documentation Package.

(1) Side Slopes

(a) **Fill Slopes.** Fill slopes can present a hazard to an errant vehicle with the degree of severity dependent upon the slope and height of the fill. Providing fill slopes that are 4H:1V or flatter can mitigate this hazard. If flattening the slope is not feasible or cost effective, the installation of a barrier might be appropriate. Figure 700-5 represents a selection procedure used to determine whether a fill side slope constitutes a hazard for which a barrier is a cost-effective mitigation. The curves are based on the severity indexes and represent the points where total costs associated with a traffic barrier are equal to the predicted accident cost associated with selected slope heights without traffic barrier. If the ADT and height of fill intersect on the “Barrier Recommended” side of the embankment slope curve, then provide a barrier if flattening the slope is not feasible or cost effective. Do not use Figure 700-5 for slope design. Design guidance for slopes is in Chapters 430 and 640. Also, if the figure indicates that barrier is not recommended at an existing slope, that result is not justification for a deviation.

For example, if the ADT is 4,000 and the embankment height is 10 feet, barrier will be cost effective for a 2H:1V slope, but not for a 2.5H:1V slope.

This process only addresses the potential hazard of the slope. Obstacles on the slope can compound the hazard. Where barrier is not cost effective, use the recovery area formula to evaluate fixed objects on critical fill slopes less than 10 feet high.

(b) **Cut Slopes.** A cut slope is usually less of a hazard than a traffic barrier. The exception is a rock cut with a rough face that might cause vehicle snagging rather than providing relatively smooth redirection.

Analyze the potential motorist risk and the benefits of treatment of rough rock cuts located within the Design Clear Zone. A cost-effectiveness analysis that considers the consequences of doing nothing, removal, or smoothing of the cut slope, and all other viable options to reduce the severity of the hazard, can be used to determine the appropriate treatment. Also consider options to reduce the potential for roadway departures. Some potential options are:

- Graded landform along the base of a rock cut.
- Flexible barrier.
- More rigid barrier.
- Rumble strips.

Conduct an individual investigation for each rock cut or group of rock cuts. Select the most cost-effective treatment.

(2) Fixed Objects

Consider the following objects for mitigation:

- Wooden poles or posts with cross sectional area greater than 16 square inches that do not have breakaway features.
- Nonbreakaway steel sign posts.
- Nonbreakaway light standards.
- Trees having a diameter of 4 inches or more measured at 6 inches above the ground surface.

- Fixed objects extending above the ground surface by more than 4 inches; for example, boulders, concrete bridge rails, signal and electrical cabinets, piers, and retaining walls.
- Existing guardrail that does not conform to current design guidance. (See Chapter 710.)
- Drainage items, such as culvert and pipe ends.

Mitigate hazards that exist within the Design Clear Zone when feasible. Although limited in application, there may be situations where removal of a hazard outside of the R.O.W. is appropriate. The possible mitigative measures are listed below in order of preference.

- Remove.
- Relocate.
- Reduce impact severity (using a breakaway feature).
- Shield the object by using longitudinal barrier or impact attenuator.

(a) **Trees.** When evaluating new plantings or existing trees, consider the maximum allowable diameter of 4 inches measured at 6 inches above the ground when the tree has matured. When removing trees within the Design Clear Zone, complete removal of stumps is preferred. However, to avoid significant disturbance of the roadside vegetation, larger stumps may be mitigated by grinding or cutting them flush to the ground and grading around them. See the *Roadside Manual* for further guidance on the treatment of the disturbed roadside.

(b) **Mailboxes.** Ensure that all mailboxes located within the Design Clear Zone have supports and connections as shown in the Standard Plans. The height from the ground to the bottom of the mailbox is 3 feet 3 inches. This height may vary from 3 feet 3 inches to 4 feet if requested by the mail carrier. If the desired height is to be different from 3 feet 3 inches provide the desired height in the contract plans. See Figure 700-6 for installation guidelines.

In urban areas where sidewalks are prevalent, contact the postal service to determine the most appropriate mailbox location. Locate mailboxes on limited access highways in accordance with Chapter 1430 “Limited Access”. A turnout, as shown on Figure 700-6, is not required on limited access highways with shoulders of 6 feet or more where only one mailbox is to be installed. On managed access highways, mailboxes must be on the right-hand side of the road in the direction of travel of the postal carrier. Avoid placing mailboxes along high-speed, high-volume highways. Locate Neighborhood Delivery and Collection Box Units (NDCBUs) outside the Design Clear Zone.

(c) **Culvert Ends.** Provide a traversable end treatment when the culvert end section or opening is on the roadway side slope and within the Design Clear Zone. This can be accomplished for small culverts by beveling the end to match the side slope, with a maximum of 4 inches extending out of the side slope.

Bars might be necessary to provide a traversable opening for larger culverts. Place bars in the plane of the culvert opening in accordance with the Standard Plans when:

1. Single cross culvert opening exceeds 40 inches measured parallel to the direction of travel.
2. Multiple cross culvert openings that exceed 30 inches each, measured parallel to the direction of travel.
3. Culvert approximately parallel to the roadway that has an opening exceeding 24 inches measured perpendicular to the direction of travel.

Bars are permitted where they will not significantly affect the stream hydraulics and where debris drift is minor. Consult the regional Maintenance Office to verify these conditions. If debris drift is a concern, consider options to reduce the amount of debris that can enter the pipe. (See the *Hydraulics Manual*). Other treatments are extending the culvert to move the end outside the Design Clear Zone or installing a traffic barrier.

(d) **Sign Posts.** Whenever possible, locate signs behind existing or planned traffic barrier installations to eliminate the need for breakaway posts. Place them at least 25 feet from the end of the barrier terminal and with the sign face behind the barrier. When barrier is not present, use terrain features to reduce the likelihood of an errant vehicle striking the sign posts. Whenever possible, depending on the type of sign and the sign message, adjust the sign location to take advantage of barrier or terrain features. This will reduce accident potential and, possibly, future maintenance costs. See Chapter 820 for additional information regarding the placement of signs.

Sign posts with cross sectional areas greater than 16 square inches that are within the Design Clear Zone and not located behind a barrier must have breakaway features as shown in the Standard Plans.

(e) **Traffic Signal Standards/Posts/Supports.** Breakaway signal posts generally are not practical or desirable. Since these supports are generally located at intersecting roadways, there is a higher potential for a falling support to impact vehicles and/or pedestrians. In addition, signal supports that have overhead masts may be too heavy for a breakaway design to work properly. Other mitigation such as installing a traffic barrier is also very difficult. With vehicles approaching the support from many different angles, a barrier would have to surround the support and would be subject to impacts at high angles. Additionally, barrier can inhibit pedestrian movements. Therefore, barrier is generally not an option. However, since speeds near signals are generally lower, the potential for a severe impact is reduced. For these reasons, the only mitigation is to locate the support as far from the traveled way as possible.

In locations where signals are used for ramp meters, the supports can be made breakaway as shown on the Standard Plan.

(f) **Fire Hydrants.** Fire Hydrants are allowed on WSDOT right of way by franchise or permit. Fire hydrants that are made of cast iron can be expected to fracture on impact and can therefore be considered a breakaway device. Any portion of the hydrants that will not be breakaway must not extend more than 4 inches above the ground. In addition, the hydrant must have a stem that will shut off water flow in the event of an impact. Mitigate all other hydrants.

(g) **Utility Poles.** Since utilities often share the right of way, utility objects such as poles will often be located along the roadside. It is undesirable/impractical to install barrier for all of these objects so mitigation is usually in the form of relocation (underground or to the edge of the right of way) or delineation. In some instances where there is a history of impacts with poles and relocation is not possible, a breakaway design might be appropriate.

Contact Headquarters Design for information on breakaway features. Coordinate with the Utilities Office where appropriate.

(h) **Light Standards.** Provide breakaway light standards unless fixed light standards can be justified. Fixed light standards may be appropriate in areas of extensive pedestrian concentrations, such as adjacent to bus shelters. Document the decision to use fixed bases in the Design Documentation Package.

(3) **Water**

Water with a depth of 2 feet or more and located with a likelihood of encroachment by an errant vehicle must be considered for mitigation on a project-by-project basis. Consider the length of time traffic is exposed to this hazard and its location in relationship to other highway features such as curves.

Analyze the potential motorist risk and the benefits of treatment of bodies of water located within the Design Clear Zone. A cost-effectiveness analysis that considers the consequences of doing nothing versus installing a longitudinal barrier can be used to determine the appropriate treatment.

For fencing considerations along water features, see Chapter 1460.

700.06 Median Considerations

Medians must be analyzed for the potential of an errant vehicle to cross the median and encounter oncoming traffic. Median barriers are normally used on limited access, multilane, high-speed, high traffic volume highways. These highways generally have posted speeds of 45 mph or greater. Median barrier is not normally placed on collectors or other state highways that do not have limited access control. Providing access through median barrier requires openings and, therefore, end-treatments.

Provide median barrier on full access control, multilane highways with median widths of 50 feet or less and posted speeds of 45 mph or more. Consider median barrier on highways with wider medians or lower posted speeds when there is a history of cross median accidents.

When installing a median barrier, provide left-side shoulder widths as shown in Chapters 430 and 440 and shy distance as shown in Chapter 710. Consider a wider shoulder area where the barrier will cast a shadow on the roadway and hinder the melting of ice. See Chapter 640 for additional criteria for placement of median barrier. See Chapter 710 for information on the types of barriers that can be used. See Chapter 650 for lateral clearance on the inside of a curve to provide the required stopping sight distance.

When median barrier is being placed in an existing median, identify the existing crossovers and enforcement observation points. Provide the necessary median crossovers in accordance with Chapter 960, considering enforcement needs. Chapter 1050 provides guidance on HOV enforcement.

700.07 Other Roadside Safety Features

(1) Rumble Strips

Rumble strips are grooves or rows of raised pavement markers placed perpendicular to the direction of travel to alert inattentive drivers.

There are three kinds of rumble strips:

- (a) **Roadway rumble strips** are placed across the traveled way to alert drivers approaching a change of roadway condition or a hazard that requires substantial speed reduction or other maneuvering. Examples of locations where roadway rumble strips may be used are in advance of:
- Stop controlled intersections.
 - Port of entry/customs stations.
 - Lane reductions where accident history shows a pattern of driver inattention.

They may also be placed at locations where the character of the roadway changes, such as at the end of a freeway.

Contact the Headquarters Design Office for additional guidance on the design and placement of roadway rumble strips.

Document justification for using roadway rumble strips.

- (b) **Shoulder rumble strips** are placed on the shoulders just beyond the traveled way to warn drivers when they are entering a part of the roadway not intended for routine traffic use. Shoulder rumble strips may be used when an analysis indicates a problem with run-off-the-road accidents due to inattentive or fatigued drivers. A comparison of rolled-in and milled-in Shoulder Rumble Strips (SRS) has determined that milled-in rumble strips, although more expensive, are more cost effective. Milled-in rumble strips are recommended.

When SRS are used, discontinue them where no edge stripe is present such as at intersections and where curb and gutter are present. Where bicycle travel is allowed, discontinue SRS at locations where shoulder width reductions can cause bicyclists to move into or across the area where rumble strips would normally be placed, such as shoulders adjacent to bridges with reduced shoulder widths.

SRS patterns vary depending on the likelihood of bicyclists being present along the highway shoulder, and whether they are placed on divided or undivided highways. Rumble strip patterns for undivided highways are shallower and may be

narrower than patterns used on divided highways. They also provide gaps in the pattern, providing opportunities for bicycles to move across the pattern without having to ride across the grooves. There are four shoulder rumble strip patterns. Consult the Standard Plans for the patterns and construction details.

1. Divided Highways

SRS are required on both the right and left shoulders of rural Interstate highways. Consider them on both shoulders of rural divided highways. Use the Shoulder Rumble Strip Type 1 pattern on divided highways.

Omitting SRS on rural highways is a design exception (DE) under any one of the following conditions:

- When another project scheduled within two years of the proposed project will overlay or reconstruct the shoulders or will use the shoulders for detours.
- When a pavement analysis determines that installing SRS will result in inadequate shoulder strength.
- When overall shoulder width will be less than 4 feet wide on the left and 6 feet wide on the right.

2. Undivided Highways

SRS are not required on undivided highways, but may be used where run-off-the-road accident experience is high. SRS usage on the shoulders of undivided highways demands strategic application because bicycle usage is more prevalent along the shoulders of the undivided highway system. Rumble strips affect the comfort and control of bicycle riders; consequently, their use is to be limited to highway corridors that experience high levels of run-off-the-road accidents. Apply the following criteria in evaluating the appropriateness of rumble strips on the shoulders of undivided highways.

- Use on rural roads only.
- Ensure shoulder pavement is structurally adequate to support milled rumble strips.

- Posted speed is 45 mph or greater.
- Ensure that at least 4 feet of usable shoulder remains between the rumble strip and the outside edge of shoulder. If guardrail or barrier is present, increase the dimension to 5 feet of usable shoulder.
- Preliminary evaluation indicates a run-off-the-road accident experience of approximately 0.6 crashes per mile per year, or approximately 34 crashes per 100 million miles of travel. (These values are intended to provide relative comparison of crash experience and are not to be used as absolute guidance on whether rumble strips are appropriate.)
- Do not place shoulder rumble strips on downhill grades exceeding 4% for more than 500 feet in length along routes where bicyclists are frequently present.
- An engineering analysis indicates a run-off-the-road accident experience considered correctable by shoulder rumble strips.
- Consult the regional members of the Washington Bicycle and Pedestrian Advisory Committee to determine bicycle usage along a route, and involve them in the decision-making process when considering rumble strips along bike touring routes or other routes where bicycle events are regularly held.

The Shoulder Rumble Strip Type 2 or Type 3 pattern is used on highways with minimal bicycle traffic. When bicycle traffic on the shoulder is high, the Shoulder Rumble Strip Type 4 pattern is used.

Shoulder rumble strip installation considered at any other locations must involve the WSDOT Bicycle and Pedestrian Advisory Committee as a partner in the decision-making process.

Consult the following web site for guidance on conducting an engineering analysis:
<http://www.wsdot.wa.gov/EESC/Design/Policy/RoadsideSafety/Chapter700/Chapter700B.htm>

(c) **Centerline rumble strips** are placed on the centerline of undivided highways to alert drivers that they are entering the opposing lane. They are applied as a countermeasure for crossover accidents. Centerline rumble strips are installed with no differentiation between passing permitted and no passing areas. Pavement marking should be refreshed when removed by centerline rumble strips.

Drivers tend to move to the right to avoid driving on centerline rumble strips. Narrow lane and shoulder widths may lead to dropping a tire off the pavement when drivers have shifted their travel path. Centerline rumble strips are inappropriate when the combined lane and shoulder widths in each direction is less than twelve feet. See Chapters 430 and 440 for guidance on lane and shoulder width. Consider short sections of roadway that are below this width only when added for route continuity.

Apply the following criteria in evaluating the appropriateness of centerline rumble strips:

- An engineering analysis indicates a crossover accident history with collisions considered correctable by centerline rumble strips. Review the accident history to determine the frequency of collisions with contributing circumstances such as inattention, apparently fatigued, apparently asleep, over centerline, or on wrong side of road.
- Centerline rumble strips are most appropriate on rural roads, but with special consideration may also be appropriate for urban roads. Some concerns specific to urban areas are noise in densely populated areas, the frequent need to interrupt the rumble strip pattern to accommodate left turning vehicles, and a reduced effectiveness at lower speeds (35 MPH and below).
- Ensure the roadway pavement is structurally adequate to support milled rumble strips. Consult the region's Materials Engineer to verify pavement adequacies.
- Centerline rumble strips are not appropriate where two-way left-turn lanes exist.

(2) **Headlight Glare Considerations**

Headlight glare from opposing traffic can cause safety problems. Glare can be reduced by the use of wide medians, separate alignments, earth mounds, plants, concrete barrier, and by glare screens. Consider long term maintenance when selecting the treatment for glare. When considering earth mound and planting to reduce glare, see the *Roadside Manual* for additional guidance. When considering glare screens, see Chapter 650 for lateral clearance on the inside of a curve to provide the required stopping sight distance. In addition to reducing glare, taller concrete barriers also provide improved crash performance for larger vehicles such as trucks.

Glare screen is relatively expensive and its use must be justified and documented. It is difficult to justify the use of glare screen where the median width exceeds 20 feet, the ADT is less than 20,000 vehicles per day, or the roadway has continuous lighting. Consider the following factors when assessing the need for glare screen:

- Higher rate of night accidents compared to similar locations or statewide experience.
- Higher than normal ratio of night to day accidents.
- Unusual distribution or concentration of nighttime accidents.
- Over representation of older drivers in night accidents.
- Combination of horizontal and vertical alignment, particularly where the roadway on the inside of a curve is higher than the roadway on the outside of the curve.
- Direct observation of glare.
- Public complaints concerning glare.

The most common glare problem is between opposing main line traffic. Other conditions for which glare screen might be appropriate are:

- Between a highway and an adjacent frontage road or parallel highway, especially where opposing headlights might seem to be on the wrong side of the driver.

- At an interchange where an on-ramp merges with a collector distributor and the ramp traffic might be unable to distinguish between collector and main line traffic. In this instance, consider other solutions, such as illumination.
- Where headlight glare is a distraction to adjacent property owners. Playgrounds, ball fields, and parks with frequent nighttime activities might benefit from screening if headlight glare interferes with these activities.

There are currently three basic types of glare screen available: chain link (see Standard Plans), vertical blades, and concrete barrier. (See Figure 700-7.)

When the glare is temporary (due to construction activity), consider traffic volumes, alignment, duration, presence of illumination, and type of construction activity. Glare screen may be used to reduce rubbernecking associated with construction activity, but less expensive methods, such as plywood that seals off the view of the construction area, might be more appropriate.

700.08 Documentation

A list of documents that are required to be preserved in the Design Documentation Package (DDP) or the Project File (PF) is on the following website:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

Design Clear Zone Distances for State Highways Outside Incorporated Cities**

(In feet from edge of traveled way***)

Posted Speed mph	Average Daily Traffic	Cut Section (Backslope) (H:V)						Fill Section (H:V)					
		3:1	4:1	5:1	6:1	8:1	10:1	3:1	4:1	5:1	6:1	8:1	10:1
35 or Less		The Design Clear Zone distance is 10 feet											
40	Under 250	10	10	10	10	10	10	*	13	12	11	11	10
	251-800	11	11	11	11	11	11	*	14	14	13	12	11
	801-2000	12	12	12	12	12	12	*	16	15	14	13	12
	2001-6000	14	14	14	14	14	14	*	17	17	16	15	14
	Over 6000	15	15	15	15	15	15	*	19	18	17	16	15
45	Under 250	11	11	11	11	11	11	*	16	14	13	12	11
	251-800	12	12	13	13	13	13	*	18	16	14	14	13
	801-2000	13	13	14	14	14	14	*	20	17	16	15	14
	2001-6000	15	15	16	16	16	16	*	22	19	17	17	16
	Over 6000	16	16	17	17	17	17	*	24	21	19	18	17
50	Under 250	11	12	13	13	13	13	*	19	16	15	13	13
	251-800	13	14	14	15	15	15	*	22	18	17	15	15
	801-2000	14	15	16	17	17	17	*	24	20	18	17	17
	2001-6000	16	17	17	18	18	18	*	27	22	20	18	18
	Over 6000	17	18	19	20	20	20	*	29	24	22	20	20
55	Under 250	12	14	15	16	16	17	*	25	21	19	17	17
	251-800	14	16	17	18	18	19	*	28	23	21	20	19
	801-2000	15	17	19	20	20	21	*	31	26	23	22	21
	2001-6000	17	19	21	22	22	23	*	34	29	26	24	23
	Over 6000	18	21	23	24	24	25	*	37	31	28	26	25
60	Under 250	13	16	17	18	19	19	*	30	25	23	21	20
	251-800	15	18	20	20	21	22	*	34	28	26	23	23
	801-2000	17	20	22	22	23	24	*	37	31	28	26	25
	2001-6000	18	22	24	25	26	27	*	41	34	31	29	28
	Over 6000	20	24	26	27	28	29	*	45	37	34	31	30
65	Under 250	15	18	19	20	21	21	*	33	27	25	23	22
	251-800	17	20	22	22	24	24	*	38	31	29	26	25
	801-2000	19	22	24	25	26	27	*	41	34	31	29	28
	2001-6000	20	25	27	27	29	30	*	46	37	35	32	31
	Over 6000	22	27	29	30	31	32	*	50	41	38	34	33
70	Under 250	16	19	21	21	23	23	*	36	29	27	25	24
	251-800	18	22	23	24	26	26	*	41	33	31	28	27
	801-2000	20	24	26	27	28	29	*	45	37	34	31	30
	2001-6000	22	27	29	29	31	32	*	50	40	38	34	33
	Over 6000	24	29	31	32	34	35	*	54	44	41	37	36

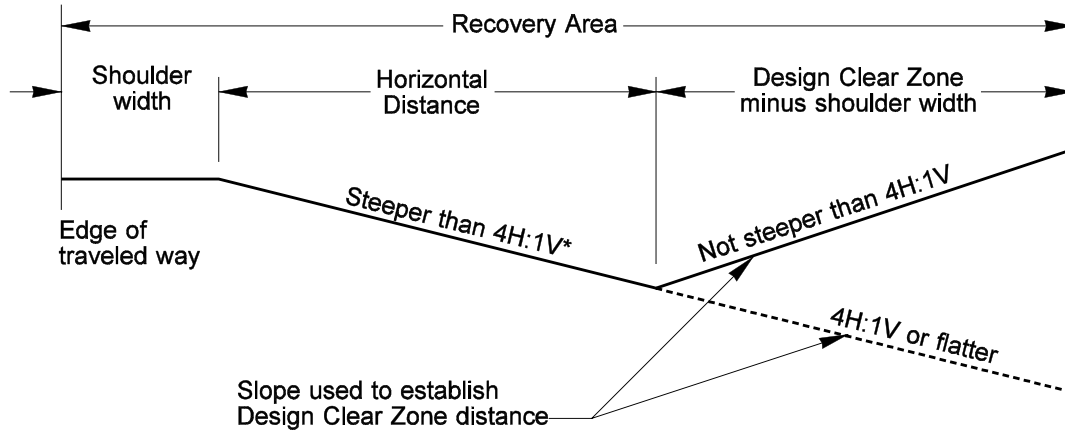
* When the fill section slope is steeper than 4H:1V but not steeper than 3H:1V, the Design Clear Zone distance is modified by the recovery area formula (Figure 700-3) and is referred to as the recovery area. The basic philosophy behind the recovery area formula is that the vehicle can traverse these slopes but cannot recover (control steering) and, therefore, the horizontal distance of these slopes is added to the Design Clear Zone distance to form the recovery area.

** This figure also applies to limited access state highways in cities and median areas on managed access state highways in cities. See 700.04 for guidance on managed access state highways within incorporated cities.

*** See 700.03 for the definition of traveled way.

Design Clear Zone Distance Table

Figure 700-1



* Recovery area normally applies to slopes steeper than 4H:1V, but no steeper than 3H:1V. For steeper slopes, the recovery area formula may be used as a guide if the embankment height is 10 feet or less.

Formula:

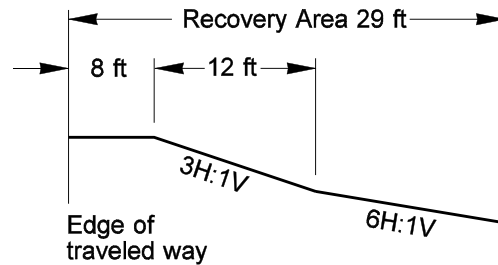
$$\text{Recovery area} = (\text{shoulder width}) + (\text{horizontal distance}) + (\text{Design Clear Zone distance} - \text{shoulder width})$$

Example:

Fill section (slope 3H:1V or steeper)

Conditions: Speed – 45 mph
 Traffic – 3000 ADT
 Slope – 3H:1V

Criteria: Slope 3H:1V – use
 Recovery area formula



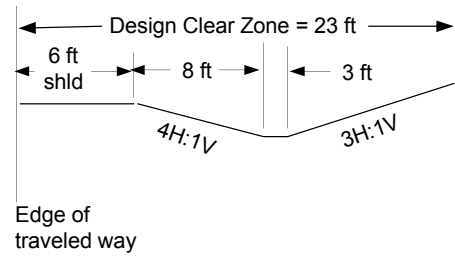
$$\begin{aligned} \text{Recovery area} &= (\text{shoulder width}) + (\text{horizontal distance}) \\ &+ (\text{Design Clear Zone distance} - \text{shoulder width}) \\ &= 8 + 12 + (17-8) \\ &= 29 \text{ feet} \end{aligned}$$

Recovery Area
Figure 700-3

Cut section with ditch (fore slope 4H:1V or flatter)

Conditions: Speed - 55 mph
 Traffic - 4200 ADT
 Slope - 4H:1V

Criteria: Greater of
 (1) Design Clear Zone for 10H:1V
 Cut Section, 23 feet
 (2) 5 feet horizontal beyond beginning
 of back slope, 22 feet



Design Clear Zone = 23 feet

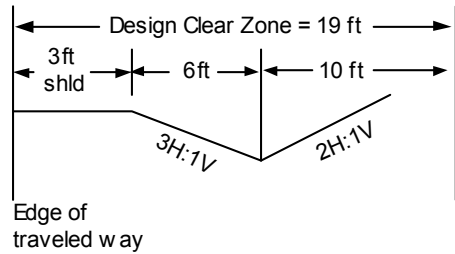
Case 1

Cut section with ditch (fore slope 3H:1V or steeper and back slope steeper than 3H:1V)

Conditions: NA

Criteria: 10 feet horizontal beyond beginning
 of back slope

Design Clear Zone = 19 feet



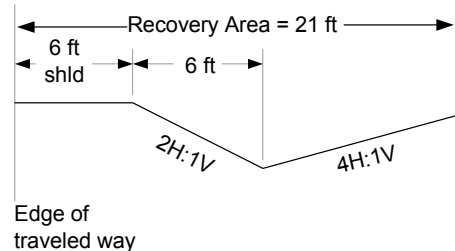
Case 2

Cut section with ditch (fore slope 3H:1V or steeper and back slope not steeper than 3H:1V)

Conditions: Speed - 45 mph
 Traffic - 3000 ADT
 Foreslope - 2H:1V
 Back slope 4H:1V

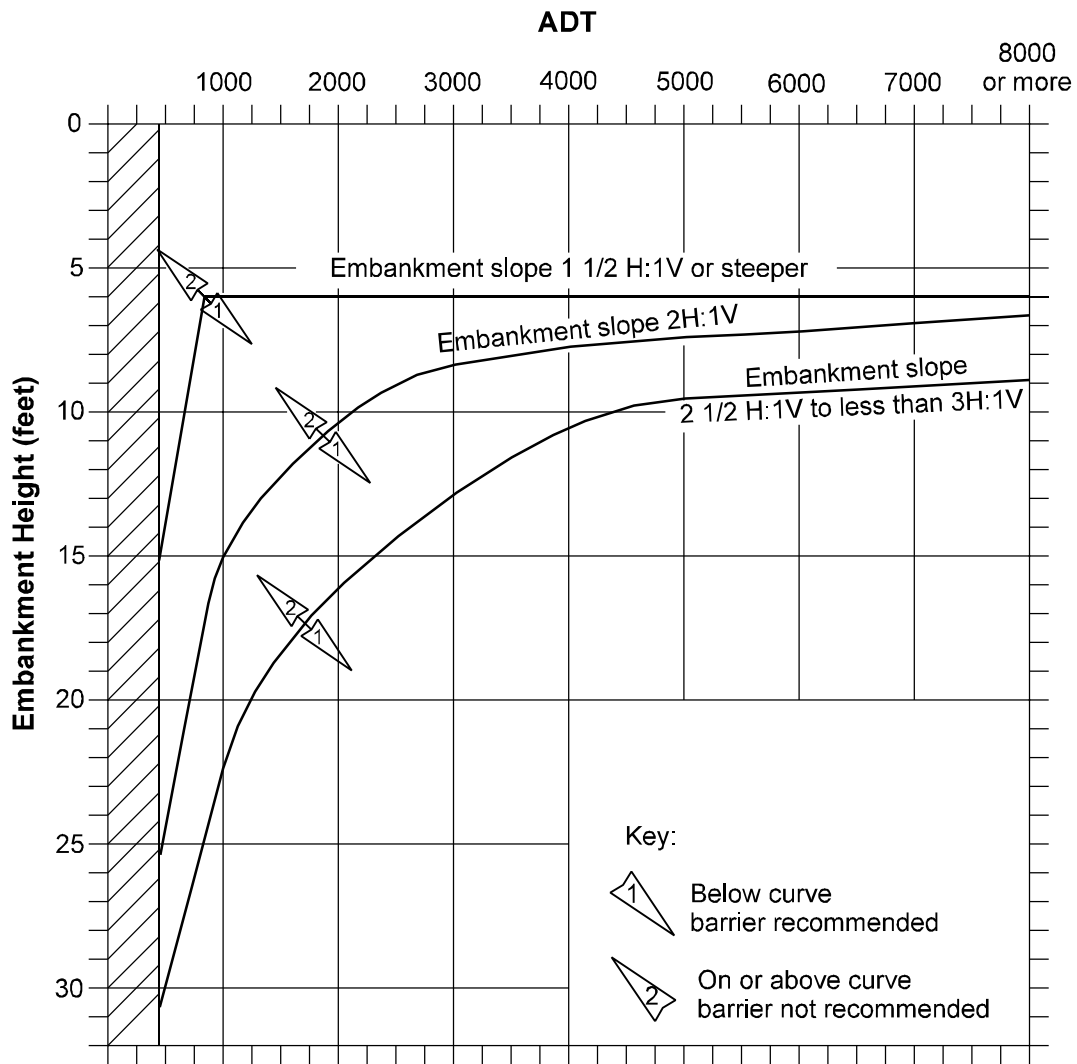
Criteria: Use recovery area formula

Recovery Area = (shoulder width) + (horizontal
 distance) + (Design Clear Zone distance - shoulder width)
 = 6 + 6 + (15 - 6)
 = 21 feet



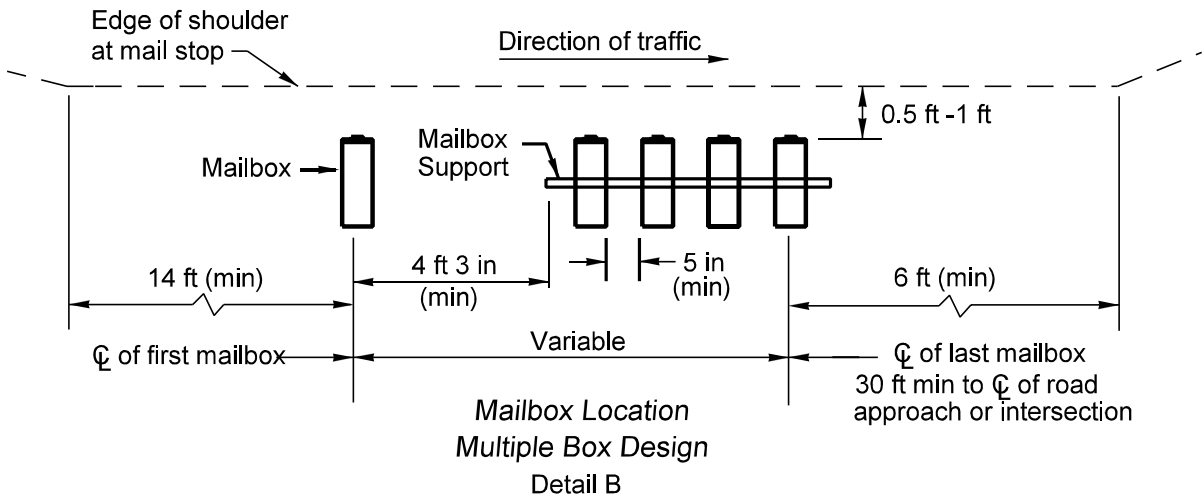
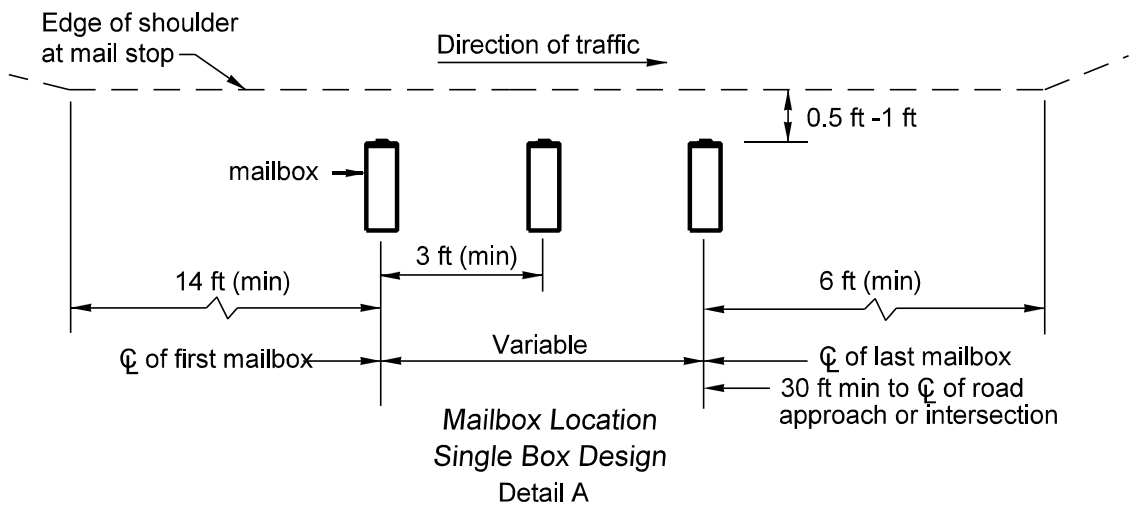
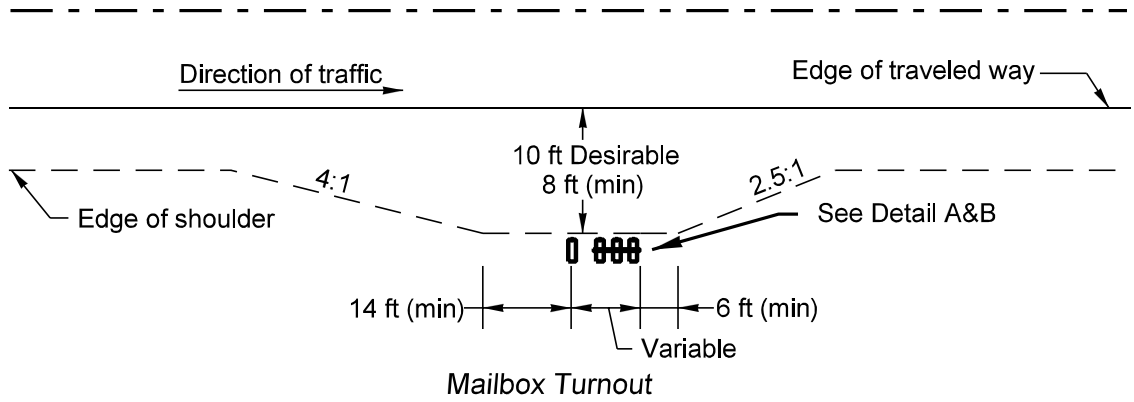
Case 3

Design Clear Zone for Ditch Sections
 Figure 700-4

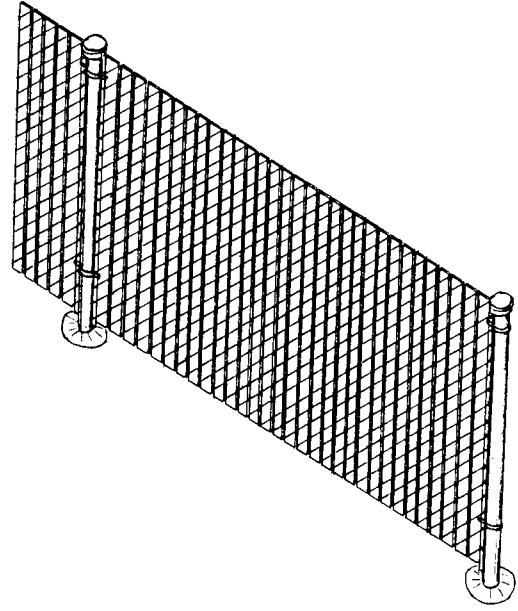
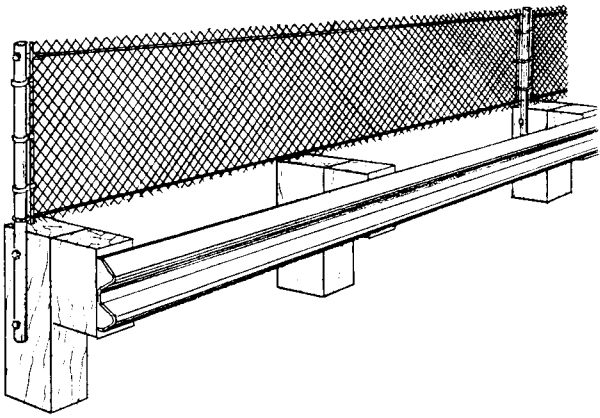


Note: Routes with ADTs under 400 may be evaluated on a case by case basis.

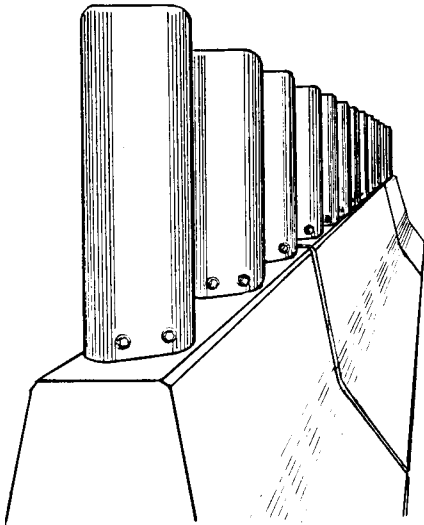
Guidelines for Embankment Barrier
Figure 700-5



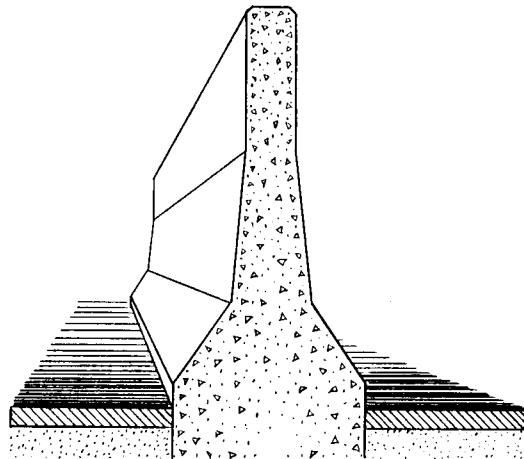
Mailbox Location and Turnout Design
Figure 700-6



Chain Link



Vertical Blades



Concrete Barrier

Glare Screens
Figure 700-7

- 720.01 Impact Attenuator Systems
- 720.02 Design Criteria
- 720.03 Selection
- 720.04 Documentation

720.01 Impact Attenuator Systems

Impact attenuator systems are protective systems that prevent an errant vehicle from impacting a hazard by either gradually decelerating the vehicle to a stop when hit head-on or by redirecting it away from the hazard when struck on the side. These barriers are used for rigid objects or hazardous conditions that cannot be removed, relocated, or made breakaway.

Approved systems are shown in Figures 720-2a through 720-4b and on the WSDOT Headquarters (HQ) Design Office web page at:
<http://www.wsdot.wa.gov/EESC/Design/Policy/RoadsideSafety/Chapter720/Chapter720B.htm>

(1) Permanent Installations

For systems used in permanent installations, a description of the system's purpose, parts, and function, as well as requirements for transition, foundation, and slope, are provided as follows and in Figure 720-5:

(a) Crash Cushion Attenuating Terminal (CAT-350)

1. **Purpose:** The CAT-350 is an end treatment for W-beam guardrail. It can also be used for concrete barrier if a transition is provided.
2. **Description:** The system consists of slotted W-beam guardrail mounted on both sides of breakaway timber posts. Steel sleeves with soil plates hold the timber posts in place. (See Figure 720-2a.)
3. **Function:** When hit head-on, the slotted guardrail is forced over a pin that shears the steel between the slots. This shearing dissipates the energy of the impact.
4. **Foundation:** Concrete footings or foundations are not required.

5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.

6. **Manufacturer/Supplier:** Trinity Industries, Inc.

(b) Brakemaster 350

1. **Purpose:** The Brakemaster 350 system is an end treatment for W-beam guardrail. It can also be used for concrete barrier if a transition is provided.
2. **Description:** The system contains an embedded anchor assembly, W-beam fender panels, transition strap, and diaphragm. (See Figure 720-2a.)
3. **Function:** The system uses a brake and cable device for head-on impacts and for redirection. The cable is embedded in a concrete anchor at the end of the system.
4. **Foundation:** A concrete foundation is not required for this system, but a paved surface is recommended.
5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.
6. **Manufacturer/Supplier:** Energy Absorption Systems

(c) QuadTrend 350

1. **Purpose:** The QuadTrend 350 is an end treatment for 2-foot-8-inches-high concrete barriers. The system's short length allows it to be used at the ends of bridges where the installation of a beam guardrail transition and terminal is not feasible.
2. **Description:** This system consists of telescoping quadruple corrugated fender panels mounted on steel breakaway posts. (See Figure 720-2a.)
3. **Function:** Sand-filled boxes attached to the posts dissipate a portion of the energy of an impact. An anchored cable installed behind the fender panels directs the vehicle away from the barrier end.

4. **Foundation:** The system is installed on a concrete foundation to support the steel posts.

5. **Slope:** A 6H:1V or flatter slope is required behind the barrier to allow for vehicle recovery.

6. **Manufacturer/Supplier:** Energy Absorption Systems

(d) **Universal TAU-II**

1. **Purpose:** The Universal TAU-II crash cushion system is an end treatment for concrete barrier, beam guardrail, and fixed objects up to 8 feet wide.

2. **Description:** The system is made up of independent collapsible bays containing energy-absorbing cartridges that are guided and supported during a head-on hit by high strength galvanized steel cables and three beam rail panels. Each bay is composed of overlapping three beam panels on the sides and structural support diaphragms on the ends. Structural support diaphragms are attached to two cables running longitudinally through the system and attached to foundations at each end of the system. (See Figure 720-2c.)

3. **Function:** Overlapping panels, structural support diaphragms, cable supports, cables, and foundation anchors allow the system to resist angled impacts and mitigate head-on impacts.

4. **Foundation:** The system is installed on a concrete foundation or asphaltic concrete foundations conforming to the manufacturer's recommendations.

5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.

6. **Manufacturer/Supplier:** Barrier Systems, Inc.

(e) **QuadGuard**

1. **Purpose:** The QuadGuard is an end treatment for concrete barrier and beam guardrail and is also used to mitigate fixed objects up to 10 feet wide.

2. **Description:** The system consists of a series of Hex-Foam cartridges surrounded by a framework of steel diaphragms and quadruple corrugated fender panels. (See Figure 720-2b.)

3. **Function:** The internal shearing of the cartridges and the crushing of the energy absorption material absorb impact energy from end-on hits. The fender panels redirect vehicles impacting the attenuator on the side.

4. **Foundation:** The system is installed on a concrete foundation.

5. **Slope:** If the site has excessive grade or cross slope, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. Excessive is defined as steeper than 8% for the QuadGuard.

6. **Manufacturer/Supplier:** Energy Absorption Systems

(f) **QuadGuard Elite**

1. **Purpose:** The QuadGuard Elite is an end treatment for concrete barrier and beam guardrail and is also used for fixed objects up to 7 feet 6 inches wide.

2. **Description:** The system consists of telescoping quadruple corrugated fender panels mounted on both sides of a series of polyethylene cylinders. (See Figure 720-2b.)

3. **Function:** The cylinders are compressed during a head-on impact and will return to their original shape when the system is reset. It is anticipated that this system will require very few replacement parts or extensive repair.

4. **Foundation:** The system is installed on a concrete foundation.

5. **Slope:** If the site has excessive grade or cross slope, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. Excessive is defined as steeper than 8% for the QuadGuard Elite.

6. **Manufacturer/Supplier:** Energy Absorption Systems

(g) **Reusable Energy Absorbing Crash Terminal (REACT 350)**

1. **Purpose:** The REACT 350 is an end treatment for concrete barriers and is also used for fixed objects up to 3 feet wide.
2. **Description:** The system consists of polyethylene cylinders with varying wall thickness, redirecting cables, a steel frame base, and a backup structure. (See Figure 720-2d.)
3. **Function:** The redirecting cables are anchored in the concrete foundation at the front of the system and in the backup structure at the rear of the system. When hit head-on, the cylinders compress, absorb the impact energy, and immediately return to much of their original shape, position, and capabilities. For side impacts, the cables restrain the system enough to prevent penetration and redirect the vehicle. It is anticipated that this system will require very few replacement parts or extensive repair.
4. **Foundation:** The system is installed on a concrete foundation.
5. **Slope:** If the site has excessive grade or cross slope, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. Excessive is defined as steeper than 8% for the REACT 350.
6. **Manufacturer/Supplier:** Energy Absorption Systems

(h) (REACT 350 Wide)

1. **Purpose:** The REACT 350 Wide is a device that can be used to shield objects with widths up to 10 feet wide.
2. **Description:** The system consists of polyethylene cylinders with varying wall thickness, internal struts, space frame diaphragms, and a monorail. (See Figure 720-2d.)

3. **Function:** When hit head-on, the cylinders compress, absorb the impact energy, and immediately return to much of their original shape, position, and capabilities. For side impacts, the system is designed to restrain and redirect the vehicle. It is anticipated that this system will require very few replacement parts or extensive repairs.
4. **Foundation:** The system is installed on a concrete foundation.
5. **Slope:** If the site has excessive grade or cross slope, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. Excessive is defined as steeper than 8% for the REACT 350 Wide.
6. **Manufacturer/Supplier:** Energy Absorption Systems

(i) **Inertial Barrier**

Inertial barrier configurations are shown in the Standard Plans. If a situation is encountered the configurations in the Standard Plans are not appropriate, contact the HQ Design Office for further information.

1. **Purpose:** Inertial barrier is an end treatment for concrete barrier and is used to mitigate fixed objects. This system does not provide redirection from a side impact.
2. **Description:** This system consists of an array of plastic containers filled with varying weights of sand. (See Figure 720-2d.)
3. **Function:** The inertial barriers slow an impacting vehicle by the transfer of the momentum of the vehicle to the mass of the barrier. This system is not suitable where space is limited to less than the widths shown in the Standard Plans. Whenever possible, align inertial barriers so that an errant vehicle deviating from the roadway by 10° would be on a parallel path with the attenuator alignment. (See the Standard Plans.) In addition, inertial barriers do not provide any redirection and are not appropriate where high angle impacts are likely.

4. **Foundation:** A concrete or paved surface is recommended.
5. **Slope:** If the site has excessive grade or cross slope, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. Excessive is defined as steeper than 5% for inertial barriers.

(j) **SCI100GM/SCI70GM**

1. **Purpose:** The SCI100GM / SCI70GM are end treatments that can be used for concrete barrier and beam guardrail with widths up to 2 feet.
2. **Description:** The system for both models consists of telescoping quadruple corrugated fender panels mounted on both sides of a series of tubular steel support frames. (See Figure 720-2e.)
3. **Function:** A hydraulic cylinder is compressed during a head-on impact.
4. **Foundation:** The system is installed on a concrete or asphalt foundation. (See manufactures installation requirements for details.)
5. **Slope:** 12H:1V or flatter slope between the edge of the traveled way and the near face of the unit.
6. **Manufacturer/Supplier:** Work Area Protection Corp.

In addition to the systems approved above, the TRACC impact attenuator may be considered for permanent use, with the concurrence of Maintenance personnel.

(2) Work Zone (Temporary) Installation

Several of the impact attenuators previously listed under the heading "Permanent Installations" are also appropriate for use in work zones or other temporary locations. The following is a list of these devices:

- QuadGuard
- QuadGuard Elite
- REACT 350

- REACT 350 Wide
- Inertial Barriers
- SCI100GM
- SCI70GM

The following systems are appropriate only in work zones or other temporary installations.

A description of each work zone (or other temporary) system's purpose, parts, and functionality, as well as requirements for transition, foundation, and slope, are provided as follows and in Figure 720-5:

(a) **ABSORB 350**

1. **Purpose:** The ABSORB 350 is an end treatment limited to temporary installations for both concrete barrier and the Quickchange Moveable Barrier (QMB).
2. **Description:** The system contains water-filled Energy Absorbing Elements. Each element is 2 feet wide, 2 feet 8 inches high, and 3 feet 3 ½ inches long. (See Figure 720-3.)
3. **Function:** The low-speed (below 45 mph) system uses five Energy Absorbing Elements and the high-speed (45 mph and above) system uses eight. The energy of an impact is dissipated as the elements are crushed.
4. **Foundation:** The system does not require a paved foundation.
5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.
6. **Manufacturer/Supplier:** Barrier Systems, Inc.

(b) **Advanced Dynamic Impact Extension Module 350 (ADIEM 350)**

1. **Purpose:** The ADIEM 350 is limited to temporary installations where vehicle speeds are 45 mph or less. It is generally used as an end treatment for concrete barrier. Currently, there are a few existing permanent units in service. It is permissible to reset these existing devices. However, some of these units may exhibit significant deterioration and replacement may be the appropriate option.

2. **Description:** The system is 30 feet long and consists of 10 lightweight concrete modules on an inclined base. (See Figure 720-3.)

3. **Functionality:** An inclined base provides a track for placement of the modules and provides redirection for side impacts for roughly half the length. The energy of an impact is dissipated as the concrete modules are crushed.

4. **Foundation:** The system does not require a paved foundation.

5. **Slope:** If the site has excessive grade or cross slope, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. Excessive is defined as steeper than 8% for the ADIEM 350.

6. **Manufacturer/Supplier:** Trinity Industries, Inc.

(c) **QuadGuard CZ**

This system is like the permanent QuadGuard listed for permanent systems above except that it can be installed on a 6-inch-minimum-depth asphalt concrete surface that has a 6-inch-minimum-depth compacted base. (See Figure 720-2b.)

(d) **Reusable Energy Absorbing Crash Terminal (REACT 350)**

This is the same system listed for permanent systems above except that it can be installed on a 6-inch-minimum-depth asphalt concrete surface that has a 6-inch-minimum-depth compacted base. (See Figure 720-2d.)

(e) **Non-Redirecting Energy Absorbing Terminal (N-E-A-T)**

1. **Purpose:** The N-E-A-T system is an end treatment for temporary concrete barrier where vehicle speeds are 45 mph or less.

2. **Description:** The N-E-A-T System's cartridge weighs about 300 pounds and is 9 feet-8 inches long. The system consists of aluminum cells encased in an aluminum shell with steel backup, attachment hardware, and

transition panels. It can be attached to the ends of New Jersey shaped portable concrete barrier and the QuickChange Moveable Barrier. (See Figure 720-3.)

3. **Functionality:** The energy of an impact is dissipated as the aluminum cells are crushed.

4. **Foundation:** The system does not require a paved foundation.

5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.

6. **Manufacturer/Supplier:** Energy Absorption Systems

(f) **Trinity Attenuating Crash Cushion (TRACC)**

1. **Purpose:** The TRACC is an end treatment for concrete barriers. It is limited to use in construction or other work zones on a temporary basis.

2. **Description:** The 21-foot-long TRACC includes four major components: a pair of guidance tracks, an impact sled, intermediate steel frames, and 10 gauge W-beam fender panels. (See Figure 720-3.)

3. **Functionality:** The sled (impact face) is positioned over the upstream end of the guidance tracks and contains a hardened steel blade that cuts the metal plates on the sides of the guidance tracks as it is forced backward when hit head-on.

4. **Foundation:** The system requires a concrete foundation.

5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.

6. **Manufacturer/Supplier:** Trinity Industries, Inc.

(g) **Inertial Barrier**

This is the same system listed for permanent systems above. It is not suitable where space is limited to less than the widths shown in the Standard Plans. (See Figure 720-2d.)

(h) **Truck Mounted Attenuator (TMA)**

TMA's are portable systems mounted on trucks. They are intended for use in work zones and for temporary hazards.

(i) **Triton CET**

1. **Purpose:** The Triton CET is an end treatment limited to temporary concrete barrier installations.
2. **Description:** The system contains water-filled Energy Absorbing Elements. (See Figure 720-3.)
3. **Function:** The system uses six Energy Absorbing Elements. The energy of an impact is dissipated as the elements are crushed.
4. **Foundation:** The system does not require a paved foundation.
5. **Slope:** 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.
6. **Manufacturer/Supplier:** Energy Absorption, Inc.

(j) **QUEST**

1. **Purpose:** The QUEST is an end treatment limited to temporary applications. This system is designed to shield hazards 2 feet or less in width.
2. **Description:** The system consists of two front anchor assemblies; a nose assembly containing an integrated trigger assembly; two shaper rail assemblies; a support rail assembly with two energy absorbing tube shapers; a diaphragm assembly; a bridge assembly; two rear rails; a freestanding backup assembly; and W-beam fender panels. Transition panels are required when traffic approaches from the rear of the unit.
3. **Function:** During head-on impacts, the Quest system telescopes rearward and energy is absorbed through momentum transfer, friction, and deformation. When impacted from the side, the QUEST System restrains lateral movement by dynamic tension developed between the end restraints.

4. **Foundation:** The system is installed on a concrete or asphalt foundation. (See manufacturer's installation requirements for details.) The unit is attached to the road surface with 30 to 34 anchors.

5. **Slope:** 12H:1V (8%) or flatter slope between the edge of the traveled way and the near face of the unit is required. In addition, if the slope varies (twists) more than 2% over the length of the system, a concrete leveling pad may be required.

6. **Manufacture/Supplier:** Energy Absorption Systems Inc.

(3) **Older Systems**

The following systems are in use on Washington State highways and may be left in place or reset. New installations of these systems require approval from the HQ Design Office.

(a) **Sentre**

The Sentre is a guardrail end treatment. Its overall length of 17 feet allowed it to be used where space was not available for a guardrail transition and terminal. The system is very similar to the QuadTrend 350 in both appearance and function except that it uses three beam fender panels instead of the quadruple corrugated panels. This system requires a transition when used to terminate rigid barriers. (See Figure 720-4a.)

(b) **TREND**

The TREND is an end treatment with a built-in transition and was used at the end of rigid barriers including bridge rails. The system is similar to the QuadTrend 350 except that it uses three beam fender panels. (See Figure 720-4a.)

(c) **G-R-E-A-T (Guard Rail Energy Absorption Terminal)**

This system was primarily used as an end treatment for concrete barrier. It is similar to the QuadGuard except that it uses three beam fender panels. (See Figure 720-4a.)

(d) Low Maintenance Attenuator System (LMA)

The LMA is an end treatment for concrete barrier and beam guardrail and was used for fixed objects up to 3 feet wide. The system is similar to the QuadGuard Elite except that it uses three beam fender panels and rubber cylinders. See Figure 720-4b.

(e) Hex-Foam Sandwich

The Hex-Foam Sandwich system is an end treatment for beam guardrail and concrete barrier and was also used for fixed objects 3 feet or more in width. This system consists of a number of Hex-Foam cartridges containing an energy absorption material separated by a series of diaphragms and restrained by anchor cables. It is installed on a concrete slab. Impact energy is absorbed by the internal shearing of the cartridges and crushing of the energy absorption material. The lapped panels on the perimeter serve to redirect vehicles for side impacts. If the site has grade or cross slope in excess of 5%, additional site preparation or modification to the units in accordance with the manufacturer's literature is required. (See Figure 720-4b.)

720.02 Design Criteria

The following design criteria apply to all new or reset permanent and temporary impact attenuators. The design criteria also apply to existing systems to be left in place when the Barrier Terminals and Transition Sections columns on a design matrix applies to the project. (See Chapter 325.)

Impact attenuators must be placed so that they do not present a hazard to opposing traffic. For median and reversible lane locations, the backup structure or attenuator-to-object connection must be designed to prevent opposing traffic from being snagged. It is desirable that all existing curbing be removed and the surface smoothed with asphalt or cement concrete pavement before an impact attenuator is installed. However, curbs 4 inches or less in height may be retained depending on the practicality of their removal. In general, attenuators are aligned parallel to the roadway except the inertial barriers.

720.03 Selection

When selecting an impact attenuator system, consider the following:

- Posted speed
- Available space (length and width)
- Maintenance costs
- Initial cost
- Duration (permanent or temporary use)
- The portion of the impact attenuator that is redirective/nonredirective. (See figures 720-5 and 6.)

It is very important for designers to consider the portion of an impact attenuator that will redirect vehicles during a side impact of the unit. It is crucial to consider that fixed objects, either permanent or temporary (such as construction equipment), should not be located behind the non-redirective portion of these devices.

The posted speed is a consideration in the selection of the QuadGuard, REACT 350 Universal TAU-II and the Inertial Barrier systems. Use Figure 720-1 to select permanent system sizes required for the various posted speeds.

Posted Speed (mph)	Quad Guard (Bays)	Universal TAU-II ⁽¹⁾ (Bays)	REACT 350 (Cylinders)	Inertial Barrier (Type)
40 or less	3	2-3	4	1
45	4	3-4	6	2
50	5	4-5	6	3
55	6	5-7	<u>6</u>	4
60	6	7-8	9	5
65	8	7-8	<u>9</u>	6
70	9	7-8	<u>9</u>	6
(1) Dependent on <u>the</u> width of <u>the</u> system				

Impact Attenuator Sizes
Figure 720-1

If it is anticipated that a large volume of traffic will be traveling at speeds greater than the posted speed limit, then the next larger unit may be specified.

For a summary of space and initial cost information related to the impact attenuator systems, see Figure 720-5.

When considering maintenance costs, anticipate the average annual impact rate. If few impacts are anticipated, lower-cost devices such as inertial barriers might meet the need. Inertial barriers have the lowest initial cost and initial site preparation. However, maintenance will be costly and necessary after every impact. Labor and equipment are necessary to clean up the debris and install new containers (barrels). Also, inertial barriers must not be used where flying debris might be a danger to pedestrians.

The REACT 350 and the QuadGuard Elite have a higher initial cost, requiring substantial site preparation, including a backup or anchor wall in some cases and cable anchorage at the front of the installation. However, repair costs are comparatively low, with labor being the main expense. Maintenance might not be required after minor side impacts with these systems.

For new installations where at least one impact is anticipated per year, limit the selection of impact attenuators to the low maintenance devices (QuadGuard Elite and REACT 350). Consider upgrading existing ADIEM, G-R-E-A-T, and Hex-Foam impact attenuators with these low maintenance devices when the repair history shows one to two impacts per year over a three to five year period.

In selecting a system, one consideration that must not be overlooked is how dangerous it will be for the workers making repairs. In areas with high exposure to danger, a system that can be repaired quickly is most desirable. Some systems require nearly total replacement or replacement of critical components (such as cartridges or braking mechanisms) after a head-on impact, while others only require resetting.

It is very important to consider that each application is unique when selecting impact attenuators for use in particular applications. This applies to both permanent and temporary installations. When specifying the system or systems that can be used at a specific location, the list shown in Figure 720-5 is to be used as a starting point. As the considerations discussed previously are analyzed, inappropriate systems may be identified and eliminated from further consideration. Systems that are not eliminated may be appropriate for the project. When the site conditions vary, it might be necessary to have more than one list of acceptable systems within a contract. Systems are not to be eliminated without documented reasons. Also, wording such as *or equivalent* is not to be used when specifying these systems. If only one system is found to be appropriate, then approval from the Assistant State Design Engineer of a public interest finding for the use of a sole source proprietary item is required.

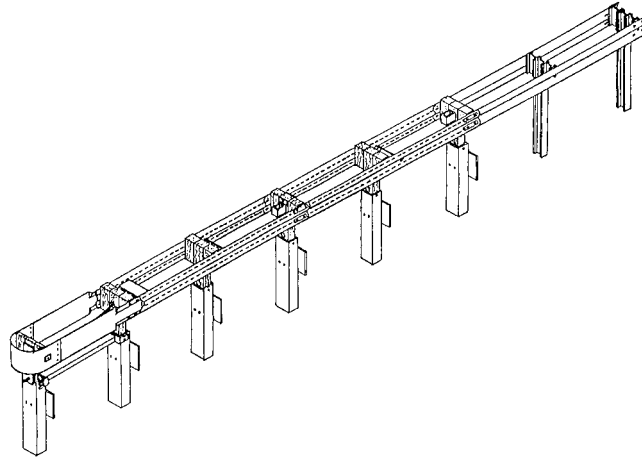
When a transition to connect with a concrete barrier (see Figure 720-5) is required, the transition type and connection must be specified and are included in the cost of the impact attenuator. (See Chapter 710 for information on the transitions and connections to be used.)

Contractors can be given more flexibility in the selection of work zone (temporary) systems, since long-term maintenance and repair are not a consideration.

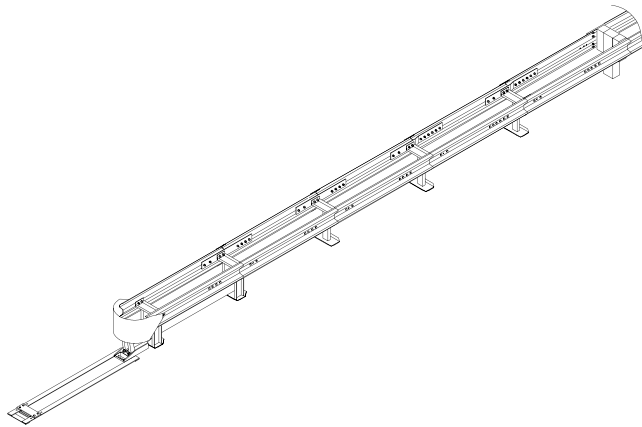
720.04 Documentation

A list of documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found is on the following web site:

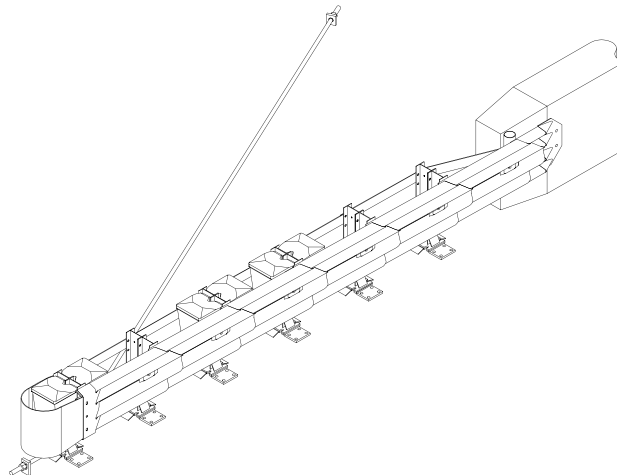
<http://www.wsdot.wa.gov/eesc/design/projectdev/>



CAT -350

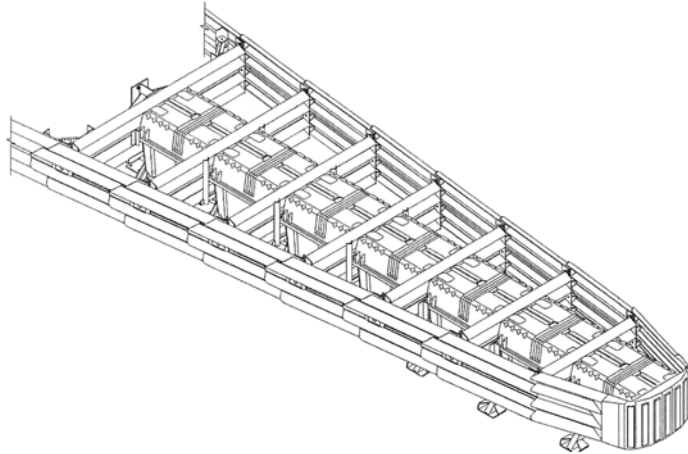


Brakemaster

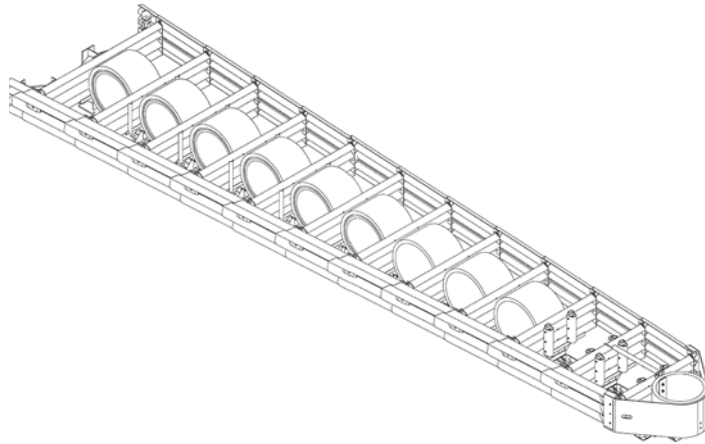


QuadTrend 350

Impact Attenuator Systems – Permanent Installations
Figure 720-2a



QuadGuard



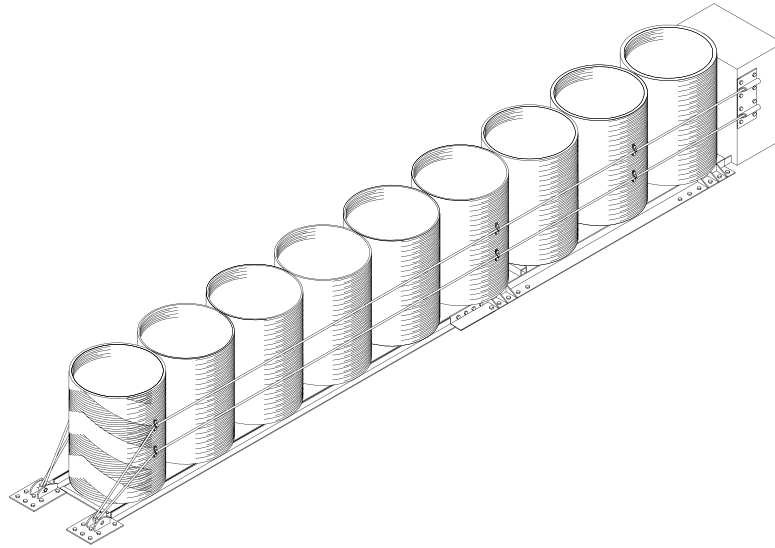
QuadGuard Elite

Impact Attenuator Systems = Permanent Installations
Figure 720-2b

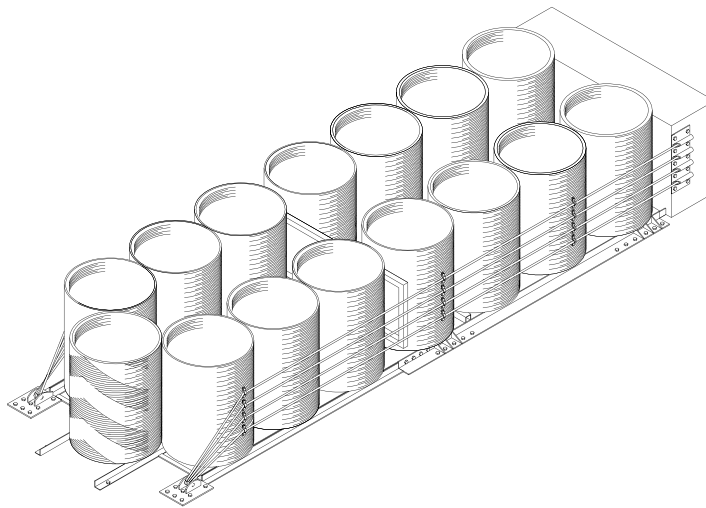


Universal TAU-II

Impact Attenuator Systems – Permanent Installations
Figure 720-2c



REACT 350



REACT 350 Wide



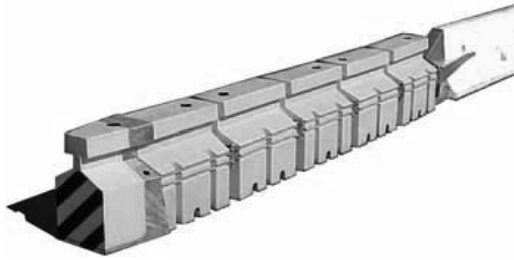
Inertial Barrier

Impact Attenuator Systems = Permanent Installations
Figure 720-2d



SCI100GM / SCI70GM

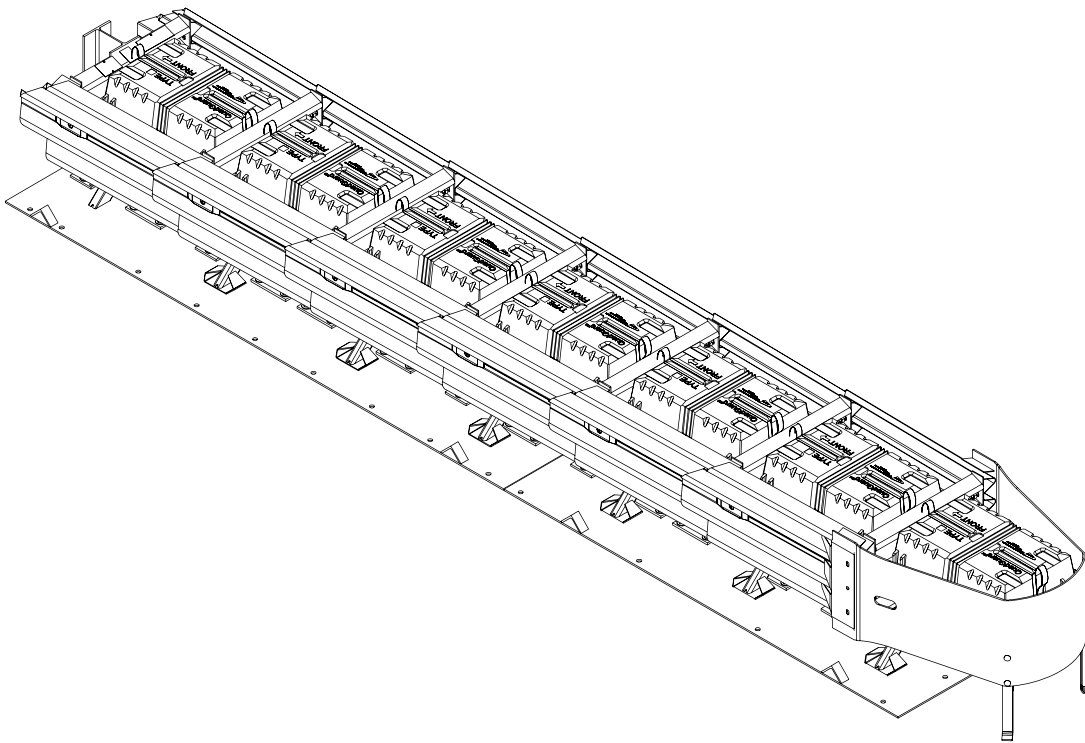
Impact Attenuator Systems – Permanent Installations
Figure 720-2e



ABSORB 350



ADIEM 350



QuadGuard CZ

Impact Attenuator Systems = Work Zone Installations
Figure 720-3a



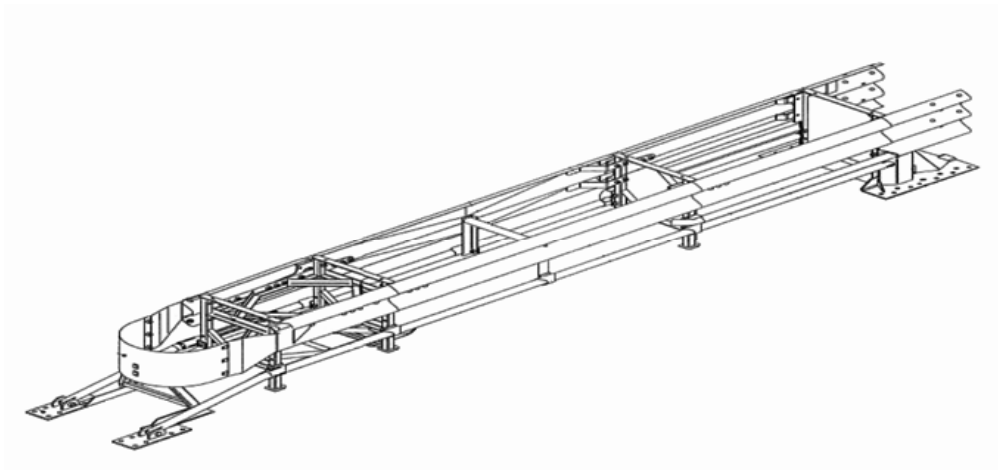
N-E-A-T



TRACC

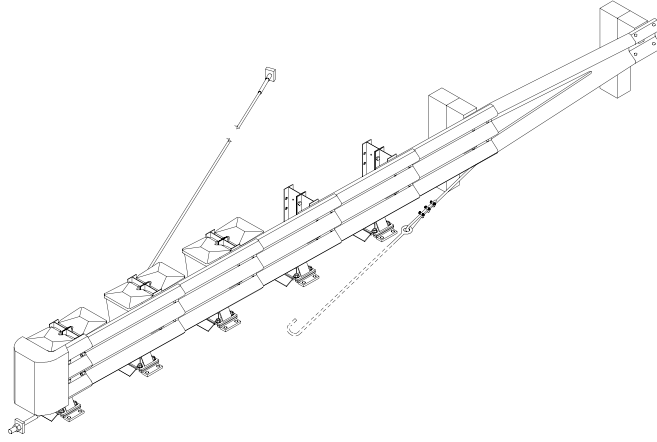


Triton CET

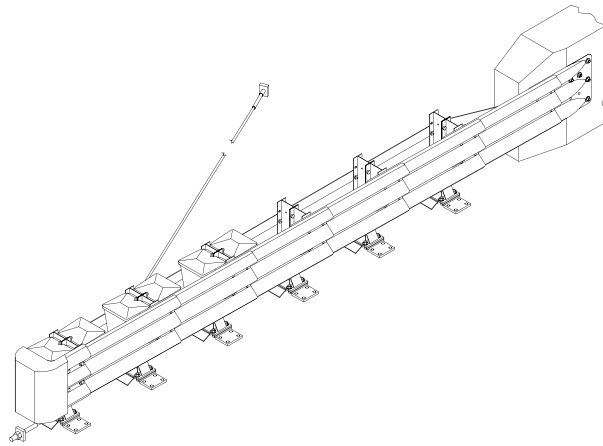


QUEST

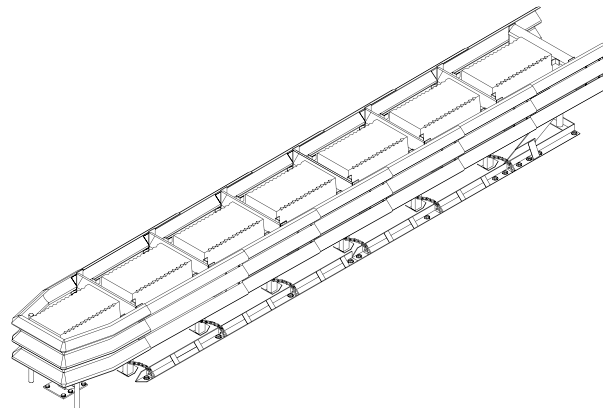
Impact Attenuator Systems – Work Zone Installations
Figure 720-3b



Sentre

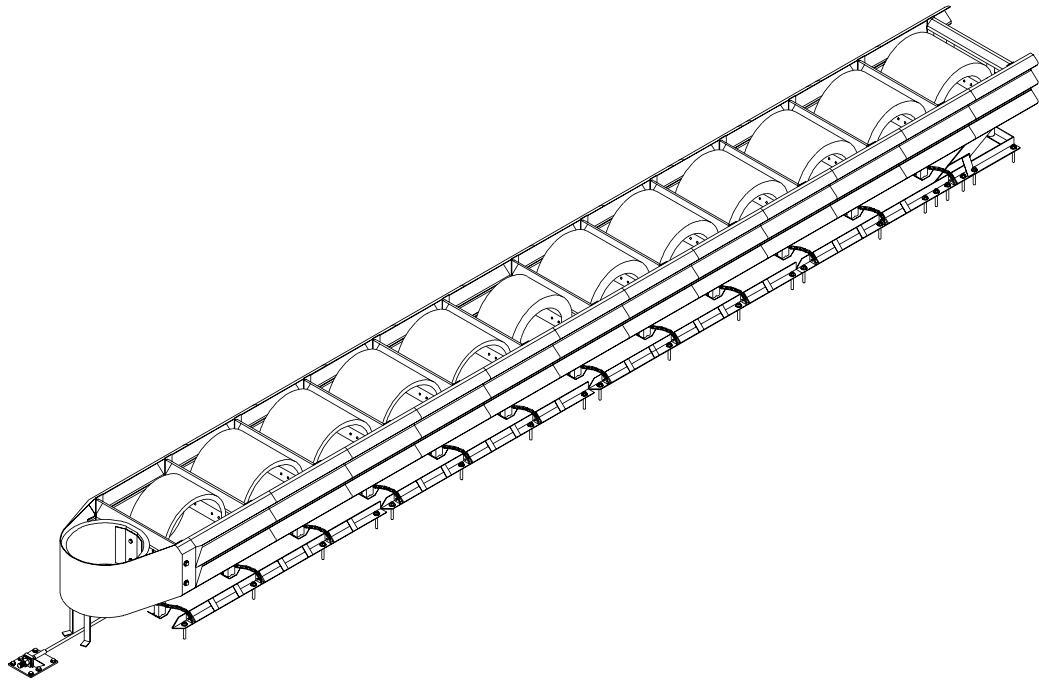


TREND

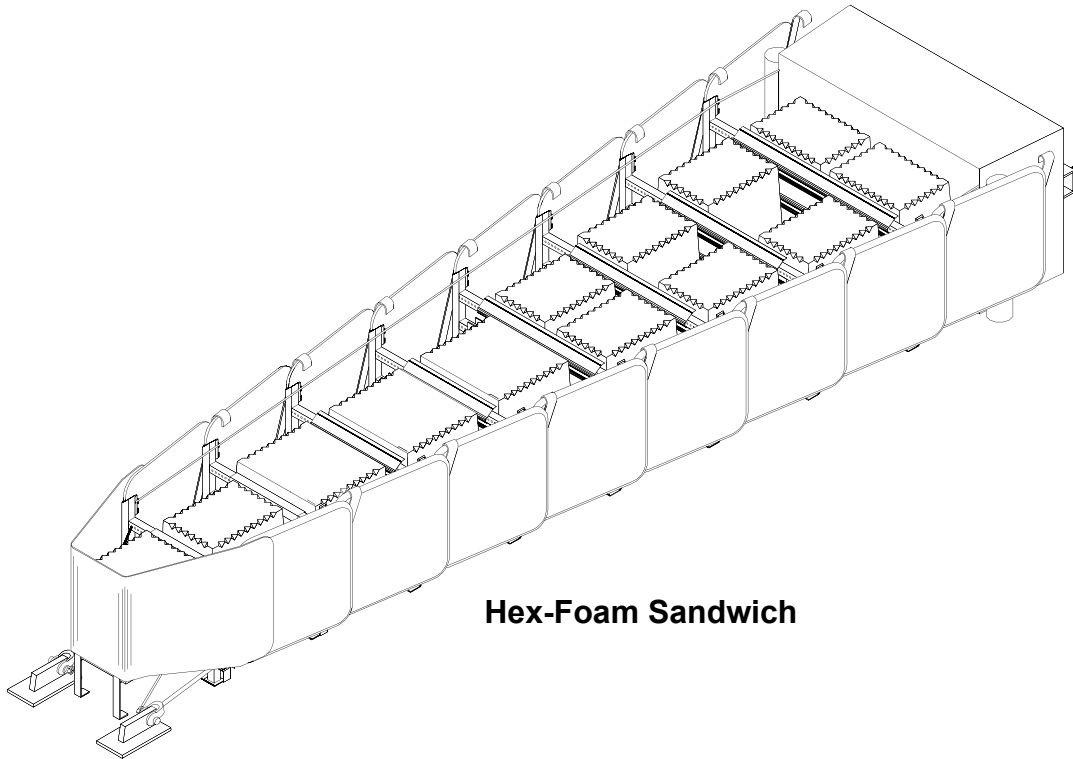


G-R-E-A-T

Impact Attenuator Systems – Older Systems
Figure 720-4a



L.M.A.



Hex-Foam Sandwich

Impact Attenuator Systems = Older Systems
Figure 720-4b

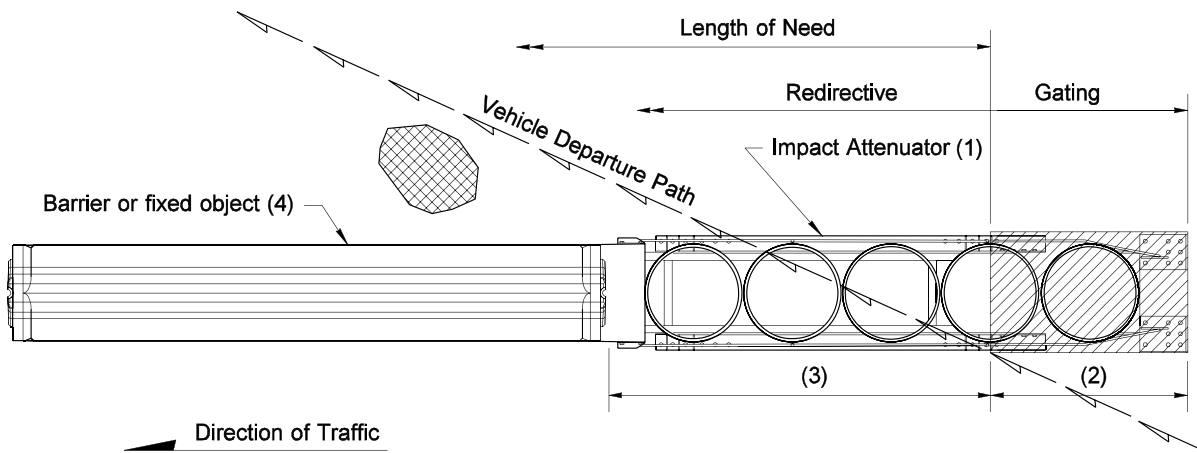
Impact Attenuator Systems (All dimensions in feet)

System	(P) Permanent (T) Temporary (B) Both	Approximate Outside Width (See Note 10)	Approximate System Length (See Note 11)	Transition to Rigid System Required?	Distance Beyond Length of Need (See Figure 720-6)	Initial Cost Category(1)
CAT 350 ⁽²⁾	P	2.5	31.3	Y	18.8	A
Brakemaster 350 ⁽²⁾	P	2.1	31.5	Y	15.8	A
QuadTrend – 350 ⁽⁶⁾	P	1.3	20.0	N	10.5	A
Universal TAU-II	P	2.9 - 8.7	12.0-26.0 ⁽⁴⁾	N	3.0	B(5)
QuadGuard	B	2.8-10.8	13.1-32.5 ⁽⁴⁾	N	3.3	B(5)
QuadGuard Elite	B	2.8-8.3	23.8-35.5	N	3.3	D
REACT 350	B	4	13.8-30.2 ⁽⁴⁾	N	4.3	C(5)
REACT 350 Wide	B	5.7-10.7	30.8-34.8	Y	4.3	D(5)
Inertial Barriers	B	7	17.0-34.5 ⁽⁴⁾	N	(3)	A(5)
SCI100GM	B	3.1	21.5	Y	3	C
SCI70GM ⁽⁸⁾	B	2.8	13.5	Y	3	B
ABSORB 350(9)	T	2	19.0-32.0	Y	(3)	A(5)
ADIEM 350 ⁽⁷⁾⁽⁸⁾	T	2.7	30	N	14.1	B
QuadGuard CZ	T	2.75-3.25	13.1-22.1	N	3.3	C ⁽⁵⁾
N-E-A-T(8)	T	1.9	9.7	N	(3)	A ⁽⁵⁾
TRACC ⁽¹²⁾	T	2.6	21.3	N	8	B
Triton CET ⁽⁹⁾	T	1.8	40	N	(3)	A
QUEST	T	2.8	22.2	Y	3.5	B

Impact Attenuator Comparison
Figure 720-5a

- 1) A (\$5,000 to \$10,000); B (\$10,000 to \$15,000); C (\$15,000 to \$25,000); D (\$25,000 to \$50,000). These are rough initial cost estimates - verify actual costs through manufacturers/suppliers. Some products are priced very close to the margin between cost categories.
- 2) Generally for use with double-sided beam guardrail. Use as an end treatment for concrete barrier requires a transition.
- 3) The N-E-A-T, inertial barriers, Triton CET, and ABSORB 350 may only be used beyond the required length of need.
- 4) For sizes or configuration type, see Figure 720-1.
- 5) The lengths of the Universal TAU-II, QuadGuard, QuadGuard Elite, REACT 350, REACT 350 Wide, ABSORB 350, QuadGuard CZ, and Inertial Barriers vary because their designs are dependent upon speed. Costs indicated are for a typical 60 mph design. In addition to length, several of the systems also vary in width. For estimating purposes, the following model widths were considered.
 - Universal TAU II – 24”
 - QuadGuard – 24”
 - QuadGuard Elite – 24”
 - REACT 350 Wide – 60”
 - QuadGuard CZ – 24”
- 6) Generally for use at the ends of bridges where installation of a beam guardrail transition and terminal is not feasible.
- 7) Generally for use with concrete barrier. Other uses may require a special transition design.
- 8) Use limited to highways with posted speeds of 45 mph or less.
- 9) Test Level 3 version on high-speed facilities should be limited to locations where the likelihood of being hit is low.
- 10) The given dimension is the approximate outside width of each system. In most cases, this width is slightly wider than the effective width. To determine the width of an object that may be shielded refer to the manufacture’s specifications. (See the WSDOT Design Policy, Standards, & Safety Research Unit web site for links to this information.)
- 11) The given dimension is the approximate system length. The effective length may vary depending on such factors as the physical design and type of anchorage used. To determine the total length needed, refer to the manufacture’s specifications. (See the WSDOT Design Policy, Standards, & Safety Research Unit web site for links to this information.)
- 12) May be considered for permanent installations with concurrence of Maintenance personnel.

Impact Attenuator Comparison
Figure 720-5b



- (1) Impact Attenuator type and manufacturer varies with application. (See Figure 720-5).
- (2) Distance beyond the length of need. (See Figure 720-5). This portion is non-redirective, (Gating).
- (3) This portion is re-redirective and can be included as part of the barrier needed to satisfy length of need requirements.
- (4) Concrete barrier shown for illustration purposes only. Type of object varies.

Impact Attenuator Distance Beyond Length of Need
Figure 720-6

- 830.01 General
- 830.02 References
- 830.03 Definitions
- 830.04 Pavement Markings
- 830.05 Guideposts
- 830.06 Barrier Delineation
- 830.07 Object Markers
- 830.08 Wildlife Warning Reflectors
- 830.09 Documentation

830.01 General

The primary function of delineation is to provide the visual information needed by a 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, guideposts, and other devices, such as curbs. (See Chapter 440.) These devices use retroreflectance, reflecting light from a vehicle's headlights back to the driver, to enhance their visibility at nighttime. The Washington State Department of Transportation (WSDOT) uses the latest edition of the MUTCD as a guide for the 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. It is important to maintain an adequate level of retroreflectivity for both traffic signs and traffic markings to enhance safety for motorists during hours of darkness and during adverse weather conditions.

Consult with the region's Traffic Operations Office early in the design process to ensure that the proposed delineation is compatible with WSDOT policy and region preference. These policies and preferences address both the type of markings and the material selection.

830.02 References

Laws – Federal and state laws and codes that may pertain to this chapter include:

Manual on Uniform Traffic Control Devices, USDOT, FHWA, National Advisory Committee on Uniform Traffic Control Devices, including the Washington State Modifications to the MUTCD, Chapter 468-95 *Washington Administrative Code* (WAC), (MUTCD)

<http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm>

Design Guidance – Design guidance included by reference within the text includes:

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

Sign Fabrication Manual, M 55-05, WSDOT

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

Supporting Information – Other resources used or referenced in this chapter include:

NCHRP Synthesis 306, Long-Term Pavement Practices, Transportation Research Board

830.03 Definitions

coefficient of retroreflection (R_L) A measure of retroreflection.

delineation Any method of defining the roadway operating area for the driver.

durability A measure of a traffic line's resistance to the wear and deterioration associated with abrasion and chipping.

extrude A procedure for applying marking material to a surface by forcing the material through a die to give it a certain shape.

glass beads Small glass spheres used in highway pavement markings to provide the necessary retroreflectivity.

mcd/m²/lux Pavement marking retroreflectivity is represented by the coefficient of retroreflected luminance (RL) measured in millicandelas per square meter.

mil Unit of measurement equivalent to 0.001 inches.

MUTCD *Manual on Uniform Traffic Control Devices.*

pavement marking A colored marking applied to the pavement to provide drivers with guidance and other information.

retroreflection The phenomenon of light rays striking a surface and being returned directly back to the source of light.

retroreflectometer An instrument used to measure retroreflectivity.

spraying A procedure for applying marking material to a surface as a jet of fine liquid particles.

service life The service life of a pavement marking is the time or number of traffic passages required for its retroreflectivity to decrease from its initial value to a minimum threshold value indicating that the marking needs to be refurbished or replaced.

traffic paint A pavement marking material that consists mainly of a binder and a solvent. The material is kept in liquid form by the solvent, which evaporates upon application to the pavement, leaving the binder to form a hard film.

wet film thickness Thickness of a pavement marking at the time of application without glass beads.

830.04 Pavement Markings

(1) Pavement Marking Types

Pavement markings have specific functions: (1) they guide the movement of traffic, and (2) they 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 the Standard Plans and the MUTCD.

(a) **Longitudinal pavement markings** define the boundary between opposing traffic flows, and identify the edges of traveled way, multiple traffic lanes, turn lanes, and special use lanes. The Standard Plans show the dimensions of longitudinal pavement markings. Longitudinal pavement markings are as follows:

barrier centerline A very wide (18 inches minimum, usually 20 inches—five 4-inch lines) solid yellow line or a combination of two single 4-inch solid yellow lines with yellow crosshatching between the lines with a total width not less than 18 inches used to separate opposing traffic movements where all movements over the line are prohibited. Barrier centerline locations require the approval of the region's Traffic Engineer and Access Engineer.

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

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

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

double lane line Two solid white lines used to separate lanes of traffic moving in the same direction where crossing the lane line marking is prohibited.

double wide lane line Two solid wide white lines used to separate a concurrent preferential lane of traffic where crossing is prohibited.

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.

edge line A solid white or yellow line used to define the outer edges of the traveled way. Edge lines are not required where curbs or sidewalks are 4 feet or less from the traveled way.

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

no-pass line A solid yellow line used in conjunction with a centerline 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.

solid lane line A solid white line used to separate lanes of traffic moving in the same direction where crossing the lane line marking is discouraged. Note: While this marking is in the MUTCD, it may not be in wide use by WSDOT, as it is the same as the edge line.

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

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

wide dotted lane line A wide broken white line used to designate a portion of a high occupancy vehicle (HOV), or business access and transit (BAT) lane located on an arterial highway where general purpose vehicles may enter to make a turn at an intersection.

wide lane 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 (HOV) lanes, or business access and transit (BAT) lanes, bike lanes, and other preferential lanes where crossing is discouraged.

(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 as follows:

access parking space symbol A white marking used to designate parking stalls provided for motorists with disabilities. The marking may have an optional blue background and white border.

aerial surveillance marker White markings used at one-mile and one-half-mile intervals on sections of highways where the State Patrol uses airplanes to enforce speed limits.

bicycle lane symbol A white marking consisting of a symbol of a bicyclist and an arrow used in a marked bike lane. (See the Standard Plans for an example of the bicycle lane symbol.) The bicycle lane symbol shall be placed immediately after an intersection and at other locations as needed. (See the MUTCD.) Typical spacing is 500 feet, with a maximum distance of 1,500 feet.

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

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.

HOV symbol A white diamond marking used for high occupancy vehicle lanes. The spacing of the markings is an engineering judgment based on the conditions of use. Typical spacing is 1,000 feet for divided highways and 500 feet 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.

stop line 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.

(2) Pavement Marking Materials

Pavement markings are applied using 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; the location; the traffic conditions; the snow and ice removal practices of the particular maintenance area; and the region’s ability to maintain the markings.

Both painted and plastic pavement markings can accomplish the goal of providing a visible (daytime) and retroreflective (nighttime) pavement marking at the completion of a contract. The difference between the two marking materials is the projected service life of the markings. Paint used on sections of highway subjected to high traffic volumes and/or snow removal operations might have a service life of only two to three months. Maintenance crews cannot restripe a highway during winter months; therefore, if a painted marking wears out prematurely, the highway will not have a stripe until maintenance crews can restripe in April or May. When these conditions are encountered in a highway project, it is strongly recommended that the designer specify one of the more durable plastic marking materials and application types that will provide an adequate service life for the marking.

For the recommended pavement marking material for different highway types and snow removal practices, see Figure 830-1. Consult with the region’s Traffic Office and Maintenance Office to select the best material for the project.

(a) **Paint.** Paint is the most common pavement marking material. It is relatively easy to apply and dries quickly (30–90 seconds in warm, dry weather) after application. This allows the application to be a moving operation, which minimizes traffic control costs and delay to the roadway users. On construction contracts, paint

is applied with two coats; the first coat is 10 mils thick, followed by a second coat 15 mils thick. The disadvantage of using paint as a pavement marking material is its short service life when subjected to traffic abrasion, sanding, or snow-removal activities. Specify paint only where it will have a service life that will provide a retroreflective stripe until the maintenance crews can repaint the line and extend its service life until the next repainting.

Paint is one of two material types dependent upon the solids carrier: solvent or waterborne. The designer is encouraged to specify waterborne paint. Waterborne paints developed in the last ten years have proven to be more durable than solvent paints. Solvent paint is also subject to a monetary penalty because it contains a high level of volatile organic compounds (VOC). There is an Environmental Protection Agency (EPA) Clean Air Act penalty assessed on solvent paint that is passed on to those that purchase solvent paint in quantity.

Durable waterborne paint or high-build waterborne paint (a recent development) allows a thicker application (20 to 30 mils), which provides additional service life. The additional thickness permits the use of larger glass beads that enhance wet night retroreflectivity.

(b) **Plastic.** 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 may provide a year-round retroreflective pavement marking, while paint may not last until the next restriping. Plastic marking materials currently listed in the Standard Specifications include the following:

- **Type A – Liquid Hot Applied Thermoplastic.** Thermoplastic material consists of resins and filler materials in solid form at room temperature. The material is heated to a semi-liquid, molten state (400° Fahrenheit) and is then applied to the roadway by spray or extrusion methods. This material can be used for both transverse and longitudinal line applications. Special equipment is required for both the initial application and subsequent maintenance

renewal. Sprayed material can be applied at a thickness of 30 mils 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 125 mils 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 raised pavement markers when a vehicle crosses over the marking.

- **Type B – Preformed Fused Thermoplastic.** This material consists of a mixture of pigment, fillers, resins, and glass beads that is factory produced in sheet form 125 mils thick. The material is applied by heating (drying) the pavement and top heating the material. The heating process fuses the preformed thermoplastic material to the pavement surface. These materials are available in white, yellow, blue, and other colors. These materials are used for transverse markings.
- **Type C – Cold Applied Preformed Tape.** Preformed tape is 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 on the underside of the tape. Preformed tape is available in a thickness of 60 mils, 90 mils, or 125 mils. (WSDOT does not currently specify 125 mil tape.) The most durable application of preformed tape is achieved when the tape is either inlaid (rolled) into hot asphalt and the top of the tape is flush with the surface of the pavement, or it is placed in a groove cut into the pavement surface and the top of the tape is slightly below the surface of the pavement.
ASTM has classified preformed tape into two categories: Type 1 and Type 2. Type 1 tape has a profiled surface and a requirement to have a retroreflectivity of over 500 mcd/m²/lux. Type 1 tape has proven to be very durable. It is used on high-volume, high-speed highways. Type 2 tape has a flat surface

and a requirement to have a retroreflectivity of over 250 mcd/m²/lux. Field tests show that Type 2 tape has a shorter service life than Type 1 tape.

- **Type D – Liquid Cold Applied Methyl Methacrylate (MMA).** Methyl methacrylate can be applied by either spraying or extrusion. Sprayed applications can be one or two coats, 30 to 45 mils thick. Extruded applications are 90 mils thick for dense asphalt or PCC pavement, or 120 mils thick for open-graded asphalt pavement. MMA can also be extruded using specialized equipment to produce a textured line 150 mils thick. The material is not heated and can be applied within an approximate temperature range of 40° to 105° Fahrenheit, 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 (Type D profiled) that slightly enhance wet night retroreflectivity. The bumps also produce the rumble effect similar to raised pavement markers.
- **Type E – Polyurea.** Polyurea is a two-component, 100% solid coating designed as a fast-setting highway marking coating that provides durability and abrasion resistance. Polyurea is formulated to provide a simple volumetric mixing ratio of two volumes of Component A to one volume of Component B. Polyurea is typically sprayed at 20 to 25 mils thickness.

(c) **Glass Beads.** Glass beads are small glass spheres used in highway markings to provide the necessary retroreflectivity. The beads are dropped onto the wet marking material immediately after it is applied (drop-on beads) or premixed into the marking material and dropped onto the wet marking material immediately after it is applied.

Proper installation of glass beads is critical to achieving good pavement marking retroreflectivity. Each glass bead works like a light-focusing lens reflecting light back to the driver. Glass beads are embedded into the pavement marking material; for optimum performance, the bead is embedded between 55% and 60% of its diameter.

Large glass beads are effective when roads are wet. Large glass beads are not appropriate for paint as the paint is too thin to properly embed the large glass beads; therefore, WSDOT specifies small glass beads for paint applications. The use of large glass beads is limited to high-build waterborne paint and other materials with a thickness of at least 22 mils.

(3) Pavement Marking Application Types

There are five application types used for pavement markings. Most pavement marking applications are applied directly to the pavement surface. In steel bit snow plowing areas, the pavement markings may be inlaid or grooved to protect the markings.

Pavement markings, because they are higher than the surrounding pavement surface, are subject to rapid wear caused by traffic and snowplows. As they wear, they lose visibility and retroreflectivity particularly in wet weather. Wear on the stripes can be greatly reduced and their service life considerably increased by placing them in a shallow groove in the surface of the pavement. The five application types for pavement markings are:

- **Flat Lines.** Pavement marking lines with a flat surface.
- **Profiled Marking.** A profiled pavement marking that consists of a base line thickness and a profiled thickness, which is a portion of the pavement marking line that is applied at a greater thickness than the base line thickness. Profiles are applied using the extruded method in the same application as the base line. The profiles may be slightly rounded if the minimum profile thickness is provided for the entire length of the profile. (See the Standard Plans for the construction details.)
- **Embossed Plastic Line.** Embossed plastic lines consist of a flat line with transverse grooves. An embossed plastic line may also have profiles. (See the Standard Plans for the construction details.)

- **Inlaid Plastic Line.** A line constructed by rolling Type C tape into Hot Mix Asphalt with the finish roller. Closely monitor the temperature of the mat to ensure compliance with the manufacturer's recommendations.
- **Grooved Plastic Line.** A line constructed by cutting a groove into the pavement surface and spraying, extruding, or gluing pavement marking material into the groove. The groove depth is dependent upon the material used, the pavement surface, and the location. The groove is typically in the range of 20 to 250 mils deep and 4 inches wide. Coordinate with the region's Traffic Office on the use and dimensions of grooved plastic line marking.

(4) Raised Pavement Markers

Raised Pavement Markers (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, and provide good wet night visibility and a rumble effect. RPMs are made from plastic materials and are available in three different types:

- **Type 1** markers are 4 inches in diameter, 3/4-inch high, and nonreflectorized
- **Type 2** markers are 4 inches wide, 2 1/2 to 4 inches long, 3/4-inch high, and reflectorized
- **Type 3** markers are 6, 8, 10, or 12 inches wide, 4 inches long, 3/4-inch high, and nonreflectorized

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, including vehicle separations and islands. Approval by the region's Traffic Engineer is required for all installations of Type 3 RPMs.

Reflectorized RPMs are not required for centerline 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.

For raised pavement marker application details, see the Standard Plans.

(5) Recessed Raised Pavement Markers

Recessed raised pavement markers (RRPMs) are raised pavement markers (RPMs) installed in a groove ground into the pavement in accordance with the Standard Plans. RRPMs provide guidance similar to RPMs in ice chisel and steel blade snow removal areas. RRPMs can also be used in rubber blade snow removal areas in accordance with region policy.

RRPMs, when specified, are installed at the locations shown for Type 2W RPMs on multilane one-way roadways, and Type 2YY RPMs on two-lane two-way roadways.

For recessed pavement marker application details, see the Standard Plans.

830.05 Guideposts

(1) General

Guideposts are retroreflective devices mounted to a support post installed 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 retroreflective device may be mounted on either a white or brown post. The types of guideposts and their application are as follows:

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

(b) **Type WW** guideposts have silver-white reflective sheeting on both sides, and are used on the outside of horizontal curves on two-way, undivided highways.

(c) **Type Y** guideposts have yellow reflective sheeting, are facing traffic, and are 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.

(d) **Type YY** guideposts have yellow reflective sheeting on both sides, and are used in the median on divided highways.

(e) **Type G1** guideposts have silver-white reflective sheeting on both sides, and green reflective sheeting below the silver-white sheeting on the side facing traffic. They are used at intersections of undivided highways without illumination.

(f) **Type G2** guideposts have silver-white reflective sheeting on both sides, and green reflective sheeting below the silver-white reflective sheeting on the back side. They are used at intersections of undivided highways without illumination.

(2) Placement and Spacing

Guideposts are placed not less than 2 feet nor more than 8 feet outside the outer edge of the shoulder. Place guideposts at a constant distance from the edge of the roadway. When an obstruction intrudes into this space, position the guideposts to smoothly transition to the inside of the obstruction. Guideposts are not required along continuously illuminated divided or undivided highways. (See Figure 830-2 for guidepost placement requirements.) The Standard Plans contain information on the different types and placement of guideposts.

830.06 Barrier Delineation

Traffic barriers are delineated where guideposts 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 guideposts. Barrier delineation is also required when the traffic barrier is 4 feet or less from the traveled way. Use a delineator spacing of no more than 40 feet at these locations.

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

Concrete barrier is delineated by placing retroreflective devices on the face of the barrier about 6 inches 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.

830.07 Object Markers

Object markers are used to mark obstructions within or adjacent to the roadway. The MUTCD details three types of object markers. The Type 3 object marker with yellow and black sloping stripes is the most commonly used object marker.

The MUTCD contains criteria for the use of object markers to mark objects in the roadway and objects adjacent to the roadway. These criteria shall be followed in project design.

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.

End of Roadway markers are similar to Type 1 object markers and are detailed in the MUTCD. They are used to alert users about the end of the roadway. The MUTCD criteria shall be followed in project design.

830.08 Wildlife Warning Reflectors

Studies show that wildlife warning reflectors are ineffective at reducing the accident potential for motor vehicle/wildlife collisions. WSDOT policy is to no longer design, place, or maintain wildlife warning reflectors.

830.09 Documentation

The list of documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

Ice Chisel Snow Removal Areas					
Roadway Classification	Marking Type ⁽³⁾				
	Centerlines ⁽⁵⁾	Lane Lines ⁽⁵⁾	Edge Lines	Wide Lines	Transverse Markings
Interstate	N.A.	Grooved Plastic ⁽¹⁾	Paint	Paint	Paint
Major Arterial	Paint & RRPMS ⁽⁴⁾ or Plastic ⁽²⁾ & RRPMS ⁽⁴⁾	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 ⁽³⁾				
	Centerlines ⁽⁵⁾	Lane Lines ⁽⁵⁾	Edge Lines	Wide Lines	Transverse Markings
Interstate-Urban	N.A.	Plastic ⁽²⁾	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾
Interstate-Rural	N.A.	Paint	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾
Major Arterial	Paint & RRPMS ⁽⁴⁾ or Plastic ⁽²⁾ & RRPMS ⁽⁴⁾	Paint	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾
Minor Arterial	Paint	Paint	Paint	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾
Collector	Paint	Paint	Paint	Paint or Plastic ⁽²⁾	Paint or Plastic ⁽²⁾
Rubber Blade Snow Removal Areas					
Roadway Classification	Marking Type ⁽³⁾				
	Centerlines ⁽⁵⁾	Lane Lines ⁽⁵⁾	Edge Lines	Wide Lines	Transverse Markings
Interstate-Urban	N.A.	PMMA ⁽⁶⁾ only or PMMA ⁽⁶⁾ & RPMs	Paint or Plastic ⁽²⁾	Plastic ⁽⁷⁾	FMMA ⁽⁸⁾
Interstate-Rural	N.A.	MMA only or (8) MMA & RPMs	Paint	Plastic ⁽²⁾ (7)	FMMA ⁽⁸⁾
Major Arterial	Paint & RPMs or Plastic ⁽²⁾ & RPMs	(7)	Paint	Plastic ⁽⁷⁾ (2)	Plastic ⁽²⁾ (7)
Minor Arterial	Paint & RPMs	Paint & RPMs	Paint	Plastic ⁽²⁾	Plastic ⁽²⁾
Collector	Paint & RPMs	Paint	Paint	Plastic ⁽²⁾	Plastic ⁽²⁾

Notes:

- (1) Grooved Plastic is a line constructed by cutting a groove into the pavement surface and spraying, extruding, or gluing pavement marking material into the groove.
- (2) Plastic refers to methyl methacrylate (MMA), thermoplastic, or preformed tape.
- (3) For RPM substitute applications and RPM applications supplementing paint or plastic, see the Standard Plans, Section M.
- (4) RRPMS refer to RPMs installed in a groove ground into the pavement. RRPMS are identified as "Recessed Pavement Markers" in the Standard Specifications and the Standard Plans.
- (5) Type 2 RPMs are not required with painted or plastic centerline or lane line in illuminated sections.
- (6) PMMA refers to profiled methyl methacrylate.
- (7) Consult region striping policy.
- (8) FMMA refers to flat methyl methacrylate.

Pavement Marking Material Guide

Figure 830-1

Highway Type	Guideposts on Tangents (See Notes 1 & 3)	Guideposts on Horizontal Curves (See Notes 1 & 3)
Divided Highways With Continuous Illumination		
Main Line	None	None
Bridge Approaches	None	None
Intersections	None	None
Lane Reductions	Standard Plan, Section H	Standard Plan, Section H
Median Crossovers	None	None
Ramps	Standard Plan, Section H	Standard Plan, Section H
Divided Highways Without Continuous Illumination		
Main Line with RPMs	None	Standard Plan, Section H
Main Line without RPMs	Right Side Only (0.10 mile spacing)	Standard Plan, Section H
Bridge Approaches	Standard Plan, Section H	Standard Plan, Section H
Intersections	Standard Plan, Section H	Standard Plan, Section H
Lane Reductions	Standard Plan, Section H	Standard Plan, Section H
Median Crossovers	Standard Plan, Section H	Standard Plan, Section H
Ramps	Standard Plan, Section H	Standard Plan, Section H
Undivided Highways With Continuous Illumination		
Main Line	None	None
Bridge Approaches	None	None
Intersections	None	None
Lane Reductions	Standard Plan, Section H	Standard Plan, Section H
Undivided Highways Without Continuous Illumination		
Main Line	See Note 2	Standard Plan, Section H (See Note 2)
Bridge Approaches	Standard Plan, Section H	Standard Plan, Section H
Intersections with Illumination	None	None
Intersections without Illumination	Standard Plan, Section H	Standard Plan, Section H
Lane Reductions	Standard Plan, Section H	Standard Plan, Section H

Notes:

1. For lateral placement of guideposts, see the Standard Plans, Section H.
2. Installation of guideposts on tangents and on the inside of horizontal curves is allowed at locations approved by the region's Traffic Engineer.
3. Barrier delineation is required when the traffic barrier is 4 feet or less from the roadway. Use delineator spacing of 40 feet or less.

Guidepost Placement
Figure 830-2

910.01	General
910.02	References
910.03	Definitions
910.04	Design Considerations
910.05	Design Vehicle
910.06	Right-Turn Corners
910.07	Channelization
910.08	Roundabouts
910.09	U-Turns
910.10	Sight Distance at Intersections
910.11	Traffic Control at Intersections
910.12	Interchange Ramp Terminals
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910.14	Documentation

910.01 General

Intersections are a critical part of highway design because of increased conflict potential. Traffic and driver characteristics, bicycle and pedestrian needs, physical features, and economics are considered during the design stage to develop channelization and traffic control to enhance safe and efficient multimodal traffic flow through intersections.

This chapter provides guidance for designing intersections at grade, including at-grade ramp terminals. See the following chapters for additional information:

Chapter	Subject
915	Roundabouts
920	Road Approaches
940	Interchanges

If an intersection design situation is not covered in this chapter, contact the Headquarters (HQ) Design Office, for assistance.

910.02 References

Laws – Federal and state laws and codes that may pertain to this chapter include:

Americans with Disabilities Act of 1990 (ADA)

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, Chapter 468-95 WAC (MUTCD), <http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm>

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

WAC 468-52, “Highway access management— Access control classification system and standards”

Design Guidance – Design guidance included by reference within the text includes:

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

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

Supporting Information – Other resources used or referenced in this chapter include:

A Policy on Geometric Design of Highways and Streets (Green Book), 2001, AASHTO

Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians, FHWA-RD-01-051, USDOT, FHWA, May 2001

Highway Capacity Manual (HCM), Special Report 209, Transportation Research Board, National Research Council

Highway Research Record No. 211
Aspects of Traffic Control Devices, pp 1-18, “Volume Warrants for Left-Turn Storage Lanes at Unsignalized Grade Intersections.” Harmelink, M. D.

NCHRP 279

Intersection Channelization Design Guide

Roundabouts: An Informational Guide, FHWA-RD-00-067, USDOT, FHWA

910.03 Definitions

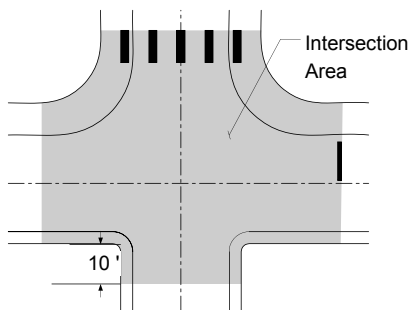
bulb out A curb and sidewalk bulge or extension out into the roadway used to decrease the length of a pedestrian crossing. (See chapter 1025.)

conflict An event involving two or more road users, in which the action of one user causes the other user to make an evasive maneuver to avoid a collision.

crossroad The minor roadway at an intersection. At a stopped controlled intersection, the crossroad has the stop.

intersection angle The angle between any two intersecting legs at the point that the center lines intersect.

intersection area The area of the intersecting roadways bounded by the edge of traveled ways and the area of the adjacent roadways to the end of the corner radii, any marked crosswalks adjacent to the intersection, or stop bar, but not less than 10 feet from the edge of shoulder of the intersecting roadway. See Figure 910-1.



Intersection Area

Figure 910-1

intersection at grade The general area where a state route or ramp terminal is met or crossed at a common grade or elevation by another state route, a county road, or a city street.

four leg intersection An intersection with four legs, as where two highways cross.

tee (T) intersection An intersection with three legs in the general form of a “T.”

split tee A four leg intersection with the cross road intersecting the through roadway at two tee intersections. The crossroad must be offset at least the width of the roadway.

wye (Y) intersection An intersection with three legs in the general form of a “Y” and the angle between two legs is less than 60°.

intersection leg Any one of the roadways radiating from and forming part of an intersection.

entrance leg The lanes of an intersection leg for traffic entering the intersection.

exit leg The lanes of an intersection leg for traffic leaving the intersection.

Whether an intersection leg is an entrance leg or an exit leg depends on which movement is being analyzed. For two way roadways, each leg is an entrance leg for some movements and an exit leg for other movements.

intersection sight distance The distance that the driver of a vehicle on the crossroad can see along the through roadway, as compared to the distance required for safe operation.

island A defined area within an intersection, between traffic lanes, for the separation of vehicle movements or for pedestrian refuge. It may be outlined with pavement markings or delineated by curbs. Within an intersection, a median is considered an island.

channelization island An island that separates traffic movements into definite paths of travel and guides traffic into the intended route.

divisional island An island introduced, on an undivided roadway, at an intersection to warn drivers of the crossroad ahead and regulate traffic through the intersection.

refuge island An island at or near a crosswalk or bicycle path to aid and protect pedestrians and bicyclists crossing the roadway.

median crossover An opening in a median provided for crossings by maintenance, law enforcement, emergency, and traffic service vehicles. (See Chapter 960.)

roundabout A circular intersection at which all traffic moves counterclockwise around a central island. (See Chapter 915)

rural intersection An intersection in a nonurban area.

urban intersection An intersection that is in one of the following areas:

- The area within the federal urban area boundary as designated by FHWA.
- An area characterized by intensive use of the land for the location of structures and receiving such urban services as sewers, water, and other public utilities and services normally associated with urbanized areas.
- An area with not more than 25% undeveloped land.

910.04 Design Considerations

Intersection design requires consideration of all potential users of the facility. This involves addressing the needs of a diverse mix of user groups including passenger cars, heavy vehicles of varying classifications, bicycles, and pedestrians. Often, meeting the needs of one user group requires a compromise in service to others. Intersection design balances these competing needs, resulting in appropriate levels of operation for all users.

In addition to reducing the number of conflicts, minimize the conflict area as much as possible while still providing for the required design vehicle (910.05). This is done to control the speed of turning vehicles and reduce vehicle, bicyclist, and pedestrian exposure.

(1) Traffic Analysis

Conduct a traffic analysis and an accident analysis to determine the design characteristics of each intersection. Include recommendations for channelization, turn lanes, acceleration and deceleration lanes, intersection configurations, illumination, bicycle and pedestrian accommodations, ADA requirements, and traffic control devices in the traffic analysis.

(2) Intersection Configurations

(a) **Intersection angle.** An important intersection design characteristic is the intersection angle. The desirable intersection angle is 90°, with 75° to 105° allowed for new, reconstructed, or realigned intersections.

Existing intersections with an intersection angle between 60° and 120° may remain. Intersection angles outside this range tend to restrict visibility, increase the area required for turning, increase the difficulty to make a turn, increase the crossing distance and time for vehicles and pedestrians, and make traffic signal arms difficult or impossible to design.

(b) **Lane alignment.** Design intersections with entrance lanes aligned with the exit lanes. Do not put angle points on the roadway alignments within intersection areas or on the through roadway alignment within 100 feet of the edge of traveled way of a crossroad. This includes short radius curves where both the PC and PT are within the intersection area. However, angle points within the intersection are allowed at intersections with a minor through movement, such as at a ramp terminal (Figure 910-18).

When practical, locate intersections so that curves do not begin or end within the intersection area. It is desirable to locate the PC and PT at least 250 feet from the intersection so that a driver can settle into the curve before the gap in the striping for the intersection area.

(c) **Split Tee.** Avoid split tee intersections where there is less than the required intersection spacing. See 910.04(4). Split tee intersections with an offset distance to the left greater than the width of the roadway, but less than the intersection spacing, may be designed with justification. Evaluate the anticipated benefits against the increased difficulty in driving through the intersection and a more complicated traffic signal design.

Split tee intersections with the offset to the right have the additional disadvantages of overlapping main line left-turn lanes, increased possibility of wrong way movements, and traffic signal design that is even more complicated. Do not design a split tee intersection with an offset to the right less than the required intersection spacing [see 910.04(4)] unless traffic is restricted to right-in right-out only.

(d) Other Nonstandard Configurations.

Do not design intersections with nonstandard configurations such as:

- Intersections with offset legs, except for split tee intersections [910.04(2)(c)].
- Intersections with more than four legs.
- Tee intersections with the major traffic movement making a turn.
- Wye intersections that are not a one-way merge or diverge.

A roundabout might be an alternative to these nonstandard configurations. (See 910.08 and Chapter 915.)

With justification and approval from the region’s Traffic Engineer existing intersections with nonstandard configurations may remain in place when an analysis shows no accident history related to the configuration.

(3) Crossroads

When the crossroad is a city street or county road, design the crossroad beyond the intersection area according to the applicable design criteria given in Chapter 440 for a city street or county road.

When the crossroad is a state facility, design the crossroad according to the applicable design level and functional class (Chapters 325, 430, and 440). Continue the cross slope of the through roadway shoulder as the grade for the crossroad. Use a vertical curve that is at least 60 feet long to connect to the grade of the crossroad.

Consider the profile of the crossroad in the intersection area. To prevent operational problems, the crown slope of the main line might need to be adjusted in the intersection area.

In areas that experience accumulations of snow and ice and for all legs that will require traffic to stop, design a maximum grade of $\pm 4\%$ for a length equal to the anticipated queue length for stopped vehicles.

(4) Intersection Spacing

Adequate intersection spacing is required to provide for safety and the desired operational characteristics for the highway. The minimum spacing for highways with limited access control is covered in Chapter 1430. For other highways, the minimum spacing is dependent on the Highway Access Management Class. See Chapter 1435 for minimum intersection spacing on Managed Access highways.

As a minimum, provide enough space between intersections for left-turn lanes and storage length. Space signalized intersections, and intersections expected to be signalized, to maintain efficient signal operation. It is desirable to space intersections so that queues will not block an adjacent intersection.

910.05 Design Vehicle

The physical characteristics of the design vehicle control the geometric design of the intersection. The following design vehicle types are commonly used:

Design Symbol	Vehicle Type
P	Passenger car, including light delivery trucks.
BUS	Single unit bus
A-BUS	Articulated bus
SU	Single unit truck
WB-40	Semitrailer truck, overall wheelbase of 40 ft
WB-50	Semitrailer truck, overall wheelbase of 50 ft
WB-67	Semitrailer truck, overall wheelbase of 67 ft
MH	Motor home
P/T	Passenger car pulling a camper trailer
MH/B	Motor home pulling a boat trailer

Design Vehicle Types
Figure 910-2

The geometric design of an intersection requires identifying and addressing the needs of all intersection users. There are competing design objectives when considering the turning requirements of the larger design vehicles and the crossing requirements of pedestrians. To reduce the operational impacts of large design vehicles, larger turn radii are used. This results in increased pavement areas, longer pedestrian crossing distances, and longer traffic signal arms.

To reduce the intersection area, a smaller design vehicle is used or encroachment is allowed. This reduces the potential for vehicle/pedestrian conflicts, decreases pedestrian crossing distance, and controls speeds of turning vehicles. The negative impacts include possible capacity reductions and greater speed differences between turning vehicles and through vehicles.

Select a design vehicle that is the largest vehicle that normally uses the intersection. The primary use of the design vehicle is to determine radii requirements for each leg of the intersection. It is possible for each leg to have a different design vehicle. Figure 910-3 shows the minimum design vehicles. As justification to use a smaller vehicle, include a traffic analysis showing that the proposed vehicle is appropriate.

Intersection Type	Design Vehicle
Junction of Major Truck Routes	WB-67
Junction of State Routes	WB-50
Ramp Terminals	WB-50
Other Rural	WB-50
Industrial	WB-40
Commercial	SU(1)(2)
Residential	SU(1)(2)
(1)	To accommodate pedestrians, the P vehicle may be used as the design vehicle if justification, with a traffic analysis, is documented.
(2)	When the intersection is on a transit or school bus route, use the BUS design vehicle as a minimum. See Chapter 1060 for additional guidance for transit facilities.

Intersection Design Vehicle
Figure 910-3

To minimize the disruption to other traffic, design the intersection to allow the design vehicles to make each turning movement without encroaching on curbs, opposing lanes, or same-direction lanes at the entrance leg. Use turning path templates (Figures 910-6a through 6c, templates from another published source, or computer generated templates) to verify that the design vehicle can make the turning movements.

Encroachment on same-direction lanes of the exit leg and the shoulder might be necessary to minimize crosswalk distances; however, this might negatively impact vehicular operations. Document and justify the operational tradeoffs associated with this encroachment. When encroachment on the shoulder is required, increase the pavement structure to support the anticipated traffic.

In addition to the design vehicle, often a larger vehicle must be considered. When vehicles larger than the design vehicle are allowed and are anticipated to occasionally use the intersection make certain that they can make the turn without leaving the paved shoulders or encroaching on a sidewalk. The amount of encroachment allowed is dependent on the frequency of the vehicle and the resulting disruption to other traffic. Use the WB-67 as the largest vehicle at all state route to state route junctions. Document and justify any required encroachment into other lanes, and any degradation of intersection operation.

910.06 Right-Turn Corners

The geometric design of an intersection requires identifying and addressing the needs of all intersection users. For the design of right-turn corners, there can be competing design objectives when considering the turning requirements of the design vehicle and the crossing requirements of pedestrians. To reduce the operational impacts of large trucks, right-turn radii are designed so that the truck can complete its turn without encroaching on the adjacent lanes at either the entrance or the exit legs of the turn. This results in larger corner radii, increased pavement area and pedestrian crossing distance, a larger conflict area, and higher vehicle turning speeds.

When pedestrian issues are a primary concern, the design objectives become one of reducing the potential for vehicle/pedestrian conflicts. This is done by minimizing pedestrian crossing distance and controlling the speeds of turning vehicles. This normally leads to right-corner designs with smaller turning radii. The negative impacts include possible capacity reductions and greater speed differences between turning vehicles and through vehicles.

Pedestrian refuge islands can also improve pedestrian safety. Pedestrian refuge islands minimize the crossing distance, reduce the conflict area, and minimize the impacts on vehicular traffic. When designing islands, speeds can be reduced by designing the turning roadway with a taper or large radius curve at the beginning of the turn and a small radius curve at the end. This allows larger islands while forcing the turning traffic to slow down.

Figure 910-7 shows right-turn corner designs for the design vehicles. These are considered the minimum pavement area to accommodate the design vehicles without encroachment on the adjacent lane at either leg of the curve.

With justification, right-turn corner designs given in Figure 910-7 may be modified. Document the benefits and impacts of the modified design including: changes to vehicle pedestrian conflicts, vehicle encroachment on the shoulder or adjacent same direction lane at the exit leg, capacity restrictions for right-turning vehicles or other degradation of intersection operations, and the effects on other traffic movements. To verify that the design vehicle can make the turn, include a plot of the design showing the design vehicle turning path template.

910.07 Channelization

Channelization is the separation or regulation of traffic movements into delineated paths of travel to facilitate the safe and orderly movement of vehicles, bicycles, and pedestrians.

Painted or plastic pavement markings are normally used to delineate travel paths. (See Chapter 830 and the Standard Plans for details.)

(1) Left-Turn Lanes

Left-turn lanes provide storage, separate from the through lanes, for left-turning vehicles waiting for a signal to change or for a gap in opposing traffic. (See 910.07(3) for a discussion on speed change lanes.)

Design left-turn channelization to provide sufficient operational flexibility to function under peak loads and adverse conditions.

(a) **One-Way Left-Turn Lanes** are separate storage lanes for vehicles turning left from one roadway onto another. When recommended, one-way left-turn lanes may be an economical way to lessen delays and accident potential involving left-turning vehicles. In addition, they can allow deceleration clear of the through traffic lanes. When considering left-turn lanes, consider impacts to all intersection movements and users.

At signalized intersections, use a traffic signal analysis to determine if a left-turn lane is needed and what the storage requirements are. (See Chapter 850.)

At unsignalized intersections, use the following as a guide to determine whether or not to provide one-way left-turn lanes:

- A traffic analysis indicates that a left-turn lane will reduce congestion. On two-lane highways, use Figure 910-8a, based on total traffic volume (DHV) for both directions and percent left-turn traffic, to determine if further investigation is needed. On four-lane highways, use Figure 910-8b to determine if a left-turn lane is recommended.
- An accident study indicates that a left-turn lane will reduce accidents.
- Restrictive geometrics require left-turning vehicles to slow greatly below the speed of the through traffic.
- There is less than decision sight distance at the approach to the intersection.

An HCM analysis may also be used to determine if left-turn lanes are necessary to maintain the desired level of service.

Determine the storage length required on two-lane highways by using Figures 910-9a through 9c. On four-lane highways use Figure 910-8b. These lengths do not consider trucks. Use Figure 910-4 for storage length when trucks are present.

Storage* Length (ft)	% Trucks in Left-Turn Movement				
	10	20	30	40	50
100	125	125	150	150	150
150	175	200	200	200	200
200	225	250	275	300	300
250	275	300	325	350	375
300	350	375	400	400	400

*Length from Figures 910-8b, 9a, 9b, or 9c.

Left-Turn Storage With Trucks (ft)
Figure 910-4

Design opposing left-turn design vehicle paths with a minimum 4-foot (12-foot desirable) clearance between opposing turning paths. Existing signalized intersections that do not meet the 4-foot clearance may remain with split signal phasing, an evaluate upgrade, and concurrence from the HQ Traffic Office.

Where one-way left-turn channelization with curbing is to be provided, ensure that surface water will drain.

Provide illumination at left-turn lanes in accordance with the guidelines in Chapter 840.

At signalized intersections with high left-turn volumes, double left-turn lanes may be needed to maintain the desired level of service. A throat width of 30 to 36 feet is desirable on the exit leg of the turn to offset vehicle offtracking and the difficulty of two vehicles turning abreast. Use turning path templates to verify that the design vehicle can complete the turn. Where the design vehicle is a WB-40 or larger it is preferred to provide for the design vehicle and an SU turning abreast rather than two design vehicles turning abreast.

Figures 910-10a through 10e show one-way left-turn geometrics. Figure 910-10a shows widening to accommodate the new lane. Figures 910-10c and 10d show the use of a median. Figure 910-10e shows the minimum protected left-turn with a median.

1. **Widening (Figure 910-10a).** It is desirable that offsets and pavement widening be symmetrical about the centerline or base line. Where right of way or topographic restrictions, crossroad alignments, or other circumstances preclude symmetrical widening, pavement widening may be on one side only.

2. **Divided Highways (Figure 910-10b through 10d).** Widening is not required for left-turn lane channelization where medians are 11 feet wide or wider. For medians between 13 feet and 23 feet or where the acceleration lane is not provided, it is desirable to design the left-turn lane adjacent to the opposing lane, as shown on Figure 910-10b, to improve sight distance.

A median acceleration lane, shown on Figures 910-10c and 10d, may be provided where the median is 23 feet or wider. The median acceleration lane might not be necessary at a signalized intersection. When a median acceleration lane is to be used, design it in accordance with 910.07(3) Speed Change Lanes. Where medians have sufficient width, provide a 2-foot shoulder adjacent to a left-turn lane.

3. **Minimum Protected Left-Turn with a Median (Figure 910-10e).** At intersections on divided highways where channelized left-turn lanes are not provided, consider the minimum protected storage area.

With justification, left-turn lane designs given in Figures 910-10a through 10d may be modified. Document the benefits and impacts of the modified design including: changes to vehicle pedestrian conflicts, vehicle encroachment, deceleration length, capacity restrictions for turning vehicles or other degradation of intersection operations, and the effects on other traffic movements. The modified design must be able to accommodate the design vehicle and provide for the striping requirements of the Standard Plans and the MUTCD. To verify that the design vehicle can make the turn, include a plot of the design showing the design vehicle turning path template.

(b) **Two-Way Left-Turn Lanes (TWLTL)** are located between opposing lanes of traffic. They are used by vehicles making left turns from either direction, either from or onto the roadway.

Use TWLTLs only on managed access highways where there are no more than two through lanes in each direction. Consider installation of TWLTLs where:

- An accident study indicates that a TWLTL will reduce accidents.
- There are existing closely spaced access points or minor street intersections.
- There are unacceptable through traffic delays or capacity reductions because of left turning vehicles.

A TWLTL can reduce delays to through traffic, reduce rear-end accidents, and provide separation between opposing lanes of traffic. However, they do not provide a safe refuge for pedestrians and can encourage strip development with additional closely spaced access points. Consider other alternatives, before using a TWLTL, such as prohibiting midblock left-turns and providing for U-turns. See Chapters 440 and 1435 for additional restrictions on the use of TWLTLs.

The basic design for a TWLTL is illustrated on Figure 910-10f. Additional criteria are:

- The desirable length of a TWLTL is not less than 250 feet.
- Provide illumination in accordance with the guidelines in Chapter 840.
- Pavement markings, signs, and other traffic control devices must be in accordance with the MUTCD and the Standard Plans.
- Provide clear channelization when changing from TWLTL to one-way left-turn lanes at an intersection.

(2) **Right-Turn Lanes and Drop Lanes**

Right-turn movements influence intersection capacity even though there is no conflict between right-turning vehicles and opposing traffic. Right-turn lanes might be needed to maintain efficient intersection operation. Use the following as guidelines to determine when to consider right-turn lanes at unsignalized intersections:

- Recommendation from Figure 910-11 based on same direction approach and right-turn traffic volumes for multilane roadways with a posted speed 45 miles per hour or above and for all two-lane roadways.
- An accident study indicates that a right-turn lane will result in an overall accident reduction.
- Presence of pedestrians who require right-turning vehicles to stop.
- Restrictive geometrics that require right-turning vehicles to slow greatly below the speed of the through traffic.
- Less than decision sight distance at the approach to the intersection.

For unsignalized intersections, see 910.07(3) Speed Change Lanes for guidance on right-turn lane lengths. For signalized intersections, use a traffic signal analysis to determine if a right-turn lane is needed and the length requirement. (See Chapter 850.)

A capacity analysis may be used to determine if right-turn lanes are necessary to maintain the desired level of service.

Where adequate right of way exists, providing right-turn lanes is relatively inexpensive and can provide increased safety and operational efficiency.

The right-turn pocket or the right-turn taper (Figure 910-12) may be used at any minor intersection where a deceleration lane is not required and turning volumes indicate a need as set forth in Figure 910-11. These designs will cause less interference and delay to the through movement by offering an earlier exit to right-turning vehicles.

If the right-turn pocket is used, Figure 910-12 shows taper lengths for various posted speeds.

A lane may be dropped at an intersection with a turn-only lane or beyond the intersection with an acceleration lane (Figure 910-14). Do not allow a lane-reduction taper to cross an intersection or end less than 100 feet before an intersection.

When a lane is dropped beyond a signalized intersection, provide a lane of sufficient length to allow smooth merging. For facilities with a posted speed of 45 miles per hour or higher, use a minimum length of 1,500 feet. For facilities with a posted speed less than 45 miles per hour, provide a lane of sufficient length so that the advanced lane reduction warning sign will be placed not less than 100 feet beyond the intersection area.

(3) Speed Change Lanes

A speed change lane is an auxiliary lane primarily for the acceleration or deceleration of vehicles entering or leaving the through traveled way. Speed change lanes are normally provided for at-grade intersections on multilane divided highways with access control. Where roadside conditions and right of way allow, speed change lanes may be provided on other through roadways. Justification for a speed change lane depends on many factors such as speed, traffic volumes, capacity, type of highway, the design and frequency of intersections, and accident history.

A deceleration lane is advantageous because, if a deceleration lane is not provided the driver leaving the highway must slow down in the through lane regardless of following traffic.

An acceleration lane is not as advantageous because entering drivers can wait for an opportunity to merge without disrupting through traffic.

When either deceleration or acceleration lanes are to be used, design them in accordance with Figures 910-13 and 14. When the design speed of the turning traffic is greater than 20 miles per hour, design the speed change lane as a ramp in accordance with Chapter 940. When a deceleration lane is used with a left-turn lane, add the deceleration length to the storage length.

(4) Shoulders

With justification, shoulder width requirements may be reduced within areas channelized for intersection turning lanes or speed change lanes. Apply left shoulder width criteria to the median shoulder of divided highways. On one-way couplets, apply the width criteria for the right shoulder to both the right and left shoulders.

For roadways without curb sections, the shoulder adjacent to turn lanes and speed change lanes may be reduced to 2 feet on the left and 4 feet on the right. When a curb and sidewalk section is used with a turn lane or speed change lane, 400 feet or less in length, the shoulder abutting the turn lane may be eliminated. In instances where curb is used without sidewalk, provide a minimum of 4 foot wide shoulders on the right. Where curbing is used adjacent to left turn lanes, the shoulder may be eliminated. Adjust the design of the intersection as necessary to allow for vehicle tracking.

Reducing the shoulder width at intersections facilitates the installation of turn lanes without unduly affecting the overall width of the roadway. A narrower roadway also reduces pedestrian exposure in crosswalks and discourages motorists from using the shoulder to bypass other turning traffic.

On routes where provisions are made for bicycles, continue the bicycle facility between the turn lane and the through lane. (See Chapter 1020 for information on bicycle facilities.)

(5) Islands

An island is a defined area within an intersection between traffic lanes for the separation of vehicle movements or for pedestrian refuge. Within an intersection, a median is considered an island. Design islands to clearly delineate the traffic channels to drivers and pedestrians.

Traffic islands perform these functions:

- Channelization islands control and direct traffic movement.
- Divisional islands separate traffic movements.
- Refuge islands provide refuge for pedestrians.
- Islands can provide for the placement of traffic control devices and luminaires.
- Islands can provide areas within the roadway for landscaping.

(a) **Size and Shape.** Divisional and refuge islands are normally elongated and at least 4 feet wide and 20 feet long. (Mountable curb, used to discourage turn movements, is not a divisional island.)

Channelization islands are normally triangular. In rural areas, 75 ft² is the minimum island area and 100 ft² is desirable. In urban areas where posted speeds are 25 miles per hour or less, smaller islands are acceptable. Use islands with at least 200 ft² if pedestrians will be crossing or traffic control devices or luminaires will be installed.

Design triangular shaped islands as shown on Figure 910-15a through 15c. The shoulder and offset widths illustrated are for islands with vertical curbs 6 inches or higher. Where painted islands are used, such as in rural areas, these widths are desirable but may be omitted. See Chapter 641 for turning roadway widths.

Island markings may be supplemented with reflective raised pavement markers.

Barrier-free access must be provided at crosswalk locations where raised islands are used. See Chapter 1025.

(b) **Location.** Design the approach ends of islands to provide adequate visibility to alert the motorist of their presence. Position the island so that a smooth transition in vehicle speed and direction is attained. Begin transverse lane shifts far enough in advance of the intersection to allow gradual transitions. Avoid introducing islands on a horizontal or vertical curve. If the use of an island on a curve cannot be avoided, provide adequate sight distance, illumination, or extension of the island.

(c) **Compound Right-Turn Lane.** To design large islands, the common method is to use a large radius curve for the turning traffic. While this does provide a larger island, it also encourages higher turning speeds. Where pedestrians are a concern, higher turning speeds are undesirable. An alternative is a compound curve with a large radius followed by a small radius (Figure 910-15b). This design forces the turning traffic to slow down.

(d) **Curbing.** Provide vertical curb 6 inches or higher for:

- Islands with luminaires, signals, or other traffic control devices.
- Pedestrian refuge islands.

In addition consider curbing for:

- Divisional and channelizing islands.
- Landscaped islands.

In general, unless required for the uses listed above, it is preferred not to use curbs on facilities with a posted speed of 45 miles per hour or greater.

Avoid using curbs if the same objective can be attained with pavement markings.

See Chapter 440 for additional information and requirements on the use of curbs.

910.08 Roundabouts

Modern roundabouts are circular intersections. They can be an effective intersection type.

Modern roundabouts differ from the old rotaries and traffic circles in two important respects: they have a smaller diameter, which lowers speeds; and they have splitter islands that provide entry constraints, slowing down the entering speeds.

When well designed, roundabouts are an efficient form of intersection control. They have fewer conflict points, lower speeds, easier decision making, and they require less maintenance. When properly designed and located, they have been found to reduce injury accidents, traffic delays, fuel consumption, and air pollution. Roundabouts also permit U-turns.

Consider roundabouts at intersections with the following characteristics:

- Where stop signs result in unacceptable delays for the cross road traffic. Roundabouts reduce the delays for the cross road, but increase the delays for the through roadway.
- With a high left-turn percentage. Unlike most intersection types, roundabouts can operate efficiently with high volumes of left-turning traffic.
- With more than four legs. When the intersection cannot be modified by closing or relocating legs, a roundabout can provide a solution.
- Where a disproportionately high number of accidents involve crossing or turning traffic.
- Where the major traffic movement makes a turn.

- Where traffic growth is expected to be high and future traffic patterns are uncertain.
- Where it is not desirable to give priority to either roadway.

There are some disadvantages with roundabouts. Roundabouts do not allow for a primary roadway to have priority because all legs entering a roundabout are treated the same.

Also, all traffic entering a roundabout is required to reduce speed. Therefore, roundabouts are not appropriate on high speed facilities, where traffic flows are unbalanced, or where an arterial intersects a collector or local road.

See Chapter 915 for information and requirements on the design of roundabouts.

910.09 U-Turns

For divided highways without full access control that have access points where a median prevents left turns, consider providing locations designed to allow U-turns. Normally, the U-turn opportunities are provided at intersections; however, where intersections are spaced far apart, consider median openings between intersections to accommodate U-turns. Use the desirable U-turn spacing (Figure 910-5) as a guide to determine when to consider U-turn locations between intersections. When the U-turning volumes are low, use longer spacing.

	U-Turn Spacing	
	Desirable	Minimum
Urban ⁽¹⁾	1,000 ft	(2)
Suburban	1/2 mi	1/4 mi ⁽³⁾
Rural	1 mi	1/2 mi
(1) For design speeds greater than 45 mph use suburban spacing. (2) The minimum spacing is the acceleration lane length from a stop (Figure 910-14) plus 300 feet (3) For design speeds 60 mph or greater, the minimum spacing is the acceleration lane length from a stop (Figure 910-14) plus 300 feet		

U-Turn Spacing
Figure 910-5

When designing U-turn locations, use Figure 910-16 as a guide. Where the median is less than 40 feet wide and a large design vehicle is required, consider the use of a U-turn roadway (jug handle).

Document the need for U-turn locations, the spacing used, and justify the selected design vehicle.

U-turns at signal controlled intersections do not require the acceleration lanes shown in Figure 910-16. At new U-turn locations at signal controlled intersections, ensure that right-turning vehicles from side streets will not conflict with U-turning vehicles. Warning signs on the cross street might be appropriate.

910.10 Sight Distance at Intersections

For traffic to move safely through intersections, drivers need to be able to see stop signs, traffic signals, and oncoming traffic in time to react accordingly.

Provide decision sight distance, where practical, in advance of stop signs, traffic signals, and roundabouts. See Chapter 650 for guidance.

The driver of a vehicle that is stopped, waiting to cross or enter a through roadway, needs obstruction-free sight triangles in order to see enough of the through roadway to safely complete all legal maneuvers before an approaching vehicle on the through roadway can reach the intersection. Use Figure 910-17a to determine minimum sight distance along the through roadway.

The sight triangle is determined as shown in Figure 910-17b. Within the sight triangle, lay back the cut slopes and remove, lower, or move hedges, trees, signs, utility poles, and anything else large enough to be a sight obstruction. Consider eliminating parking so sight distance is not obstructed. In order to maintain the sight distance, the sight triangle must be within the right of way or a state maintenance easement (see Chapter 1410).

The minimum setback distance for the sight triangle is 18 feet from the edge of traveled way. This is for a vehicle stopped 10 feet from the edge of traveled way. The driver is almost always 8 feet or less from the front of the vehicle; therefore, 8 feet is added to the setback. When the stop bar is placed more than 10 feet from the edge of traveled way, consider providing the sight triangle to a point 8 feet back of the stop bar.

Provide a clear sight triangle for a P vehicle at all intersections. In addition to this, provide a clear sight triangle for the SU vehicle for rural highway conditions. If there is significant combination truck traffic, use the WB-50 or WB-67 rather than the SU. In areas where SU or WB vehicles are minimal, and right of way restrictions prohibit adequate sight triangle clearing, only the P vehicle need be considered.

At existing intersections, when sight obstructions within the sight triangle cannot be removed due to limited right of way, the intersection sight distance may be modified. A driver that does not have the desired sight distance will creep out until the sight distance is available; therefore, the 10-foot stopping distance from the edge of traveled way may be reduced to 2-foot, reducing the setback to 10 feet. Also, the time gap (t_g) may be reduced by the 2-second perception/reaction time. Document the right of way width and provide a brief analysis of the intersection sight distance clarifying the reasons for reduction. Verify and document that there is not an accident problem at the intersection. Document as a design exception.

If the intersection sight distance cannot be provided using the reductions in the preceding paragraph, the calculated sight distance may be reduced, with HQ Design Office approval. Provide as much sight distance as practical, but not less than the stopping sight distance required for the major roadway, with visibility at the 10-foot setback point. (For required stopping sight distance, see Chapter 650.) Document the right of way width and provide a brief analysis of the intersection sight distance clarifying the reasons for reduction. Verify and document that there is not an accident problem at the intersection. Document as a design exception.

In some instances intersection sight distance is provided at the time of construction, but subsequent vegetative growth has degraded the sight distance available. The growth may be seasonal or occur over time. In these instances, the intersection sight distance will be restored through periodic scheduled maintenance of vegetation in the sight triangle within the WSDOT right of way or state maintenance easement.

At intersections controlled by traffic signals, provide sight distance for right-turning vehicles.

Designs for movements that cross divided highways are influenced by the median widths. If the median is wide enough to store the design vehicle, with 3 feet clearance at both ends of the vehicle, sight distances are determined in two steps. The first step is for crossing from a stopped position to the median storage; the second step is for the movement, either across, or left into the through roadway.

Design ramp terminal sight distance as at-grade intersections considering only left- and right- turning movements. An added element at ramp terminals is the grade separation structure. Figure 910-17b gives the sight distance considerations in the vicinity of a structure. In addition, when the crossroad is an undercrossing, check the sight distance under the structure graphically using a truck eye height of 6 feet and an object height of 1.5 feet.

Document a brief description of the intersection area, sight distance restrictions, and traffic characteristics to support the design vehicle and sight distances chosen.

910.11 Traffic Control at Intersections

Intersection traffic control is the process of moving traffic safely through areas of potential conflict where two or more roadways meet. Signs, signals, channelization, and physical layout are the major tools used to establish intersection control.

There are three objectives to intersection traffic control that can greatly improve intersection operations.

- **Maximize Intersection Capacity.** Since two or more traffic streams cross, converge, or diverge at intersections, capacity of an intersection is normally less than the roadway between intersections. It is usually necessary to assign right of way through the use of traffic control devices to maximize capacity for all users of the intersection. Turn prohibitions may be used to increase intersection capacity.
- **Reduce Conflict Points.** The crossing, converging, and diverging of traffic creates conflicts which increase the potential for accidents. Establishing appropriate controls can reduce the possibility of two cars attempting to occupy the same space at the same time. Pedestrian accident potential can also be reduced by appropriate controls.
- **Priority of Major Streets.** Traffic on major routes is normally given the right of way over traffic on minor streets to increase intersection operational efficiency.

If a signal is being considered or exists at an intersection that is to be modified, a preliminary signal plan is required (Chapter 850). If a new signal permit is required, it must be approved before the design is approved.

A proposal to install a traffic signal or a roundabout on a state route, either NHS or Non-NHS, with a posted speed limit of 45 miles per hour or higher requires an analysis of alternatives, approved by the region's Traffic Engineer with review and comment by the Headquarters Design Office, prior to proceeding with the design.

Include the following alternatives in the analysis:

- Channelization, providing deceleration lanes, storage, and acceleration lanes for left- and right-turning traffic.
- Right-off /right-on with U-turn opportunities.
- Grade separation.
- Roundabouts.
- Traffic control signals.

Include a copy of the analysis with the preliminary signal plan or roundabout justification.

910.12 Interchange Ramp Terminals

The design to be used or modified for use on one-way ramp terminals with stop or traffic signal control at the local road is shown on Figure 910-18. Higher volume intersections with multiple ramp lanes are designed individually.

Due to probable development of large traffic generators adjacent to an interchange, width for a median on the local road is desirable whenever such development is believed imminent. This allows for future left-turn channelization. Use median channelization when justified by capacity determination and analysis, or by the need to provide a smooth traffic flow.

Determine the number of lanes for each leg by capacity analysis methods assuming a traffic signal cycle, preferably 45 or 60 seconds in length, regardless of whether a signal is used or not. Consider all terminals in the analysis.

Adjust the alignment of the intersection legs to fit the traffic movements and to discourage wrong way movements. Use the allowed intersecting angles of 75° to 105° (60° to 120° for modified design level) to avoid broken back or reverse curves in the ramp alignment.

910.13 Procedures

Document design considerations and conclusions in accordance with Chapter 330. For highways with limited access control, see Chapter 1430 for requirements.

(1) Approval

An intersection is approved in accordance with Chapter 330. When required, the following items must be completed before an intersection may be approved:

- Traffic analysis.
- Deviations approved in accordance with Chapter 330.
- Preliminary traffic signal plan approved by the HQ Traffic Office. (See Chapter 850.)
- HQ Design Office approval for intersections with roundabouts. See Chapter 915 for approval procedures.

(2) Intersection Plans

Intersection plans are required for any increases in capacity (turn lanes) of an intersection, modification of channelization, or change of intersection geometrics. Support the need for intersection or channelization modifications with history, school bus and mail route studies, hazardous materials route studies, pedestrian use, public meeting comments, and so forth.

For information to be included on the Intersection Plan for Approval, see the Intersection/Channelization Plan for Approval Check List on the following web site:

<http://www.wsdot.wa.gov/EESC/Design/projectdev/default.htm>

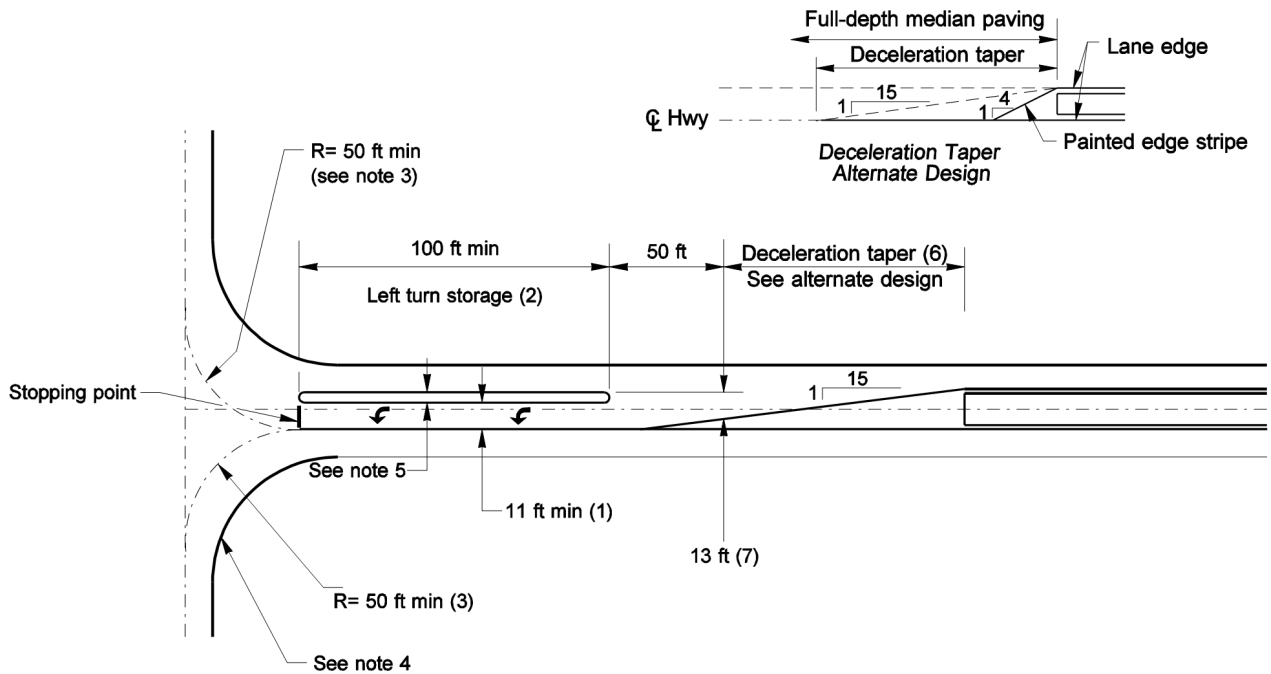
(3) Local Agency or Developer Initiated Intersections

There is a separate procedure for local agency or developer-initiated projects at intersections with state routes. The project initiator submits an intersection plan, and the documentation of design considerations that led to the plan, to the region for approval. For those plans requiring a deviation, the deviation must be approved in accordance with Chapter 330 prior to approval of the plan. After the plan approval, the region prepares a construction agreement with the project initiator. (See the *Utilities Manual*.)

910.14 Documentation

The list of documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) is on the following web site:

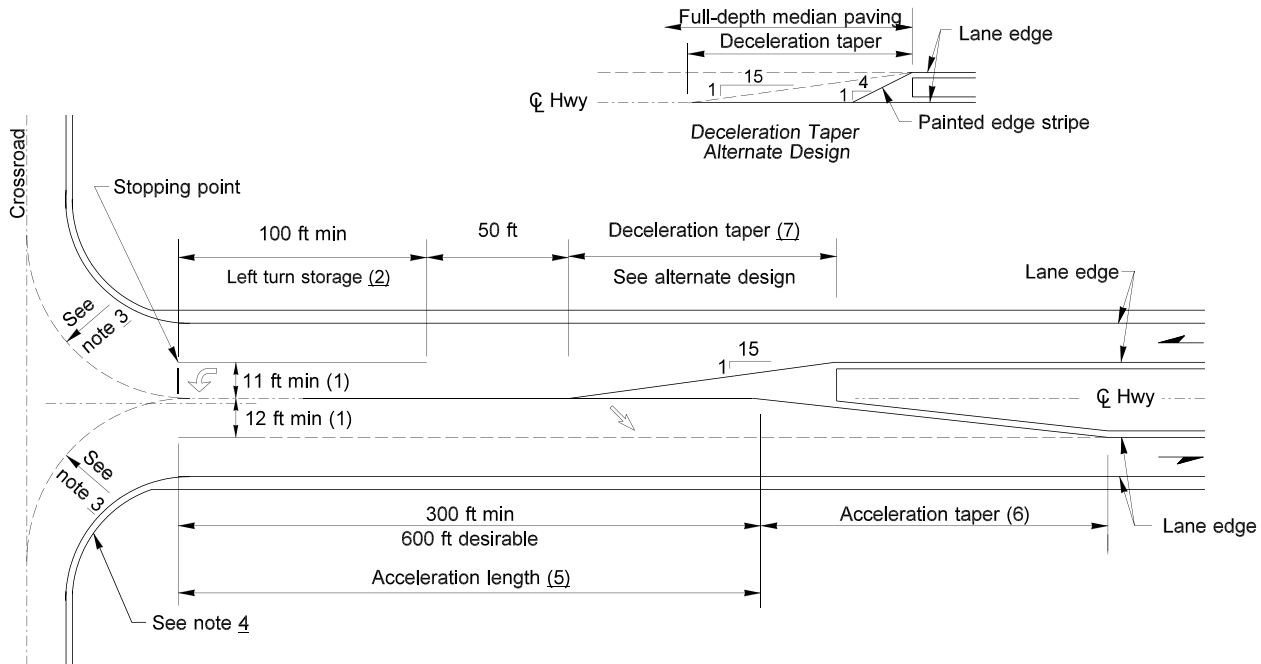
<http://www.wsdot.wa.gov/eesc/design/projectdev/>



Notes:

- (1) Lane width of 13 ft is desirable.
- (2) For left-turn storage length, see Figures 910-8b for 4-lane roadways or 9a through 9c for 2-lane roadways.
- (3) Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.
- (4) See Figure 910-7 for right-turn corner design.
- (5) For median widths greater than 13 ft, it is desirable to locate the left-turn lane adjacent to the opposing through lane with excess median width between the same direction through lane and the turn lane.
- (6) For increased storage capacity, consider the left-turn deceleration taper alternate design.
- (7) Reduce to lane width for medians less than 13 ft wide.
- (8) See Standard Plans and MUTCD for pavement marking details.

Median Channelization (Median Width 11 ft or more)
Figure 910-10b



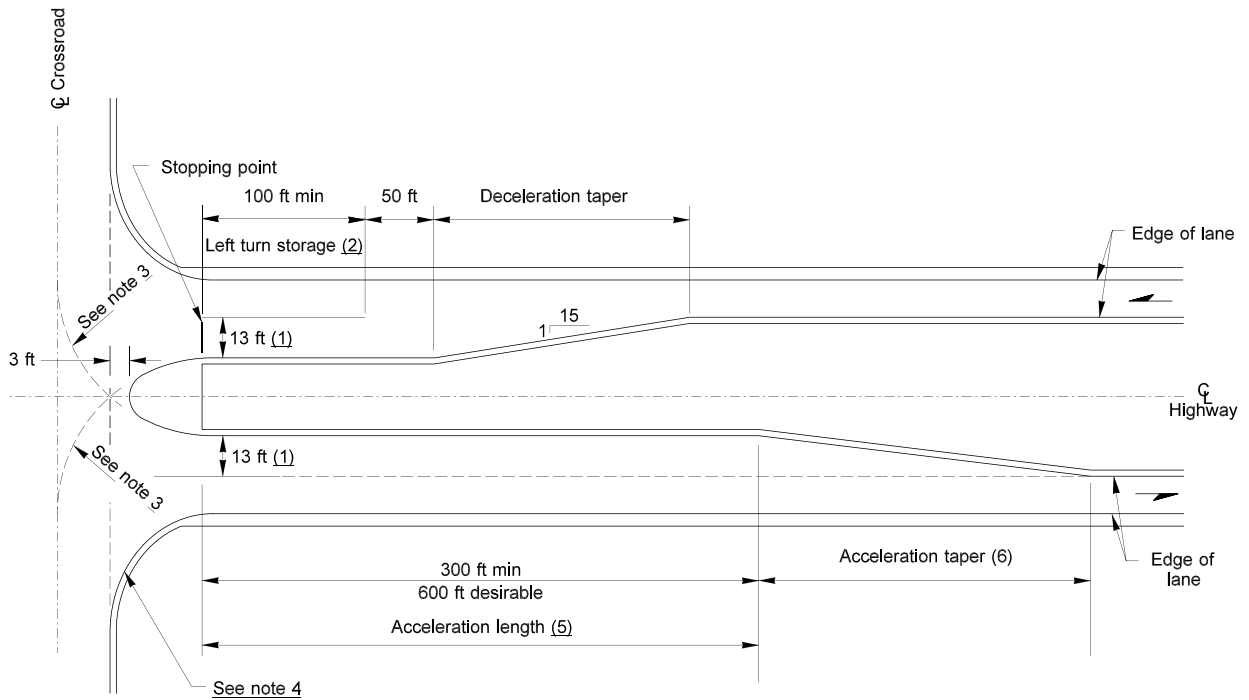
Notes:

- (1) Lane widths of 13 ft are desirable for both the left-turn storage lane and the median acceleration lane.
- (2) For left-turn storage length, see Figures 910-8b for 4-lane roadways or 9a through 9c for 2-lane roadways.
- (3) Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.
- (4) See Figure 910-7 for right-turn corner design.
- (5) The minimum total length of the median acceleration lane is shown in Figure 910-14.
- (6) See Table 2, for acceleration taper rate.
- (7) For increased storage capacity, consider the left-turn deceleration taper alternate design.
- (8) See Standard Plans and MUTCD for pavement marking details.

Posted Speed	Taper Rate
55 mph	55:1
50 mph	50:1
45 mph	45:1
40 mph	27:1
35 mph	21:1
30 mph	15:1
25 mph	11:1

Table 2

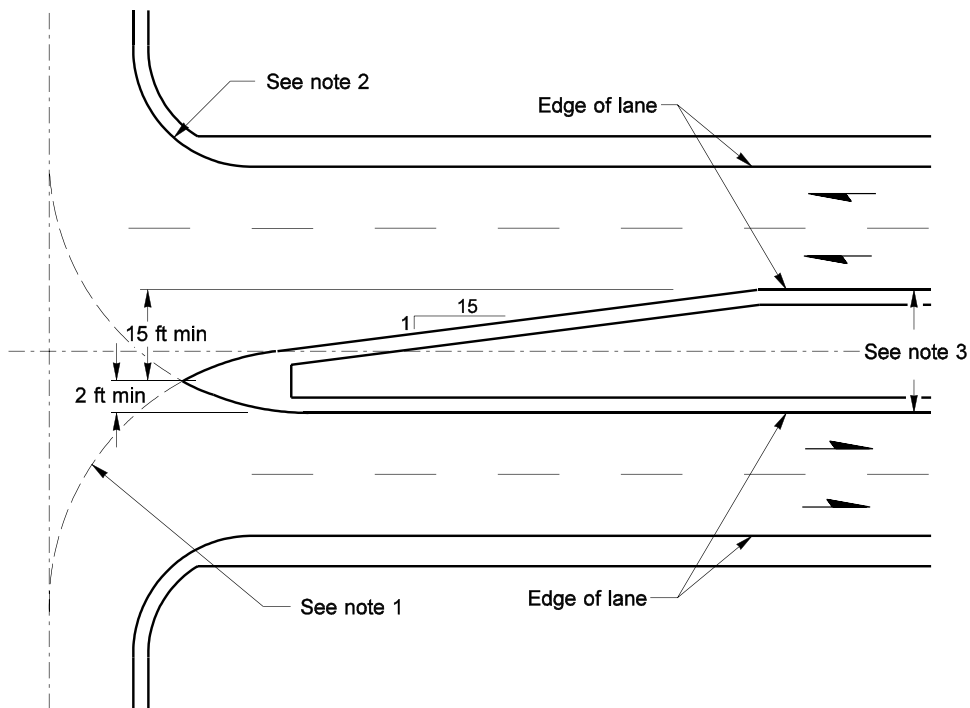
Median Channelization (Median Width 23 ft to 26 ft)
Figure 910-10c



Notes:

- (1) May be reduced to 11 ft, with justification.
- (2) For left-turn storage length, see Figures 910-8b for 4-lane roadways or 9a through 9c for 2-lane roadways.
- (3) Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.
- (4) See Figure 910-7 for right-turn corner design.
- (5) The minimum length of the median acceleration lane is shown in Figure 910-14.
- (6) See Table 2 Figure 910-10c for acceleration taper rate.
- (7) See Standard Plans and MUTCD for pavement marking details.

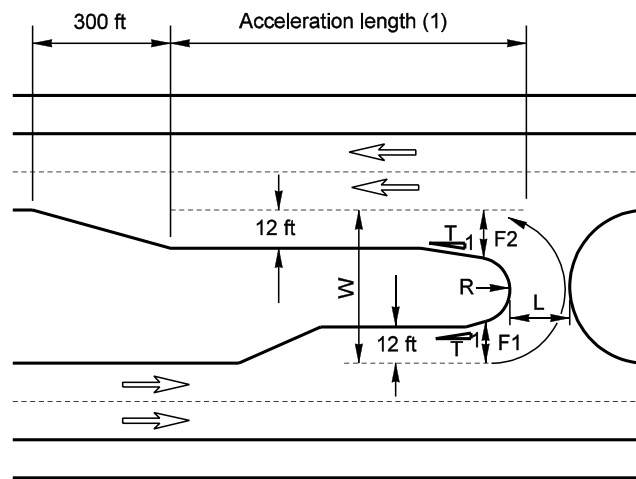
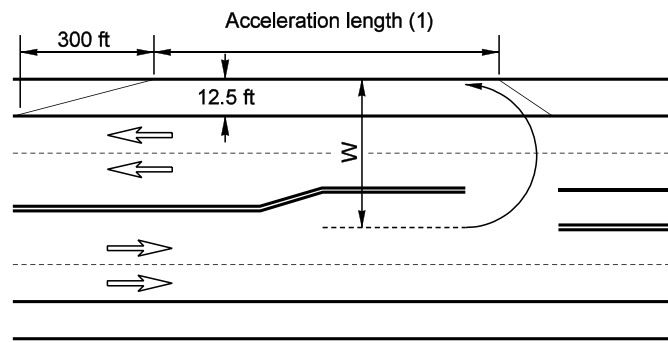
Median Channelization (Median Width of More Than 26 ft)
Figure 910-10d



Notes:

- (1) Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.
- (2) See Figure 910-7 for right-turn corner design.
- (3) For median width 17 ft or more. For median width less than 17 ft, widen to 17 ft or use Figure 910-10b.
- (4) See Standard Plans and MUTCD for pavement marking details.

Median Channelization (Minimum Protected Storage)
Figure 910-10e



Vehicle	W	R	L	F1	F2	T
P	52	14	14	12	12	—
SU	87	30	20	13	15	10:1
BUS	87	28	23	14	18	10:1
WB-40	84	25	27	15	20	6:1
WB-50	94	26	31	16	25	6:1
WB-67	94	22	49	15	35	6:1
MH	84	27	20	15	16	10:1
P/T	52	11	13	12	18	6:1
MH/B	103	36	22	15	16	10:1

U-Turn Design Dimensions

Notes:

(1) The minimum length of the acceleration lane is shown in Figure 910-14. Acceleration lane may be eliminated at signal controlled intersections.

(3) When U-turn uses the shoulder, provide 12.5 ft shoulder width and shoulder pavement designed to the same depth as the through lanes for the acceleration length and taper.

(2) All dimensions in feet.

U-Turn Locations

Figure 910-16

- 960.01 General
- 960.02 Analysis
- 960.03 Design
- 960.04 Approval
- 960.05 Documentation

960.01 General

This chapter provides guidance for locating and designing median crossovers.

Median crossovers are provided at selected locations on divided highways for crossing by maintenance, traffic service, emergency, and law enforcement vehicles. The use of any median crossover is restricted to the users noted above.

Crossovers may be provided:

- Where analysis demonstrates that access through interchanges or intersections is not practical
- As part of region maintenance operations
- As necessary for law-enforcement functions

For median openings to provide turning movements for public access to both sides of the roadway, see Chapter 910, Intersections At Grade.

960.02 Analysis

A list of existing median crossovers is available from the Headquarters (HQ) Access and Hearings Unit. The Statewide Master Plan for Median Crossovers can be found at:

<http://www.wsdot.wa.gov/eesc/design/access/1MasterPlanXoversHistory.pdf>.

The general categories of vehicles recognized as legitimate users of median crossovers are: law enforcement and official services vehicles, these include emergency, traffic service, and maintenance vehicles.

In both urban and rural areas, crossovers may be necessary for law enforcement operations. In urban areas with a high occupancy vehicle lane adjacent to the median, crossovers may be considered for law enforcement. See Chapter 1050.

In areas where there are three or more miles between access points, providing an unobtrusive crossover can improve emergency service or improve efficiency for traffic service and maintenance forces.

Where crossovers are justified and used for winter maintenance operations such as snow and ice removal, the recommended minimum distance from the ramp merge or diverge point should be 1,000 feet to accommodate future ramp improvements. This distance may be decreased to improve winter maintenance efficiency based on an operational analysis. Include an operational analysis in the Design Documentation Package.

960.03 Design

Utilize the following design criteria for all median crossovers, while taking into consideration the intended vehicle usage. Some of the criteria below may not apply to crossovers intended primarily for law enforcement:

- Adequate median width at the crossover location is required to allow the design vehicle to complete a U-turn maneuver without backing. Use of the shoulder area is allowed for the execution of the U-turn maneuver. The typical design vehicles for this determination are a passenger car and a single unit truck.
- Consider the type of vehicles using the median crossover.
- The minimum recommended throat width is 30 feet.
- Use grades and radii that are suitable for all authorized user vehicles. (See Chapter 920)
- Ten-foot inside shoulders are adequate for most cases. Consider full ten-foot shoulders for a distance of 450 feet upstream of the crossover area to accommodate deceleration, and extend downstream of the crossover area for a distance of 600 feet to allow acceleration prior to entering the travel lane. Where inside shoulders can be constructed wide enough

to allow vehicle deceleration and acceleration to occur off the travel lanes, documentation is not required.

- Provide adequate stopping sight distance for vehicles approaching the crossover area. Because of the unexpected maneuvers associated with these inside access points and higher operating speeds commonly experienced in the inside travel lanes, use conservative values for stopping sight distance. (See Chapter 650.)
- Provide adequate intersection sight distance at crossover locations where authorized user vehicles must encroach on the travel lanes. (See Chapter 910.)
- For the crossing, use side slopes no steeper than 10H:1V. Grade for a relatively flat and gently contoured appearance that is inconspicuous to the public.
- Consider impacts to existing drainage.
- Do not use curbs or pavement markings.
- Flexible guide posts may be provided for night reference, as shown in the Standard Plans.
- Consider the terrain and locate the crossover to minimize visibility to the public.
- Vegetation may be used to minimize visibility. Low vegetation, with a 3-foot year-round maximum height is recommended for this purpose. (See Chapter 1300).
- In locations where vegetation cannot be used to minimize visibility to the traveling public and there is a high incidence of unauthorized use; appropriate signing such as “No U-Turns” may be used to discourage unauthorized use.
- A stabilized all-weather surface is required. Urban crossovers for a high occupancy vehicle enforcement plan are usually paved. Paving at other types of crossovers may be paved when justified. Paving of crossings is determined on a case-by-case basis.

960.04 Approval

All approved crossover locations will be designated on the Statewide Master Plan for Median Crossovers. A committee consisting of the Assistant Regional Administrator for Operations or Project Development, the Washington State Patrol Assistant District Commander, the HQ Access Engineer and the FHWA Area Engineer or their designees, will be responsible for establishing and updating this plan as appropriate. Contact the Access and Hearings Unit for interim review and approvals for the following: proposed new crossings, relocation of previously approved crossings, or removal of crossings that are no longer necessary.

To expedite the team process, provide pictures of the existing crossings and the interchanges on a strip map. Include MP locations and spacing between existing and planned crossings and interchanges. The use of SR view at the team meeting helps the members determine which crossings may remain, which need to be relocated, and which to eliminate.

Regional Administrators or their designee, are responsible for the design and construction of median crossovers. Prior to construction of the opening, submit the documentation of the crossover need and the design data (together with a right of way plan showing the opening in red) to the State Design Engineer for right of way or limited access plan approval. Construction may not proceed prior to approval. (Refer to the DDP checklist.)

After notification of approval, the HQ Right of Way Plans Section sends the region a revised reproducible right of way or limited access plan which includes the approved crossover location.

960.05 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site: <http://www.wsdot.wa.gov/eesc/design/projectdev/>

- 1010.01 General
- 1010.02 References
- 1010.03 Definitions
- 1010.04 Climbing Lanes
- 1010.05 Passing Lanes
- 1010.06 Slow-Moving Vehicle Turnouts
- 1010.07 Shoulder Driving for Slow Vehicles
- 1010.08 Emergency Escape Ramps
- 1010.09 Chain-Up Areas
- 1010.10 Documentation

1010.01 General

Auxiliary lanes are used to comply with capacity requirements; to maintain lane balance; to accommodate speed change, weaving, and maneuvering for entering and exiting traffic; or to encourage carpools, vanpools, and the use of transit.

For signing of auxiliary lanes, see the Traffic Manual and the MUTCD.

Although slow-vehicle turnouts, shoulder driving for slow vehicles, and chain-up areas are not auxiliary lanes they are covered in this chapter because they perform a similar function.

For additional information, see the following chapters:

Chapter	Subject
910	turn lanes
910	speed change lanes at intersections
940	speed change lanes at interchanges
940	collector-distributor roads
940	weaving lanes
1050	high occupancy vehicle lanes

1010.02 References

Laws – Federal and state laws and codes that may pertain to this chapter include:

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, Chapter 468-95 WAC, (MUTCD) <http://wsdot.wa.gov/biz/trafficoperations/mutcd.htm>

Revised Code of Washington (RCW) 46.61, Rules of the Road

Design Guidance – Design guidance included by reference within the text includes:

Traffic Manual, M 51-02, WSDOT

Supporting Information – Other resources used or referenced in this chapter include:

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2001

Emergency Escape Ramps for Runaway Heavy Vehicles, FHWA-T5-79-201, March 1978

Highway Capacity Manual (Special Report 209), Transportation Research Board

NCHRP Synthesis 178, *Truck Escape Ramps*, Transportation Research Board

1010.03 Definitions

auxiliary lane The portion of the roadway adjoining the through lanes for parking, speed change, turning, storage for turning, weaving, truck climbing, passing, and other purposes supplementary to through-traffic movement.

climbing lane An auxiliary lane used for the diversion of slow traffic from the through lane.

design speed The speed used to determine the various geometric design features of the roadway.

emergency escape ramp A roadway leaving the main roadway designed for the purpose of slowing and stopping out-of-control vehicles away from the main traffic stream.

lane A strip of roadway used for a single line of vehicles.

lateral clearance The distance from the edge of traveled way to a roadside object.

operating speed The speed at which drivers are observed operating their vehicles during free-flow conditions. The 85th percentile of the distribution of observed speeds is most frequently used.

posted speed The maximum legal speed as posted on a section of highway using regulatory signs.

passing lane An auxiliary lane on a two-lane highway used to provide the desired frequency of safe passing zones.

roadway The portion of a highway, including shoulders, for vehicular use.

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.

slow-moving vehicle turnout A widened shoulder area to provide room for a slow-moving vehicle to pull safely out of the through traffic, allow vehicles following to pass, and return to the through lane.

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.

warrant A minimum condition for which an action is authorized. Meeting a warrant does not attest to the existence of an unsafe or undesirable condition. Further justification is required.

1010.04 Climbing Lanes

(1) General

Climbing lanes normally are associated with truck traffic, but they may also be considered in recreational or other areas that are subject to slow-moving traffic. Climbing lanes are designed independently for each direction of travel.

Generally, climbing lanes are provided when the requirements of two warrants speed reduction and level of service are exceeded. The requirements of either warrant may be waived if, for example, slow-moving traffic is demonstrably causing a high accident rate or congestion that could be corrected by the addition of a climbing lane. However, under most conditions, climbing lanes are built when the requirements of both warrants are satisfied.

(2) Warrant No. 1 - Speed Reduction

Figure 1010-2a shows how the percent and length of grade affect vehicle speeds. The data are based on a typical truck.

The maximum entrance speed, as reflected on the graphs, is 60 miles per hour. This is the maximum value regardless of the posted speed of the highway. When the posted speed is above 60 miles per hour, use 60 miles per hour in place of the posted speed. Examine the profile at least $\frac{1}{4}$ mile preceding the grade to obtain a reasonable approach speed.

If a vertical curve makes up part of the length of grade, approximate the equivalent uniform grade length.

Whenever the gradient causes a 10 mile per hour speed reduction below the posted speed limit a for typical truck for either two-lane or multilane highways, the speed reduction warrant is satisfied (see Figure 1010-2b for an example).

(3) Warrant No. 2 - Level of Service (LOS)

The level of service warrant for two-lane highways is fulfilled when the upgrade traffic volume exceeds 200 vehicles per hour and the upgrade truck volume exceeds 20 vehicles per hour. On multilane highways, use Figure 1010-3.

(4) Design

When a climbing lane is justified, design it in accordance with Figure 1010-4. Provide signing and delineation to identify the presence of the auxiliary lane. Begin climbing lanes at the point where the speed reduction warrant is met and end them where the warrant ends for multilane

highways and 300 feet beyond for two-lane highways. Consider extending the auxiliary lane over the crest to improve vehicle acceleration and sight distance.

Design climbing lane width equal to that of the adjoining through lane and at the same cross slope as the adjoining lanes. When ever possible, maintain the shoulder width for the class of highway. However, on two-way two-lane highways, the shoulder may be reduced to 4 feet, with justification.

1010.05 Passing Lanes

(1) General

Passing lanes are desirable where a sufficient number and length of safe passing zones do not exist and the speed reduction warrant for a climbing lane is not satisfied. Figure 1010-5 may be used to determine whether a passing lane is recommended.

(2) Design

When a passing lane is justified, design it in accordance with Figure 1010-6. Make the lane long enough to permit several vehicles to pass. Passing lanes longer than 2 miles can cause the driver to lose the sense that the highway is basically a two-lane facility. Where practicable, locate passing lanes on an upgrade to increase their efficiency.

Passing lanes are preferably four-lane sections; however, a three-lane section may be used. When a three-lane section is used, alternate the direction of the passing lane at short intervals to ensure passing opportunities for both directions and to discourage illegal actions of frustrated drivers.

Make the passing lane width equal to the adjoining through lane and at the same cross slope. Full-width shoulders for the highway class are preferred; however, with justification, the shoulders may be reduced to 4 feet. Provide adequate signing and delineation to identify the presence of an auxiliary lane.

1010.06 Slow-Moving Vehicle Turnouts

(1) General

On a two-lane highway where passing is unsafe, a slow-moving vehicle is required (See RCW 46.61.427) to turn off the through lane wherever a safe turnout exists, in order to permit the vehicles following to proceed. A slow-moving vehicle is one that is traveling at a speed less than the normal flow of traffic, behind which five or more vehicles are formed in a line.

A slow-moving vehicle turnout is not an auxiliary lane. Its purpose is to provide sufficient room for a slow-moving vehicle to safely pull out of through traffic and stop if necessary, allow vehicles following to pass, then return to the through lane. Generally, a slow-moving vehicle turnout is provided on existing roadways where passing opportunities are limited, where slow-moving vehicles such as trucks and recreational vehicles are predominant, and where the cost to provide a full auxiliary lane would be prohibitive.

(2) Design

Base the design of a slow-moving vehicle turnout primarily on sound engineering judgment and Figure 1010-7. Design may vary from one location to another. A minimum length of 100 feet provides adequate storage, since additional storage is provided within the tapers and shoulders. The maximum length is 1/4 mile including tapers. Surface turnouts with a stable unyielding material such as BST or HMA with adequate structural strength to support the heavier traffic.

Locate slow-moving vehicle turnouts where at least design stopping sight distance (See Chapter 650) is available, decision sight distance is preferred, so that vehicles can safely reenter the through traffic. Sign slow-moving vehicle turnouts to identify their presence.

When a slow-moving vehicle turnout is to be built, document the need for the turnout, the location of the turnout, and why it was selected over a passing or climbing lane.

1010.07 Shoulder Driving for Slow Vehicles

(1) General

For projects where climbing or passing lanes are justified, but are not within the scope of the project, or where meeting the warrants for these lanes is borderline, the use of a shoulder driving section is an alternative.

Review the following when considering a shoulder driving section:

- Horizontal and vertical alignment
- Character of traffic
- Presence of bicycles
- Clear zone (See Chapter 700)

(2) Design

When designing a shoulder for shoulder driving, locate where full design stopping sight distance (speed/path/direction decision sight distance is desirable) and a minimum length of 600 feet are available. Where practicable, avoid sharp horizontal curves. The minimum shoulder width is 10 feet, with 12 feet preferred. When barrier or other roadside objects are present, the minimum width is 12 feet. The shoulder width depends on the vehicles that will be using the shoulder. Where trucks will be the primary vehicle using the shoulder, use a 12-foot width; when passenger cars are the primary vehicle, a 10-foot width may be used. Shoulder driving and bicycles are not compatible. When the route has been identified as a local, state, or regional significant bike route, shoulder driving for slow vehicles is undesirable. Adequate structural strength for the anticipated traffic is necessary and may require reconstruction. Select locations where the side slope meets the requirements of Chapter 640 for new construction and Chapter 430 for existing roadways. When a transition is required at the end of a shoulder driving section, use a 50:1 taper.

Signing for shoulder driving is required. Install guideposts when shoulder driving is to be permitted at night.

Document the need for shoulder driving and why a lane is not being built.

1010.08 Emergency Escape Ramps

(1) General

Consider an emergency escape ramp whenever long, steep down grades are encountered. In this situation, the possibility exists of a truck losing its brakes and going out of control at a high speed. Consult local maintenance personnel and check traffic accident records to determine if an escape ramp is justified.

(2) Design

(a) **Type.** Escape ramps include the following types:

- Gravity escape ramps are ascending grade ramps paralleling the traveled way. They are commonly built on old roadways. Their long length and steep grade can present the driver with control problems, not only in stopping, but with rollback after stopping. Gravity escape ramps are the least desirable design.
- Sand pile escape ramps are piles of loose, dry sand dumped at the ramp site, usually not more than 400 feet in length. The deceleration is usually high and the sand can be affected by weather conditions; therefore, they are less desirable than arrester beds. However, where space is limited they may be suitable.
- Arrester beds are parallel ramps filled with smooth, free-draining gravel. They stop the out-of-control vehicle by increasing the rolling resistance. Arrester beds are commonly built on an up grade to add the benefit of gravity to the rolling resistance. However, successful arrester beds have been built on a level or descending grade.
- *The Dagnet Vehicle Arresting Barrier.* (See Chapter 710 for additional information.)

(b) **Location.** The location of an escape ramp will vary depending on terrain, length of grade, and roadway geometrics. The best locations include in advance of a critical curve, near the bottom of a grade, or before a stop. It is desirable that the ramp leave the roadway on a tangent at least 3 miles from the beginning of the down-grade.

(c) **Length.** Lengths will vary depending on speed, grade, and type of design used. The minimum length is 200 feet. Calculate the stopping length using the following equation:

$$L = \frac{V^2}{0.3(R \pm G)}$$

Where:

- L = stopping distance (ft)
- V = entering speed (mph)
- R = rolling resistance (see Figure 1010-1)
- G = grade of the escape ramp (%)

Speeds of out-of-control trucks rarely exceed 90 mph; therefore, an entering speed of 90 mph is preferred. Other entry speeds may be used when justification and the method used to determine the speed are documented.

Material	R
Roadway	1
Loose crushed aggregate	5
Loose noncrushed gravel	10
Sand	15
Pea gravel	25

Rolling Resistance (R)
Figure 1010-1

(d) **Width.** The width of each escape ramp will vary depending on the needs of the individual situation. It is desirable for the ramp to be wide enough to accommodate more than one vehicle. The desirable width of an escape ramp to accommodate two out-of-control vehicles is 40 feet and the minimum width is 26 feet.

(e) The following items are additional considerations in the design of emergency escape ramps:

- If possible, at or near the summit, provide a pull-off brake-check area. Also, include informative signing about the upcoming escape ramp in this area.
- A free-draining, smooth, noncrushed gravel is preferred for an arrester bed. To assist in smooth deceleration of the vehicle, taper the depth of the bed from 3 inches at the entry to a full depth of 18 to 30 inches in not less than 100 feet.

- Mark and sign in advance of the ramp. Discourage normal traffic from using or parking in the ramp. Sign escape ramps in accordance with the guidance contained in the MUTCD for runaway truck ramps.
- Provide drainage adequate to prevent the bed from freezing or compacting.
- Consider including an impact attenuator at the end of the ramp if space is limited.
- A surfaced service road adjacent to the arrester bed is needed for wreckers and maintenance vehicles to remove vehicles and make repairs to the arrester bed. Anchors are desirable at 300-foot intervals to secure the wrecker when removing vehicles from the bed.

A typical example of an arrester bed is shown in Figure 1010-8.

Include justification, all calculations, and any other design considerations in the documentation of an emergency escape ramp documentation.

1010.09 Chain-Up Areas

Provide chain-up areas to allow chains to be put on vehicles out of the through lanes at locations where traffic enters chain enforcement areas. Provide chain-off areas to remove chains out of the through lanes for traffic leaving chain enforcement areas.

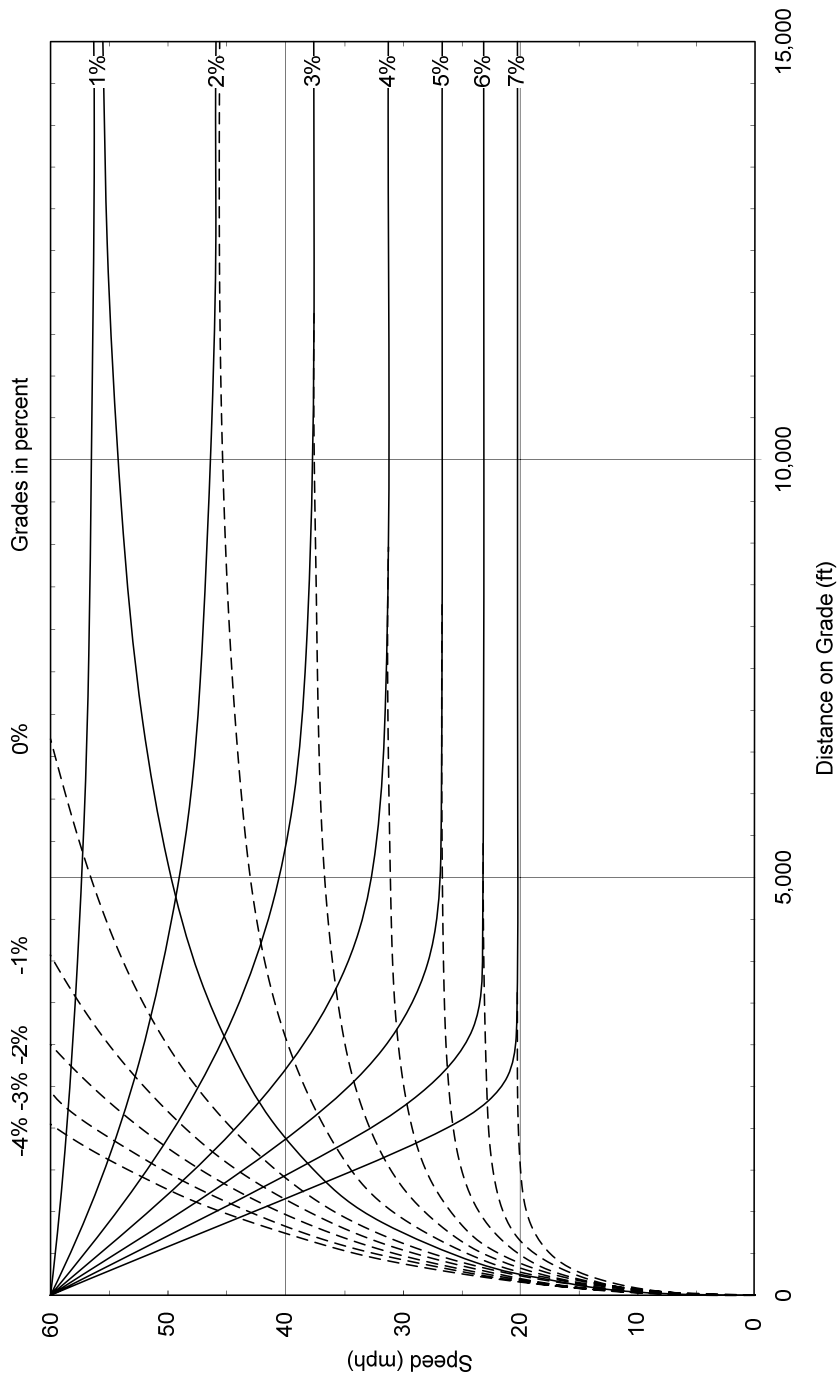
Chain-up or chain-off areas are widened shoulders, designed as shown in Figure 1010-9. Locate chain-up and chain-off areas where the grade is 6% or less and preferably on a tangent section.

Consider illumination for chain-up and chain-off areas on multilane highways. When deciding whether or not to install illumination, consider traffic volumes during the hours of darkness and the availability of power.

1010.10 Documentation

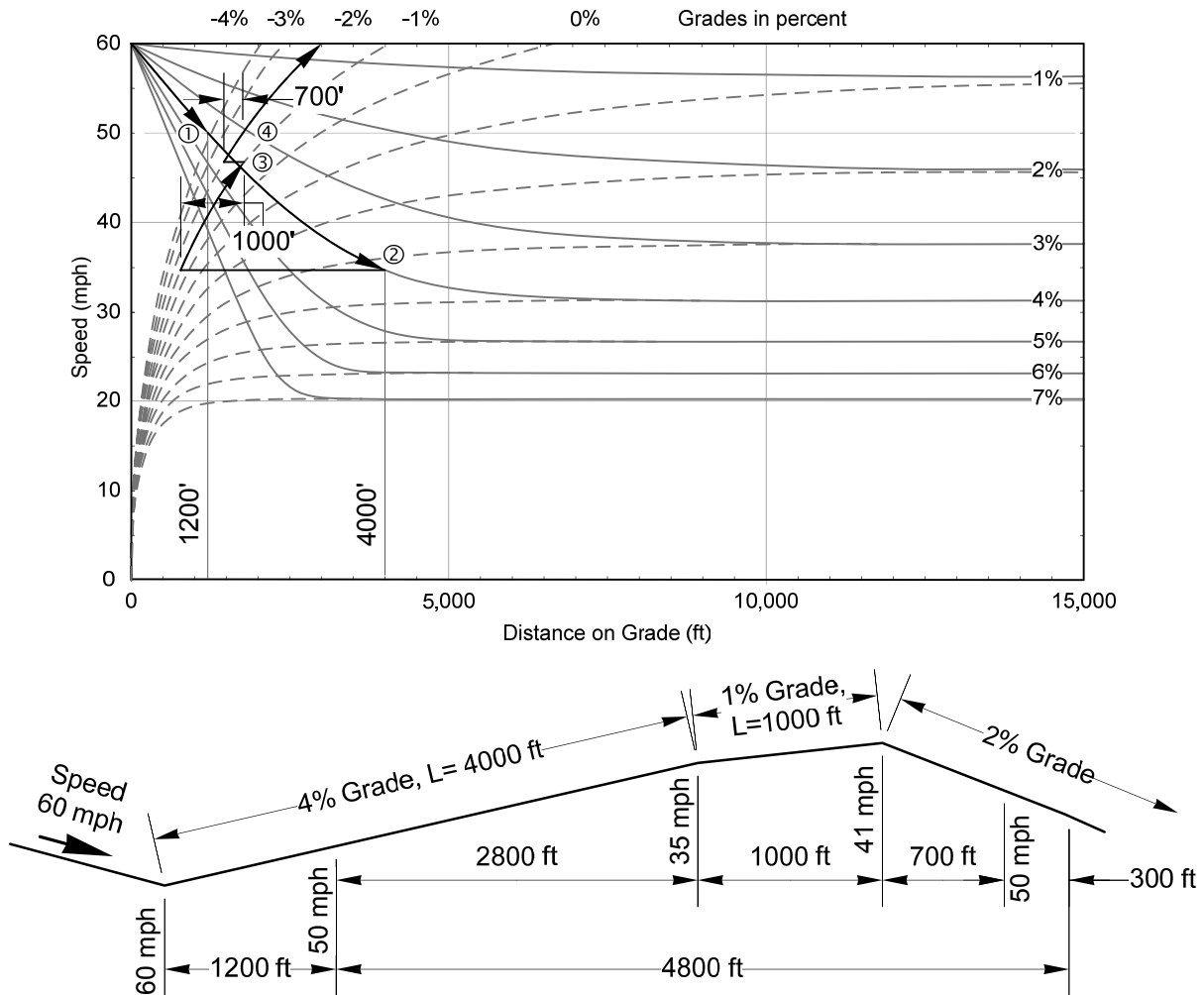
The list of documents required to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>



Speed Reduction Warrant (Performance for Trucks)

Figure 1010-2a



Given:

A two-lane highway meeting the level of service warrant, with the above profile, and a 60 mph posted speed.

Determine:

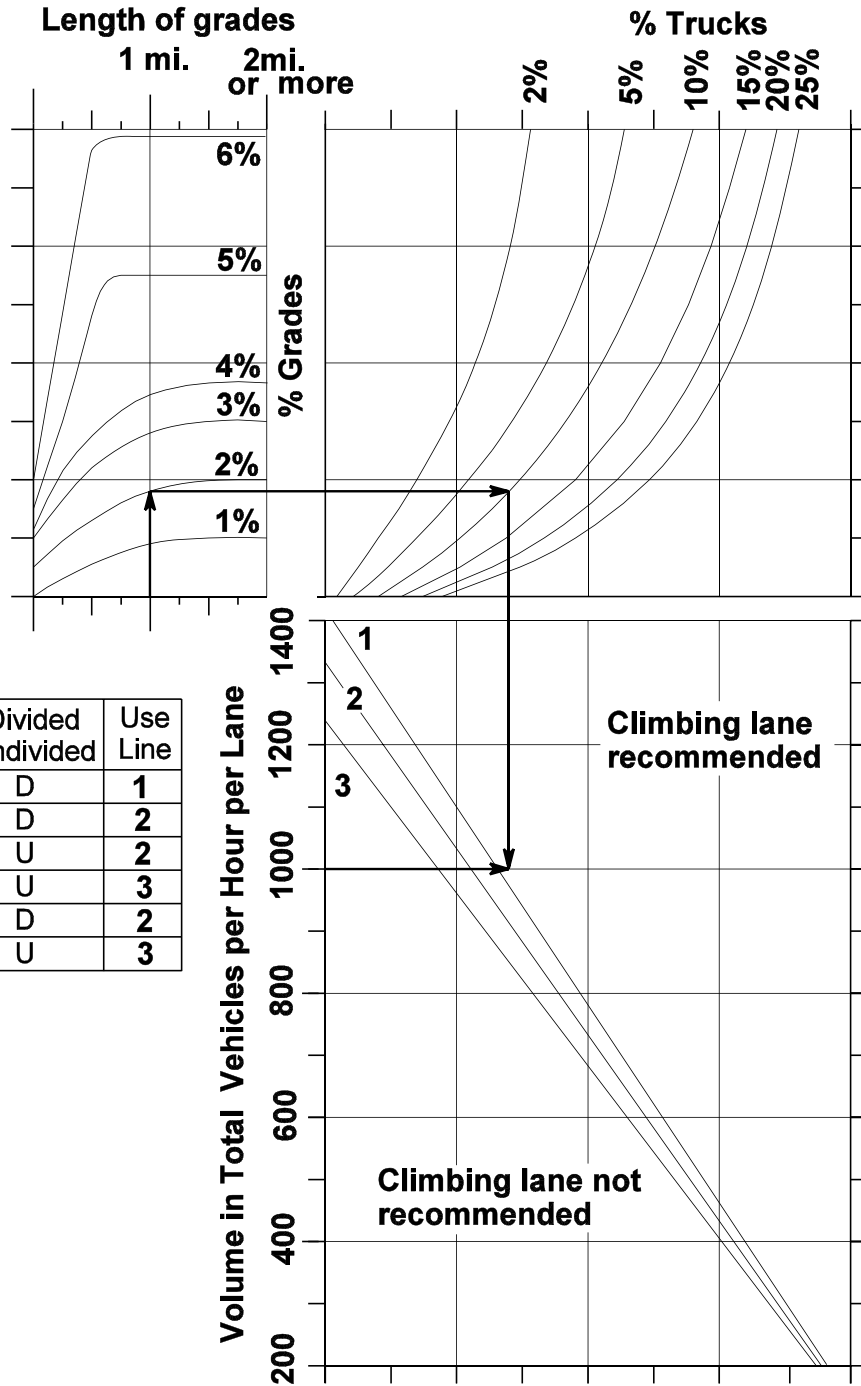
Is the climbing lane warranted and, if so, what length?

Solution:

1. Follow the 4% grade deceleration curve from a speed of 60 mph to a speed of 50 mph at 1,200 feet. The speed reduction warrant is met and a climbing lane is needed.
2. Continue on the 4% grade deceleration curve to 4,000 feet. Note that the speed at the end of the 4% grade is 35 mph.
3. Follow the 1% grade acceleration curve from a speed of 35 mph for 1,000 feet. Note that the speed at the end of the 1% grade is 41 mph.
4. Follow the -2% grade acceleration curve from a speed of 41 mph to a speed of 50 mph, ending the speed reduction warrant. Note the distance required is 700 feet.
5. The total auxiliary lane length is $(4,000 - 1,200) + 1,000 + 700 + 300 = 4,800$ feet. 300 feet is added to the speed reduction warrant for a two-lane highway. (See the text and Figure 1010-4.)

Speed Reduction Warrant (Example)

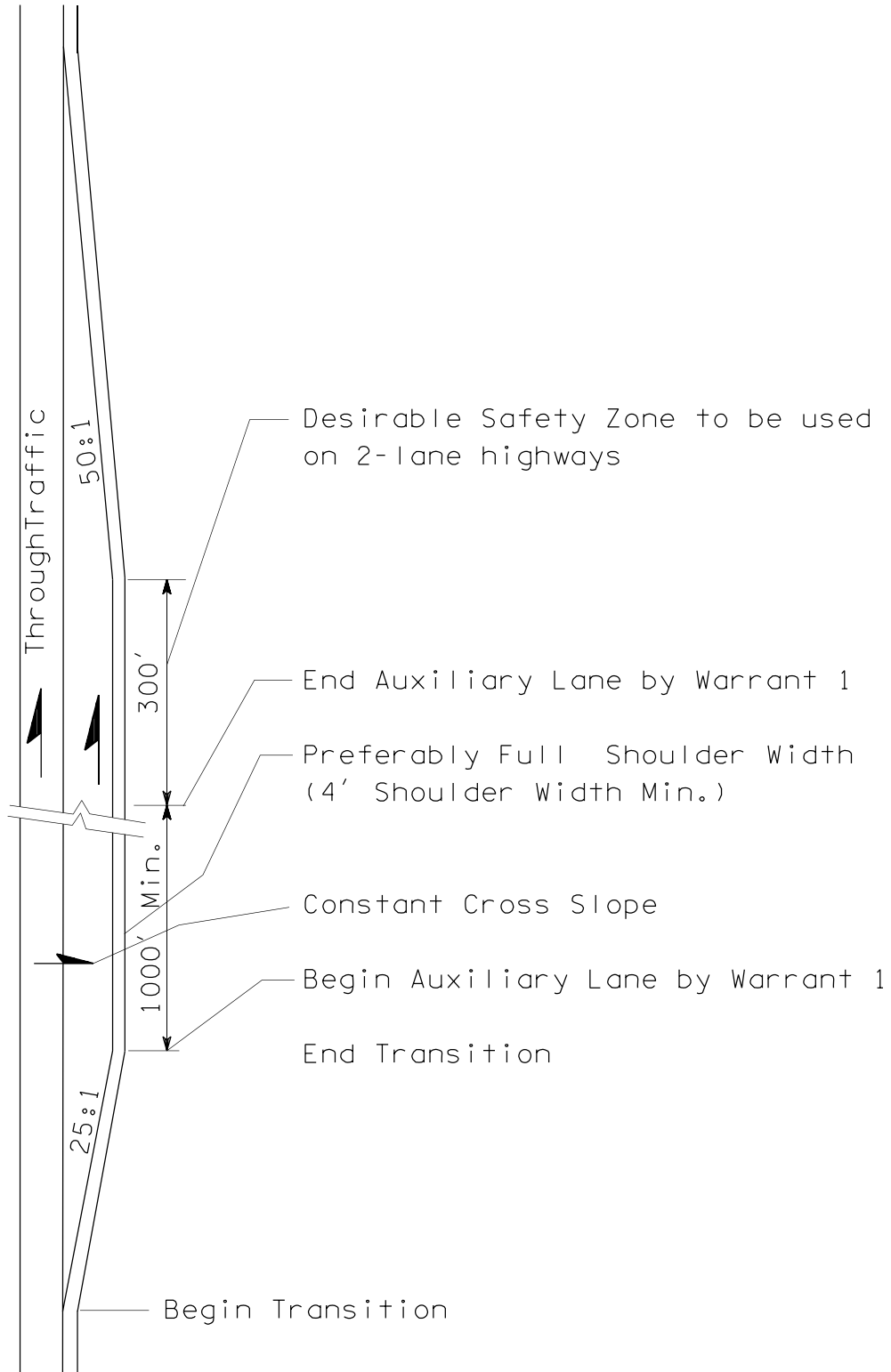
Figure 1010-2b



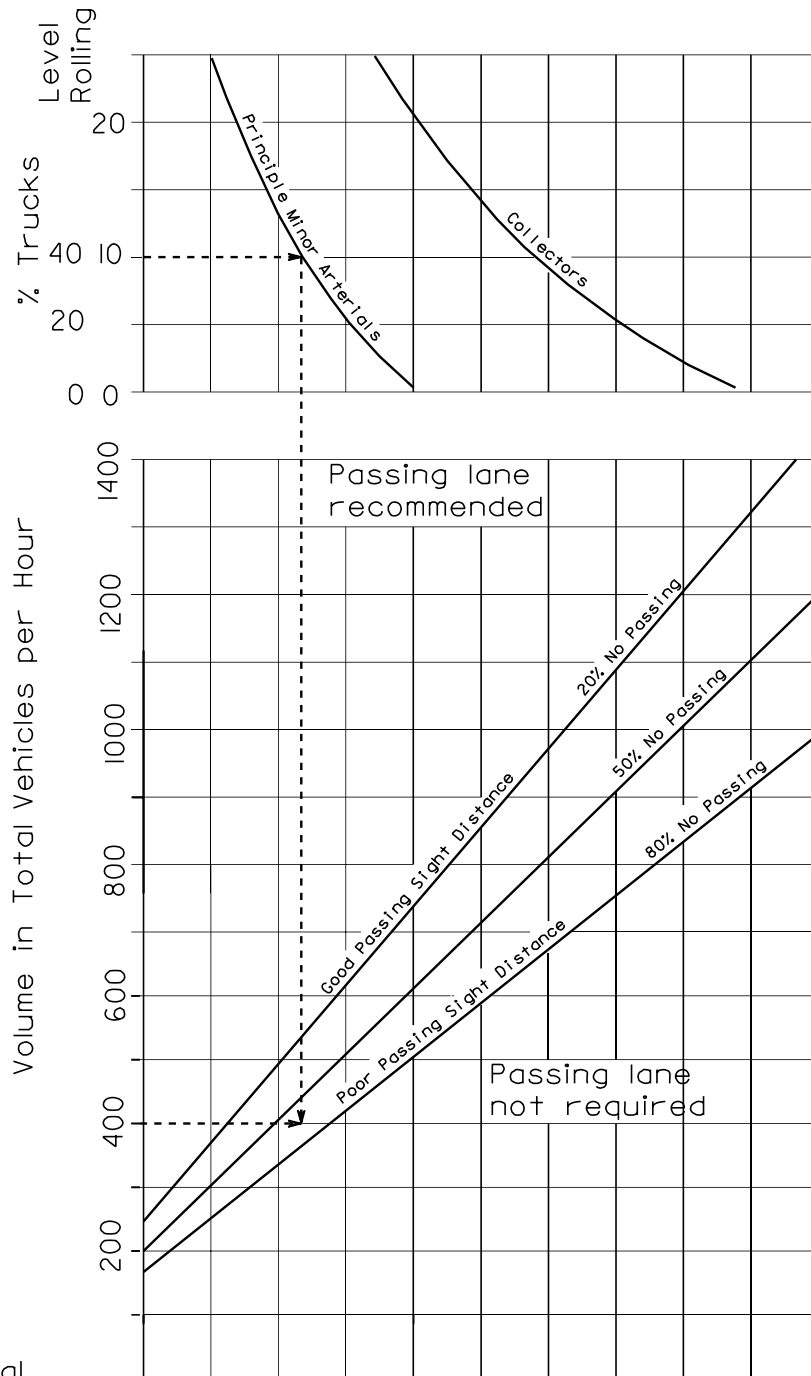
Example

2% grade for 1 Mile
10% Trucks
12' Lanes
Lateral Clearance
≥ 6'
4 Lane, Divided
DDHV = 2000
From the chart,
climbing lane
is recommended

Level of Service Warrant - Multilane
Figure 1010-3



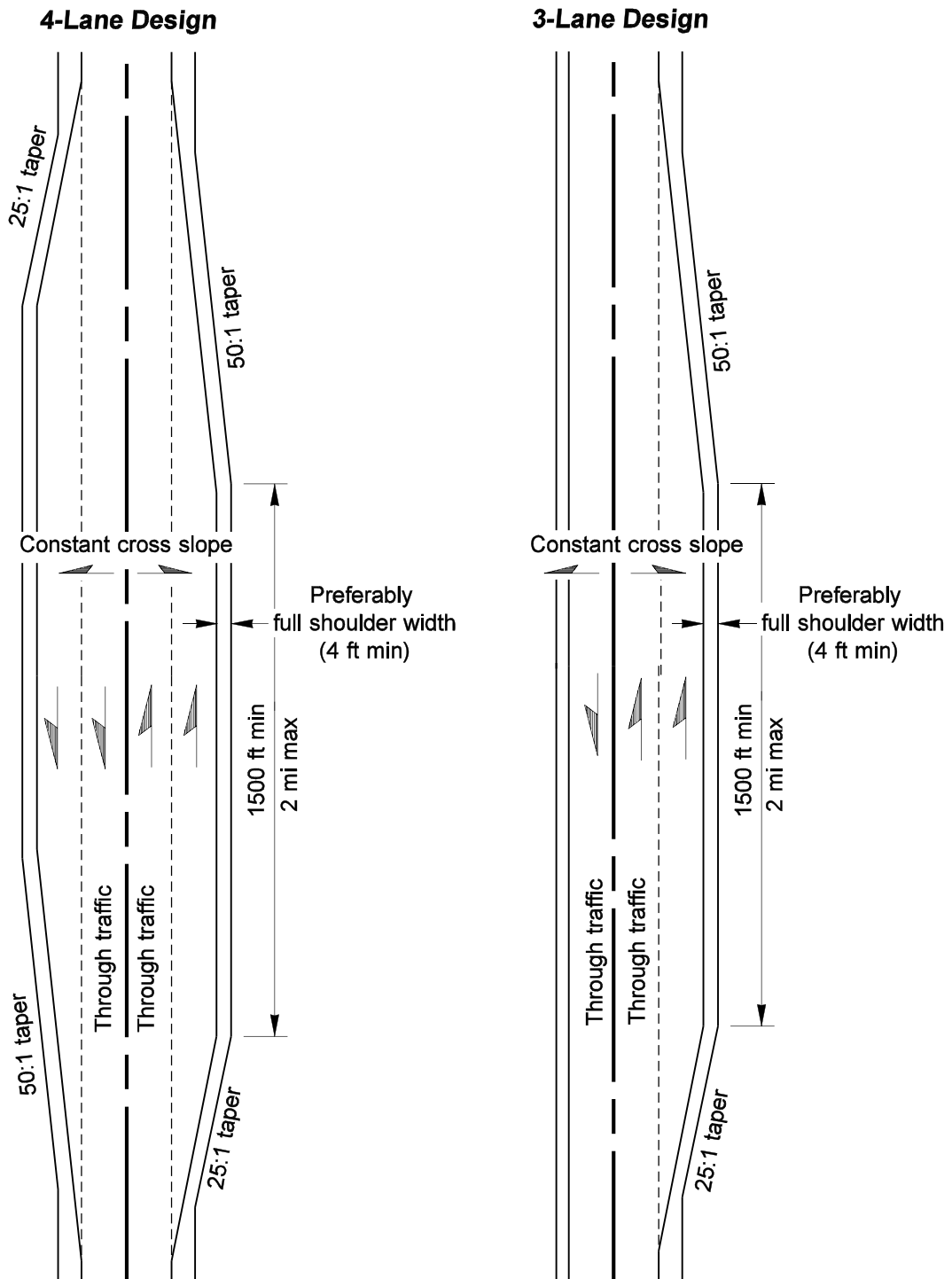
Auxiliary Climbing Lane
Figure 1010-4



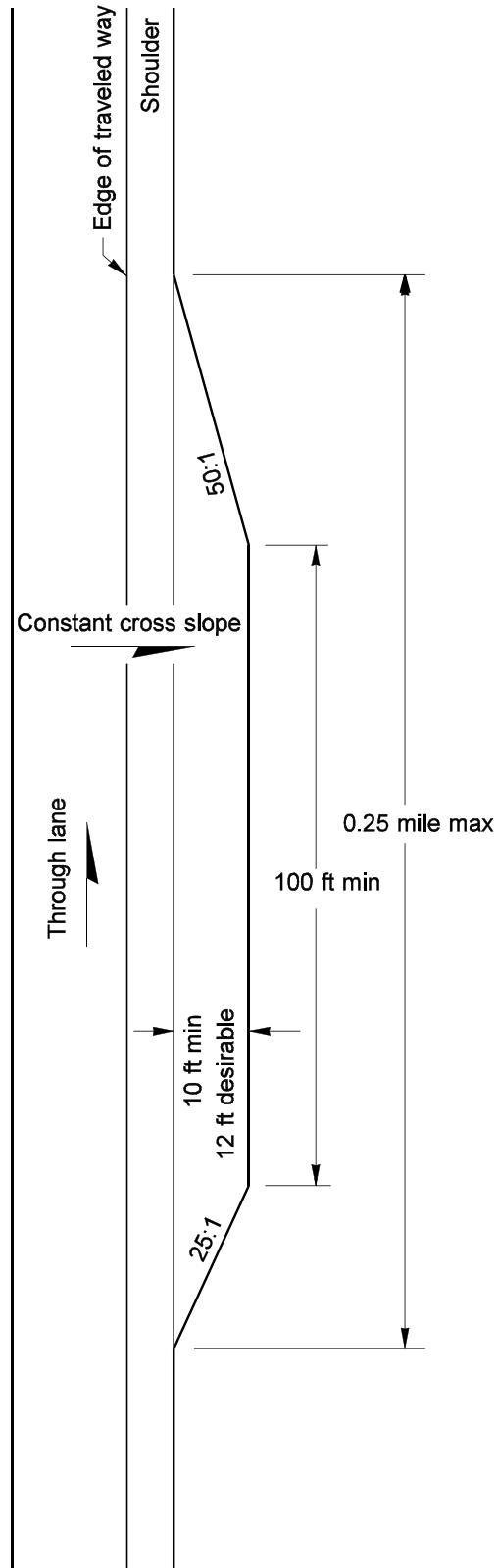
EXAMPLE

For a Minor Arterial
 Given: DHV=400 VPH
 10% Trucks
 50% No Passing Zones
 Rolling Terrain
 From the Chart, Passing Lane NOT Required.

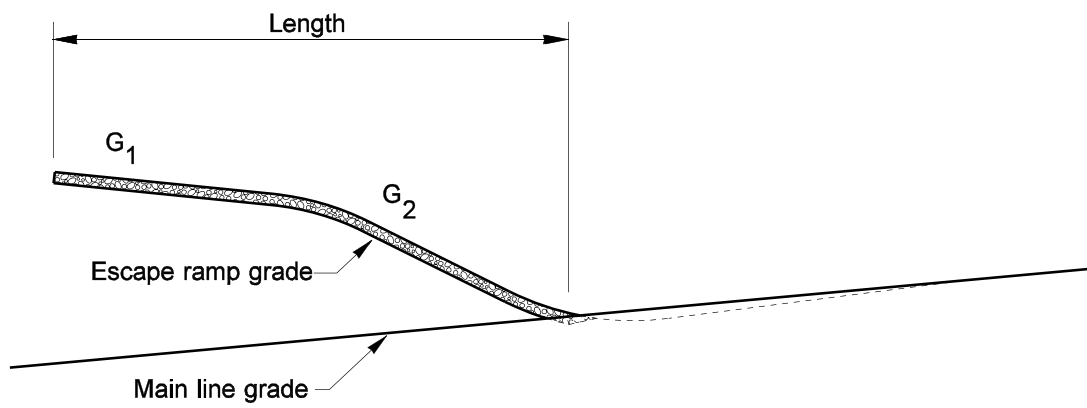
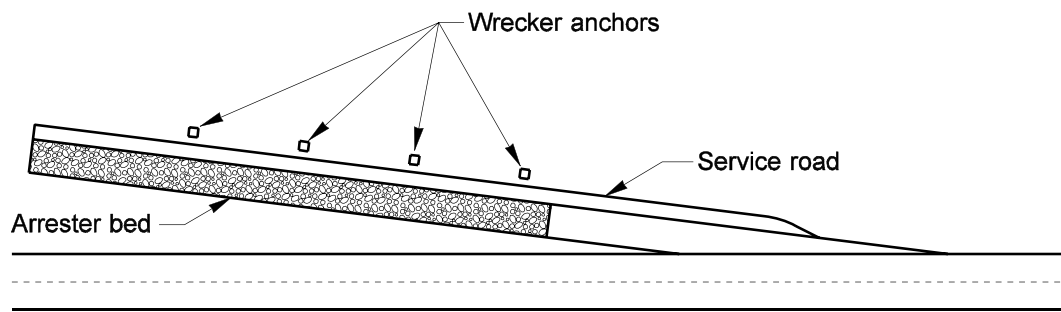
Warrant for Passing Lanes
Figure 1010-5



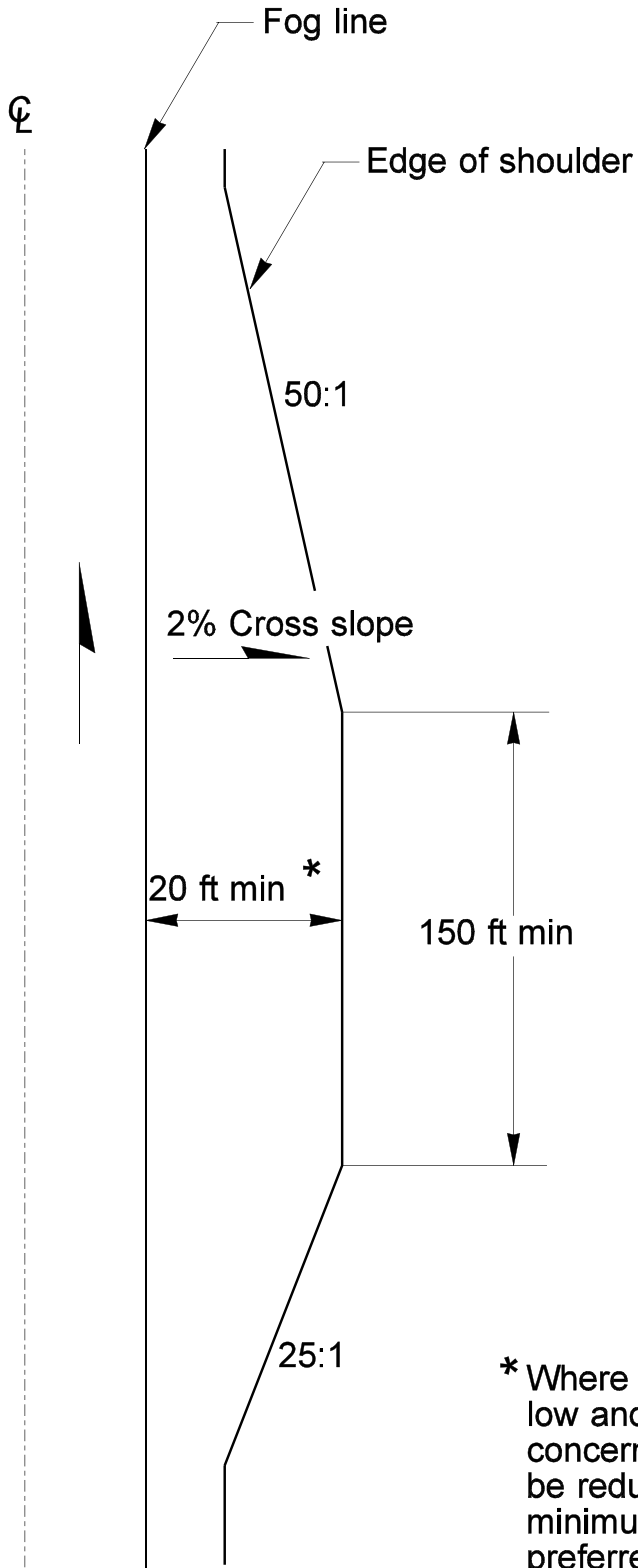
Auxiliary Passing Lane
Figure 1010-6



Slow-Moving Vehicle Turnout
Figure 1010-7



Typical Emergency Escape Ramp
Figure 1010-8



* Where traffic volumes are low and trucks are not a concern, the width may be reduced to 10 ft minimum with 15 ft preferred.

Chain Up/Chain Off Area
Figure 1010-9

- 1025.01 General
- 1025.02 References
- 1025.03 Definitions
- 1025.04 Policy
- 1025.05 Pedestrian Facility Design
- 1025.06 Documentation

1025.01 General

Pedestrians are present on most highways and transportation facilities, yet their travel mode differs vastly and sometimes is in conflict with the requirements for vehicular travel. Pedestrian travel is a vital transportation mode. It is used at some point by nearly all citizens and is the main link to everyday life for many others. Pedestrians vary in their physical abilities; this variation must be accommodated in design to allow near universal access. Keep the pedestrian space free of obstacles. In areas of heavy snowfall, avoid using the pedestrian space for snow storage. The challenge is to provide safe and efficient facilities that address these two interests within a limited amount of right of way.

1025.02 References

(1) Law

Laws and codes (both federal and state) that may pertain to this chapter include the following:

23 *Code of Federal Regulations* (CFR) Part 652

28 CFR Part 35

28 CFR Part 36, Appendix A, as revised July 1, 1994

49 CFR Part 27 (Authority: Section 504 of the Rehabilitation Act of 1973, as amended – 29 USC 794)

Manual on Uniform Traffic Control Devices, USDOT, FHWA; including the *Washington State Modifications* to the MUTCD, Chapter 468-95 WAC, (MUTCD).

<http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm>

Revised Code of Washington (RCW) 35.68, “Sidewalks, Gutters, Curbs and Driveways – All Cities and Towns”

RCW 35.78, “Streets – Classification and Design Standards”

RCW 46.04.160, “Crosswalk”

RCW 46.61.235, “Crosswalk”

RCW 46.61.240, “Crossing at other than crosswalks”

RCW 46.61.261, “Sidewalks, Crosswalks – Pedestrians, Bicycles”

RCW 47.24.010, City streets as part of state highways, “Designation – Construction, maintenance – Return to city or town”

RCW 47.24.020, City streets as part of state highways, “Jurisdiction, control”

RCW 47.30.030, “Facilities for Non-Motorized Traffic”

RCW 47.30.050, “Expenditures for Paths and Trails”

(2) Design Guidance

The following contain guidance that is included by reference within the text:

Roadside Manual, M 25-30, WSDOT

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

Understanding Flexibility in Transportation Design – Washington, WSDOT, 2005

(3) Supporting Information

The following were used in the development of this chapter or contain additional information:

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2001

Accessible Rights-of-Way; A Design Guide, U.S. Access Board, Washington D.C.

Building a True Community: Accessible Public Rights-of-Way (Draft,) U.S. Access Board, Washington D.C.

Design Guidance, Accommodating Bicycle and Pedestrian Travel. A Recommended Approach, USDOT Policy Statement, 2001

Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide, USDOT, FHWA, 2001

Guide for the Planning, Design, and Operation of Pedestrian Facilities, AASHTO, 2004

Highway Capacity Manual, Transportation Research Board (TRB), 2000

Pedestrian Facilities Users Guide – Providing Safety and Mobility, FHWA, 2002

Pedestrian Facilities Guidebook: Incorporating Pedestrians into Washington's Transportation System, OTAK, 1997

1025.03 Definitions

accessible route A continuous unobstructed pedestrian route that connects accessible elements and spaces of a building or facility. Exterior accessible routes include parking access aisles, sidewalks, sidewalk ramps, and crosswalks at vehicular ways, walkways, ramps, paths, trails, and lifts.

ADA An abbreviation for the Americans with Disabilities Act of 1990. The ADA is a civil rights law that identifies and prohibits discrimination based on disability. The ADA requires public entities to design new facilities or alter existing facilities, including sidewalks and trails that are accessible to people with disabilities.

ADAAG ADA Accessibility Guidelines. The guidelines contain requirements that apply to new construction and alterations. Refer to the following web site:

<http://www.access-board.gov/prowac/guide/PROWGuide.htm>

Bituminous Surface Treatment (BST) A bituminous surface treatment, also known as a seal coat or chip seal, is a thin protective wearing surface that is applied to a pavement or base course. BSTs can provide a waterproof layer to

protect the underlying pavement; increased skid resistance; a fill for existing cracks or raveled surfaces; an anti-glare surface during wet weather; and an increased reflective surface for night driving. BSTs are primarily used for preventative maintenance and waterproofing of the existing pavement.

crosswalk A crosswalk is defined as:

1. The portion of the roadway between the intersection area and a prolongation or connection of the farthest sidewalk line or, in the event there are no sidewalks, then between the intersection area and a line ten feet therefrom, except as modified by a marked crosswalk (RCW 46.04.160).
2. (a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of the roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line. (b) Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by lines on the surface, which may be supplemented by contrasting pavement texture, style, or color. (MUTCD, 2003)

curb extension A curb and sidewalk bulge or extension out into the parking lane, or shoulder used to decrease the length of a pedestrian crossing and increase visibility.

detectable warning A tactile surface that can be detected by vision-impaired pedestrians. The detectable warning signals a change in the pedestrian environment, where the pedestrian is moving into a vehicular traffic area, railroad crossing, or vertical drop-off at a transit loading facility. The only acceptable warnings are truncated domes. The detectable warning must contrast with the surrounding surface.

flangeway gap The space between the inner edge of a rail and the crossing surface. The gap is of sufficient space to permit a rail car wheel to pass through; approximately 3 inches. If there is insufficient space, a derailment is possible.

landing A level area, 4 feet by 4 feet (not steeper than 2% slope in any direction), at the top and bottom of a pedestrian ramp.

midblock pedestrian crossing A marked pedestrian crossing located between intersections.

pedestrian facilities Walkways such as sidewalks, highway shoulders, walking and hiking trails, shared-use paths, pedestrian grade separations, crosswalks, and other improvements provided for the benefit of pedestrian travel. Pedestrian facilities are intended to be accessible routes.

pedestrian refuge island A raised area between traffic lanes that provides a place for pedestrians to wait to cross the roadway. Wheelchair access (cut-through) must be provided in all pedestrian refuge islands.

raised median A raised island in the center of a road used to restrict vehicle left turns and side street access. Pedestrians often use this median as a place of refuge when crossing a roadway. Raised medians must include wheelchair access (cut through).

rural area An area that meets none of the conditions to be an urban area.

suburban area A term for the area at the boundary of an urban area. Suburban settings may combine the higher speeds common in rural areas with activities that are more similar to urban settings.

traffic calming A set of self-enforcing engineered techniques designed to reduce the speed and aggressiveness of traffic. Strategies include lane narrowing, sidewalk extensions, surface variations, and visual clues in the vertical plane.

train dynamic envelope The clearance required for a train and its cargo overhang due to any combination of loading, lateral motion, or suspension failure.

truncated domes Truncated domes are small raised protrusions of between 7/8 inch and 1 7/16 inch in diameter and 3/16 inch in height arranged in a distinctive pattern that is readily detected and recognized by a vision-impaired person using a cane for guidance. The Standard Plans show the appropriate pattern and dimensions.

urban area An area defined by one or more of the following:

- An area including and adjacent to a municipality or other urban place having a population of 5000 or more, as determined by the latest available published official federal census (decennial or special), within boundaries to be fixed by a state highway department, subject to the approval of the FHWA.
- Within the limits of an incorporated city or town.
- Characterized by intensive use of the land for the location of structures and receiving such urban services as sewer, water, and other public utilities and services normally associated with an incorporated city or town.
- With not more than 25% undeveloped land.

1025.04 Policy

(1) General

Pedestrian facilities are required along and across sections of state routes and city streets, and are an integral part of the transportation system. FHWA policy (23 CFR 652.5) suggests that safe bicycle and pedestrian facilities be given full consideration on all federal aid highway improvement projects. Provide ADA-compliant pedestrian facilities on highway projects unless one or more of the three conditions below are met:

- Pedestrians are prohibited by law from using the facility.
- The cost of the improvements is excessive and disproportionate to the original need or probable use (as a guide, more than 20% of the project estimate). In these instances, evaluate options to modify the scope of the pedestrian improvements or investigate funding for a separate pedestrian project. Any improvement must comply with ADA accessibility requirements. Include documentation of the results of the investigation for funding a separate pedestrian project.
- Low population density or other factors (such as a lack of pedestrian generators within a quarter-mile radius of the project) indicate there is no need.

Consider whether the project is within a city or an urban growth area that is intended to be ultimately developed as an urban density area, which will be served by urban services including transit. Inside incorporated cities, design pedestrian facilities in accordance with the city design standards adopted in accordance with RCW 35.78.030. Exceptions to adopted design standards require a deviation approved by the designated authority identified in Chapter 330.

(2) Jurisdiction

When city streets form a part of the state highway system within the corporate limits of cities and towns, the city has full responsibility for and control over any such street beyond the curbs and, if no curb is installed, beyond that portion of the highway used for highway purposes. (See RCW 47.24.020.) Proposed projects that will damage or remove existing sidewalks or other walkways within the city's jurisdiction must include reconstruction of these facilities. This jurisdictional distinction does not relieve the agency (or agencies) initiating a project from addressing ADA compliance.

The title to limited access facilities within incorporated cities and towns remains with the state. Within these areas the state maintains full jurisdiction, responsibility, and control as provided in RCW 47.24.20.

(3) Full Access Control

Walking and hiking trails and shared-use paths within the right of way are separated from vehicular traffic with physical barriers. These facilities can connect with other facilities outside the right of way once proper documentation has been obtained. Contact HQ Real Estate Services to determine the required documentation. Grade separations are provided when the trail crosses the highway.

(4) Partial or Modified Access Control

Walking trails and shared-use paths may be located between the access points of interchanges or intersections. Pedestrian crossings are usually either at grade with an intersecting crossroad or a grade separation. Consider midblock pedestrian crossings at pedestrian generators when the

roadway has the characteristics associated with an urban area and appropriate operational and geometric characteristics that allow for a crossing.

Consider providing sidewalks at signalized intersections. Evaluate extending sidewalks on a project-by-project basis.

(5) Managed Access Control

In rural areas, paved shoulders are usually used for pedestrian travel. When pedestrian activity is high, separate walkways may be provided. Sidewalks are used in urban growth areas where there is an identified need for pedestrian facilities.

Consider providing sidewalks at signalized intersections. Evaluate extending sidewalks on a project-by-project basis.

Trails and paths, separated from the roadway alignment, are used to connect areas of community development. Pedestrian crossings are typically at grade.

(6) ADA Compliance

Detectable warnings are required on all vehicular roadway and railroad crossings intended for pedestrian use.

Improvement projects address the construction of a new roadway or produce major modifications to an existing roadway. In these projects, the pedestrian's needs are assessed and included, when applicable. Develop the pedestrian facilities consistent with the requirements listed in Figure 1025-2, using the ADA Standards for Improvement Projects column.

Preservation projects on state highways (except for BSTs) are considered alterations of the roadway. Address pedestrian needs and include, to the maximum extent feasible, access for persons with disabilities. If an existing sidewalk ramp adjacent to the roadway meets the ADA minimums for preservation projects in the Preservation Projects column in Figure 1025-2, no further action is required. If an existing ramp does not meet the ADA minimums, then it will need to be removed and constructed or modified to meet the standards for improvement projects, unless installing truncated domes would meet requirements.

It is not always feasible or even possible to build pedestrian facilities to full ADA standards (as shown in the column ADA Standards for Improvement Projects) in preservation projects or alterations. When this is the case, the ADA minimums for preservation projects are applicable.

In these circumstances, the alteration shall provide the maximum physical accessibility feasible. Any altered features of the facility that can be made accessible shall be made accessible.

When a preservation project is going through an area with pedestrian facilities that meet these requirements, no other action is necessary at this time. The agency (or agencies) initiating the project is responsible for funding this work.

1025.05 Pedestrian Facility Design

(1) Facilities

The type of pedestrian facility provided is based on local transportation plans, the roadside environment, pedestrian volumes, user age group, safety-economic analysis, and continuity of local walkways along or across the roadway. Sidewalks can be either immediately adjacent to streets and highways or separated from them by a buffer.

The type of walkway also depends on the access control of the highway as follows:

(2) Pedestrian Travel Along Streets and Highways

(a) **General.** Examples of various types of pedestrian walkways are shown in Figures 1025-3a and 3b. A generalized method of assessing the need for and adequacy of pedestrian facilities can be found in Figure 1025-4. These guidelines do not establish minimum requirements. Consider a study which addresses roadway classification, traffic speed, crash data, pedestrian generators, school zones, transit routes, and land use designation to assist in facility choices.

The minimum clear width for an ADA-accessible route is 4 feet. Utility poles and other fixtures located in the sidewalk can be obstacles for pedestrians with disabilities. To the maximum extent possible, provide a continuous unobstructed route for pedestrians

with disabilities. When an unobstructed route is not feasible, provide an ADA-compliant route around these obstructions. When relocation of these utility poles and other fixtures is necessary in a project, determine the impact of their new location on any pedestrian walkways. Utility vaults and junction boxes with special lids are used for installations in sidewalks to reduce tripping hazards. Improvement projects might provide opportunities to eliminate existing utilities that are obstructions in the pedestrian route.

Hanging or protruding objects within the walkway present obstacles for pedestrians with visual impairments. The minimum vertical clearance for objects overhanging a walkway, including signs, is 7 feet. Objects that protrude more than 4 inches into the walkway are considered to be obstacles, and warning devices are necessary. Wall-mounted and post-mounted objects that protrude 4 inches or more into the walkway between 27 inches and 80 inches above the sidewalk shall be equipped with warning devices detectable by persons with impaired vision using a cane.

Where the walkway is located behind guardrail, cut off protruding guardrail bolts or install a rub rail to prevent snagging on the bolts. Specify these construction requirements in the contract.

Provide a smooth finish to vertical concrete surfaces adjacent to a pedestrian facility to prevent snagging or abrasive injuries from accidental contact with the surface.

(b) **Shoulders.** Paved shoulders are an acceptable pedestrian facility along rural roadways. Pedestrian activity is usually minimal along rural roadways. Determine if the roadway's shoulders are of sufficient width and condition to permit safe travel for pedestrians. In urban areas, a shoulder can provide a buffer between the vehicle and the pedestrian facility. Paved shoulders are preferable for an all-weather walking surface and for ADA compliance. A 4-foot-wide shoulder is acceptable where pedestrian activity is minor. Wider shoulders, up to 8 or 10 feet, are desirable along high-speed highways, particularly when truck volumes are high or pedestrian activities are high. Longitudinal travel along shoulders with cross

slopes greater than 2% can be difficult for people with mobility disabilities. Horizontal curves are usually superelevated and can have cross slopes steeper than 2%. The shoulders on these curves often have the same cross slope as the roadway. In rural areas, the probability of a shoulder being used by someone in a wheelchair is remote. However, if pedestrians use the shoulder frequently, consider flattening the shoulder cross slope or provide a separate pedestrian route. (See Chapter 640 when flattening the shoulder slope.)

(c) **Shared-Use Paths.** Shared-use paths are used by pedestrians and bicyclists. Shared-use paths that function as sidewalks must comply with ADA sidewalk requirements. Pedestrian facilities differ from bicycle facilities in their design requirements and goals, and they are not always compatible. When it is determined that a shared-use path is in the best interests of both groups, see Chapter 1020, “Bicycle Facilities.”

(d) **Walking Trails.** Walking trails are considered on a project-by-project basis. Trails that function as sidewalks are required to meet ADA standards, and they may be unpaved. Unpaved trails, to the maximum extent possible, shall be firm and stable allowing potential wheelchair accessibility. (See Figure 1025-1 for trail width, vertical clearance, and grade guidelines.) The clear area is the cross-sectional area of the trail that is cleared of limbs, exposed roots, brush, and other obstacles that might be obstructions.

	Clear Area	Trail Width	Maximum Grade
Walking Trail	8' high & 6' wide	4'	10%
<p>* Note: When grades of 5% or more are used, provide 5-foot-square resting areas adjacent to the trail every 200 feet.</p>			

Walking Trail Guidelines
Figure 1025-1

(e) **Sidewalks.** Details for raised sidewalks are shown in the *Standard Plans*. Wherever appropriate, make sidewalks continuous and provide access to side streets. The most desirable installation for the pedestrian is a sidewalk separated from the traveled way by a planted buffer strip. Consider buffer strips of 4 feet for collector routes and 6 feet for arterial routes. If trees or shrubs are included, make sure they do not limit the visibility of motorists or pedestrians or pose hazards for persons with disabilities. (See Chapter 920.) Shoulders, bike lanes, and on-street parking can also be used to provide an adequate buffer zone for pedestrian facilities. The minimum clear width for the sidewalk is 5 feet. (See the *Standard Plans*.) Where a sidewalk is separated from the traveled way with only a curb, the minimum sidewalk width is 6 feet. Wider sidewalks are preferable in areas of high pedestrian traffic, such as a central business district (CBD), and along parks, schools and other major pedestrian generators. Sidewalks 10 to 15 feet wide may be more appropriate at these locations. Coordinate with the city for appropriate sidewalk width and participation.

In areas with heavy snowfall, consider wider sidewalks or a sidewalk with a buffer to provide snow storage and to minimize the disruption to pedestrian travel. Sidewalks and trails must be maintained to ADA requirements; thus, ensure that maintenance access is not obstructed. Consider limiting or consolidating driveways (vehicle access points). Driveways are to be constructed in accordance with ADA requirements, or provide an ADA-accessible route.

(See Chapter 1420 for access control information, and the *Standard Plans* for vehicle approach details and ADA requirements.)

Consider sidewalk enhancements such as unobstructed visibility for both motorists and pedestrians to encourage walkway use and increase pedestrian comfort.

A grade of 8.33% or less is required when the sidewalk is on an independent alignment and does not follow an adjacent roadway grade. Sidewalks located adjacent to a street or highway shall not exceed that facility's grade. On roadways with prolonged severe grades, provide railings and, to the maximum extent possible, level landings adjacent to the sidewalk at approximately 200-foot intervals as resting areas for people with physical disabilities. Design sidewalks with cross slopes no more than 2%. Steeper cross slopes are difficult for people in wheelchairs to negotiate.

The side slope adjacent to the sidewalk is a critical design element. (See Figures 1025- 3a and 3b.) On embankment slopes of 4H:1V or flatter, provide a 1-foot widening at the back of the sidewalk. On steeper embankment slopes, provide a 4-foot embankment widening or use a sidewalk design with a 2-foot widening and a raised 4-inch-high lip at the back edge of the sidewalk. When the adjacent roadway has a posted speed of 35 mph or less and there is a vertical drop-off of 2 feet 6 inches or more directly behind the sidewalk, provide a pedestrian railing when embankment widening is not possible. (See Figure 1025-3b.) Pedestrian railings are not always designed to withstand vehicular impacts or redirect errant vehicles. When a vertical drop-off is present on a higher-speed roadway, the Design Clear Zone is the primary consideration and a crash-worthy traffic barrier is required if within the Design Clear Zone. (See Chapter 700.) Where the walkway is adjacent to a vertical drop-off and is separated from the roadway, consider installing the traffic barrier between the traveled way and the walkway. The pedestrian railing is then installed between the walkway and the vertical drop-off.

(f) **Vehicle Bridges and Underpasses.** Provide provisions for pedestrians on vehicle bridges and underpasses where pedestrians are not prohibited; contact the HQ Bridge and Structures Office. Provide either raised sidewalks or ramps on the approaches to bridges when there are raised sidewalks on the bridge. The ramp is constructed of either asphalt or cement concrete and has a slope of 20H:1V or flatter. These ramps can also

be used as a transition from a raised sidewalk down to a paved shoulder. The ramp provides pedestrian access and mitigates the raised, blunt end of the concrete sidewalk.

In underpasses where pedestrians are not prohibited, providing sidewalks and maintaining the full shoulder width is desirable. When bridge columns are placed on either side of the roadway, consider placing the walkway between the roadway and the columns for pedestrian visibility and security. Adequate lighting and drainage are important for pedestrian safety and comfort.

(g) **Railroad Crossings.** Crossing railroad tracks can be difficult or even impossible for a person who requires a wheelchair, crutches, or walking aids for mobility. The concrete or rubber railroad crossings required to permit vehicle travel are extended into the shoulders of the roadway to enhance pedestrian travel. When a raised sidewalk is adjacent to the roadway, provide ramps to bring the pedestrian walkway down to the same grade as the roadway. Whenever possible, make crossings perpendicular to the tracks. In this type of installation, the truncated domes are placed at the outside edges of the train's dynamic envelope and are not placed at the bottom of the sidewalk ramp. Keep flangeway gaps to no more than 2.5 or 3 inches.

(3) **Pedestrian Crossings At Grade**

(a) **General.** The chart in Figure 1025-5 provides recommendations for determining pedestrian markings based on vehicular traffic volume and speed. Minimum lighting requirements and additional requirements are also recommended in this chart.

Pedestrian crossings are permitted along the length of most highways. Pedestrian crossing of all legs of an intersection is also permitted. An illegal pedestrian crossing only occurs when signs prohibit a particular crossing at an intersection or the crossing occurs between two adjacent signalized intersections. (See RCW 46.61.240.) When considering prohibiting a pedestrian crossing, ensure a reasonable alternative crossing is provided.

(b) **Crosswalks.** Crosswalks, whether marked or not, exist at all intersections. An unmarked crosswalk is the 10-foot-wide area across the intersection behind a prolongation of the curb or edge of the through traffic lane. (See RCW 46.04.160.) A marked crosswalk is required when the intended pedestrian route is different than that cited in the RCW. (See Figure 1025-5.) At roundabouts and intersections with triangular refuge islands or offset legs, the desired pedestrian crossings might not be consistent with the definition of an unmarked crosswalk and markings become necessary. Inside city limits where the population exceeds 22,500, the decision to mark crosswalks resides with the city subject to approval by WSDOT of the installation and type. In unincorporated areas and within cities with populations less than 22,500, WSDOT has decision authority.

Crosswalk lines are not to be used indiscriminately. Perform an engineering study before installing crosswalks away from highway traffic signals or stop signs. Evaluate the following factors at a minimum. Consider unmarked crossings as candidates for marking if:

- The crosswalk would serve 20 pedestrians per hour during the peak hour, 15 elderly and/or children per hour, or 60 pedestrians total for the highest consecutive 4-hour period.
- The crossing is on a direct route to or from a pedestrian generator, such as a school (see the MUTCD), library, hospital, senior center, community center, shopping center, park, employment center, or transit center. Generators in the immediate proximity of the highway are of primary concern. Pedestrian travel distances greater than 1/4 mile generally do not attract many pedestrians.
- The comprehensive plan includes the development of pedestrian facilities in the project vicinity.
- The location is 300 feet or more from another crossing.
- The location has decision sight distance and/or sight distance will be improved prior to marking the crossing. (See Chapter 650, "Decision Sight Distance.")
- Safety considerations do not preclude a crosswalk.

A significant pedestrian accident history may also warrant the installation or marking of a crosswalk.

For marked crosswalks, the standard crosswalk marking consists of a series of wide white lines aligned with the longitudinal axis of the roadway. Crosswalk widths of at least 6 feet and 10 feet are preferred in central business districts. The lines are positioned at the edges and centers of the traffic lanes to place them out of the normal wheel path of vehicles. This type of crosswalk is a longitudinal pattern known as a Ladder Bar and is shown in the Standard Plans. Designers are encouraged to set back stop and yield lines to ensure visibility. Stop and yield line dimensions and placement shall conform to the MUTCD.

Communities sometimes request specially textured crosswalks (consisting of colored pavement, bricks, or other materials) in community enhancement projects. These crosswalks do not always fall within the legal definition of a marked crosswalk and parallel white crosswalk lines might be necessary to define the crosswalk. (See the MUTCD or Local Agency Crosswalk Options web site, <http://www.wsdot.wa.gov/eesc/design/designstandards/psl/PM-2/pm-2.htm>.) Provide a non-slip surface, appropriate for wheelchair use.

When locating crosswalks at intersections, consider the visibility of the pedestrian from the motorist's point of view. Shrubbery, signs, parked cars, and other roadside appurtenances can block the motorist's view of the pedestrian. Figure 1025-7a illustrates these sight distance problems.

When designing crosswalks and pedestrian signals, consider the needs of older pedestrians and pedestrians with disabilities, as they might walk at a significantly slower pace than the average pedestrian. Include countdown clocks where appropriate to assist older and disabled pedestrians to determine the time remaining to cross. Determine if there are pedestrian generators in the project vicinity that might attract older and disabled pedestrians. Consult with the region's Maintenance Office regarding maintenance requirements for these devices.

Consider the use of ADAAG-compliant audible pedestrian signals where suitable for pedestrian safety. Determine if there are pedestrian generators in the project vicinity that might attract hearing-impaired pedestrians for which audible signals are appropriate. Consult with the region's Maintenance Office regarding maintenance requirements for these devices. (See Chapter 850 and the MUTCD for additional information.)

Wide, multilane streets are often difficult for pedestrians to cross, particularly when there are insufficient gaps in vehicular traffic because of heavy volumes. Consider the use of raised medians with cut-throughs on roadways with the following conditions:

- Two-way arterial street with high speeds and high average daily traffic (ADT), and large pedestrian volumes
- The crossing distance exceeds 60 feet
- Complex or irregularly shaped intersections

The minimum width of a raised median refuge area is 4 feet to accommodate people in wheelchairs. Raised medians that exceed the minimum are encouraged. Raised medians are usually too narrow to allow the installation of ramps and a level landing. When the median is 16 feet or less in width, provide a passageway wide enough to accommodate wheelchairs through the median. This passageway connects with the two separate roadways and cannot exceed a grade of 5%. Truncated domes are required on both sides of a median cut-through.

Design ramp terminals for both off-ramps and on-ramps as at-grade intersections. (See Chapters 910 and 940.)

For pedestrian safety, design turn lanes to ensure that turning speeds are kept low and sight distance is not compromised. Consider the following measures to help reduce conflict:

- Reduce turning radii
- Prohibit right turns on red
- Place crosswalks so they are visible and adjacent to the pedestrian facility
- Use a separate left-turn phase in conjunction with a "WALK/DON'T WALK" signal
- Restrict left turns at certain times

- Shorten crossing distance
- Use a raised median
- Use pedestrian signals
- Use signage
- Place crosswalks as close as practicable to the traveled way
- Provide pedestrian-level lighting

The island used for channelized right-turn slip lanes can provide a pedestrian refuge, but may promote faster turning speeds. To reduce conflicts, keep the lane as narrow as practical and attempt to maintain a 90° intersection angle. (See Chapter 910 for more information about turn lanes, Chapter 940 for more information about interchange ramps, and Chapter 915 for information about pedestrian accommodations in roundabouts.)

(c) **Managing Traffic Speed and Flow.** Curb extensions are a traffic calming measure that, when used appropriately, may increase pedestrian safety. In urban areas where vehicle speeds are in the range of 25 to 35 mph, a sidewalk curb extension is sometimes used as a traffic calming measure to help reduce traffic speeds. Parked cars can be a safety hazard for pedestrians by limiting driver visibility. Curb extensions can improve safety by placing the pedestrian at a more visible location, shortening the length of the pedestrian crossing, and reducing the pedestrian's exposure time. Curb extensions can also increase the effective sidewalk width at intersections. Extend the curb to the width of the parking lane. Consider low-level landscaping that does not create a sight obstruction and an approach nose. At intersections with traffic signals, the curb extension can be used to reduce pedestrian signal timing. Examples of sidewalk curb extensions are shown in Figure 1025-7b and 1025-8.

The right turn path of the design vehicle or the vehicle most likely to make this turn is a critical element in determining the size and shape of the curb extension. Sidewalk curb extensions tend to restrict the width of the roadway and can make right turns difficult for large trucks. Avoid interrupting bicycle traffic with curb extensions. If the route is identified as a local, state, or regional significant bike route, provide a

minimum shoulder width of 4 feet. (See Chapter 1020 for additional information.) Do not use curb extensions in any of the following circumstances on state highways:

- The Design Vehicle is required to encroach on curbs, opposing lanes, or same-direction lanes (see the *Design Vehicle* section in Chapter 910)
- Shoulder parking is not present
- The posted speed is above 35 mph

Plantings that obstruct neither pedestrian's nor driver's vision may be used as traffic calming measures by creating the illusion of narrow streets. Consider motorist and pedestrian visibility and Design Clear Zone requirements. (See Chapter 700.)

Traffic signal progressions can be used to address traffic speeds.

Consider narrower lane widths on portions of non-NHS two-lane routes to reduce the expanse of visible pavement to the motorist and help slow traffic when the following conditions exist:

- Within incorporated cities
- High pedestrian use

For minimum lane widths, see Chapters 430 and 440.

(d) **Midblock Crossings.** On roadways with pedestrian crossing traffic caused by nearby pedestrian generators, consider a midblock pedestrian crossing. (See 1025.05 (3)(b) for crosswalk criteria and Figure 1025-5 for marked crosswalk recommendations at unsignalized intersections.) The installation of a midblock pedestrian crossing on a state highway, however, is a design deviation that requires approval and documentation. An example of a midblock crossing is shown in Figure 1025-9.

Conditions that might favor a midblock crossing include:

- Significant pedestrian crossings and substantial pedestrian and vehicle conflicts occur.
- The proposed crossing can concentrate or channel multiple pedestrian crossings to a single location.

- The crossing is at an approved school crossing on a school walk route.
- The adjacent land use creates high concentrations of pedestrians needing to cross the highway.
- The pedestrians fail to recognize the best or safest place to cross along a highway and there is a need to delineate the optimal location.
- There is adequate sight distance for motorists and pedestrians.

Midblock pedestrian crossings on state highways are not desirable at the following locations:

- Immediately downstream (less than 300 feet) from an existing traffic signal where motorists do not expect a pedestrian to cross.
- Within 600 feet of another pedestrian crossing.
- Where pedestrians must cross three or more lanes of traffic in the same direction.

(4) Sidewalk Ramps

Sidewalk curb ramps are required at all intersections, unless pedestrians are prohibited from crossing the roadway and on midblock crossings where sidewalks are present. These ramps provide an easily accessible connection from a raised sidewalk down to the roadway surface. To comply with ADA requirements, these ramps are at least 4 feet wide and have slopes 12H:1V or flatter and a cross slope of not greater than 2%. Curb ramp flares do not exceed 10%. Examples of sidewalk curb ramps are shown in the Standard Plans.

The lower terminus of the sidewalk ramp is always located at the beginning of a marked or unmarked crosswalk when separate ramps are used for each direction. A separate sidewalk ramp is preferred for each crossing because the crossing distance is shorter and people with vision impairments or in wheelchairs have fewer difficulties with this arrangement. A single diagonal ramp, serving two crossings, is sometimes necessary where right of way constraints make the installation of separate ramps infeasible. The use of a diagonal ramp requires the approval of the region's Traffic Engineer. If

inside an incorporated city, the city must approve the use of a diagonal ramp. In all cases, detectable warning strips are to be installed.

Surface water runoff from the roadway can flood the lower end of a sidewalk ramp. Determine the grades along the curb line and provide catch basins or inlets to prevent the flooding of the ramps. Figure 1025-10 shows examples of how drainage structures are located. Verify that the drainage structure will not be in the path of a wheelchair user.

A level landing is necessary at the top and bottom of a sidewalk ramp. The top landing is provided to allow a person in a wheelchair room to maneuver into a position to use the ramp or to bypass it. The lower landing allows a wheelchair user to transition from the ramp to the roadway crossing. In preservation projects, the landings must be at least 3 feet square. In new construction, a 4-foot-square landing is required. When right of way constraints are not an issue, provide a larger 5-foot-square landing. If the landing is next to a vertical wall, a 5-foot-wide clear area is desirable to allow a person in a wheelchair more room to maneuver.

At signalized intersections, pedestrian push buttons are located near the sidewalk ramps for ADA accessibility. (See Chapter 850, "Traffic Control Signals," for information on pedestrian requirements at traffic signal locations.)

(5) Pedestrian Grade Separations

(a) **General.** In extreme cases where pedestrian need is high, consider providing a pedestrian grade separation along freeways and other high-speed facilities. When considering a pedestrian structure, determine if the conditions that require the crossing are permanent. If there is a likelihood that the pedestrian activity generator might not exist in the near future, consider less costly solutions. Locate the grade-separated crossing where pedestrians are most likely to cross the roadway. A crossing might not be used if the pedestrian is required to deviate significantly from a more direct route. A structure might be underutilized if the additional average walking distance for 85% of pedestrians exceeds 1/4 mile. It is sometimes necessary to install fencing or

other physical barriers to channel the pedestrians to the structure and reduce the possibility of undesired at-grade crossings. The Bridge and Structures office is responsible for the design of pedestrian structures.

Consider grade-separated crossings under the following conditions:

- Where there is moderate to high pedestrian demand to cross a freeway or expressway
- Where there are large numbers of young children, particularly on schools routes, who regularly cross high-speed or high-volume roadways
- On streets with high vehicular volumes and high pedestrian crossing volumes, and the crossings are extremely hazardous for pedestrians

(b) **Pedestrian Bridges.** Pedestrian grade-separation bridges are more effective when the roadway is below the natural ground line as in a "cut" section. Elevated grade separations, where the pedestrian is required to climb stairs or use long approach ramps, tend to be underutilized. Pedestrian bridges require adequate right of way to accommodate accessible ramps.

For the minimum vertical clearance from the bottom of the pedestrian structure to the roadway beneath, see Chapter 1120. This minimum height requirement can affect the length of the pedestrian ramps to the structure. To comply with ADA requirements, a ramp cannot have a grade exceeding 8.33%, and landings for resting areas are required every 2 feet 6 inches of rise or every 30 feet. Landings are a minimum of 5 feet long and shall not be less than the ramp width. When ramps are not feasible, provide both elevators and stairways. Stairways are designed in accordance with the Standard Plans.

Railings are provided on pedestrian bridges. Protective screening is sometimes necessary to prevent objects from being thrown from an overhead pedestrian structure. (See Chapter 1120, "Bridges.") Consider a clear width of 14 feet when a pedestrian bridge is enclosed or shared with bicycles.

(c) **Pedestrian Tunnels.** Tunnels are an effective method of providing crossings for

roadways located in embankment sections. When possible, design the tunnel with a nearly level profile to provide complete vision from portal to portal. Pedestrians are reluctant to enter a tunnel with a depressed profile because they are unable to see whether the tunnel is occupied. Police officers also have difficulty patrolling depressed profile tunnels. Provide vandal-resistant daytime and nighttime illumination within the pedestrian tunnel. Installing gloss-finished tile walls and ceilings can also enhance light levels within the tunnel. The minimum overhead clearance for a tunnel is 10 feet. Provide a tunnel width between 12 and 18 feet depending on usage and the length of the tunnel.

(6) Transit Stops

The location of transit stops is an important consideration in providing appropriate pedestrian facilities. (Contact the local transit provider for additional information.) Newly constructed transit stops must conform to ADA requirements. (See Chapter 1060, "Transit Benefit Facilities.") Ensure that the transit stop is accessible from the sidewalk or paved shoulder. A transit stop on one side of a street usually has a counterpart on the opposite side because transit routes normally function in both directions on the same roadway. Provide adequate crossing facilities for pedestrians.

When locating transit stops consider the following:

- ADT
- Traffic speed
- Crossing distance
- Accident history
- Sight distance

If any of these suggest an undesirable location for a pedestrian crossing, consider a controlled crossing or another location for the transit stop.

When analyzing high pedestrian accident locations, consider the presence of nearby transit stops and opportunities for pedestrians to safely cross the street. At-grade midblock pedestrian crossings are effective at transit stop locations on roadways with lower vehicular volumes.

Pedestrian grade separations are appropriate at midblock locations when vehicular traffic volumes prohibit pedestrian crossings at grade. (See Figure 1025-5 for recommendations for marked crosswalks at unsignalized intersections.)

(7) School Bus Stops

School bus stops are typically adjacent to sidewalks in urban areas and along shoulders in rural areas. Determine the number of children using the stop and provide a waiting area that allows the children to wait safely for the bus. Children, because of their smaller size, might be difficult for motorists to see at crossings or stops. Determine whether utility poles, vegetation, and other roadside features interfere with the motorist's ability to see the children. When necessary, relocate the obstructions or move the bus stop. Parked vehicles can also block visibility and parking prohibitions might be necessary near the bus stop.

(8) Illumination and Signing

In Washington State, the highest number of collisions between vehicles and pedestrians occur during November through February, when there is poor visibility and fewer daylight hours. Illumination of pedestrian crossings and other walkways is an important design consideration, because lighting has a major impact on a pedestrian's safety and sense of security. Illumination provided solely for vehicular traffic is not always effective in lighting parallel walkways for pedestrians. Consider pedestrian-level lighting (mounted at a lower level) for walkways, intersections, and other pedestrian crossing areas with high nighttime pedestrian activity such as shopping districts, transit stops, schools, community centers, and other major pedestrian generators or areas with a history of pedestrian accidents. Design guidance for illumination is in Chapter 840. (See Chapter 820 and the MUTCD for pedestrian-related signing.)

(9) Work Zone Pedestrian Considerations

Providing access and mobility for pedestrians through and around work zones is an important design concern. In work zones, consider:

- Separating pedestrians from conflicts with work zone equipment and operations.
- Separating pedestrians from traffic moving through or around the work zone.
- Providing pedestrians with a safe, accessible, and convenient travel path that duplicates, as closely as possible, the characteristics of sidewalks or footpaths.

Ensure that walkways are clearly marked, pedestrian barriers are continuous, nonbendable, and detectable to persons with impaired vision using a cane, keep the pedestrian head space clear. Keep walkways free from pedestrian hazards such as holes, debris, and abrupt changes in grade or terrain. Keep wheelchair access along sidewalks clear of construction traffic control signs.

Temporary pedestrian facilities within the work zone shall be detectable and include accessibility features consistent with the features present in the existing pedestrian facility.

Consider the use of flaggers if pedestrian generators such as schools are in the work zone vicinity.

Provide advance notification of sidewalk closures.

Where transit stops are affected or relocated because of work activity, access to temporary transit stops shall be provided.

For further information or guidance on work zone pedestrian considerations, see the MUTCD.)

1025.06 Documentation

A list of documents that are required to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

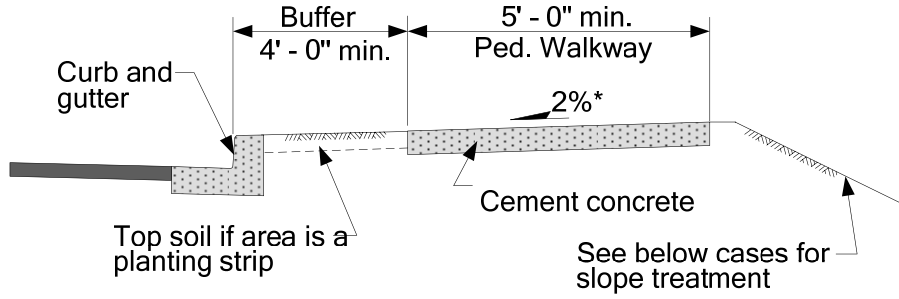
<http://www.wsdot.wa.gov/eesc/design/projectdev/>

Item	ADA Standards for Improvement Projects (New, Reconstruction, or Modification)	ADA Minimums for Evaluating Existing Facilities on Preservation Projects (Resurfacing or Paving)
Sidewalk Ramps		
Truncated Domes	Bottom 2 feet of ramp	Bottom 2 feet of ramp
Contrasting Colors	Yes	Yes
Landings ¹	48 inches square Min. ²	36 inches Min. ²
Longitudinal Slopes	12H:1V (8%)	8H:1V ³
Cross Slopes	48H:1V (2%)	Minimum feasible
Width	48 inches ²	36 inches ²
Flare Side Slopes	10H:1V ⁴	10H:1V
Accessible Routes		
Width	48 inches ⁵	36 inches
Longitudinal Slopes	20H:1V (5%) ^{6,7}	20H:1V(5%) ^{6,7}
Cross Slopes	48H:1V (2%)	Minimum feasible
Ramps^{8, 9}		
Landings ¹⁰ (Length)	60 inches ²	60 inches ²
Longitudinal Slopes	12H:1V (8%) ⁶	8H:1V ³
Cross Slopes	48H:1V (2%)	Minimum feasible
Width	44 inches	36 inches
Max. Rise Btwn. Landings	30 inches	30 inches

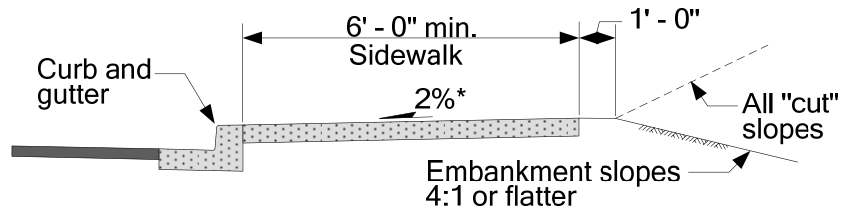
Notes:

1. The slope of the gutter pan or roadway surface at the bottom of ramp cannot exceed 20H: 1V.
2. The width of the landing shall not be less than the ramp width. Provide a 60 inch x 60 inch landing when a change of direction is required at the landing.
3. 10H:1V to 12H:1V is allowed for rises up to 6 inches; 8H:1V to 10H:1V is allowed for rises up to 3 inches.
4. Exception: Where the width of the walking surface at the top of the ramp and parallel to the run is less than 48 inches, the maximum side slope shall be 12H:1V.
5. If the width is less than 60 inches, passing spaces at least 60 inches x 60 inches shall be provided at intervals not to exceed 200 feet.
6. If accessible route is adjacent to a roadway, then the slope is allowed to match the profile of the road.
7. Slopes exceeding 5% must meet the requirements for ramps when accessible route is on a separate alignment and does not abut a roadway.
8. A ramp in this context is on a walkway on a separate alignment and does not abut a roadway. These ramps have slopes greater than 20H:1V.
9. Ramps shall have handrails, with the exception of curb ramps.
10. Landings required at top and bottom of ramp.

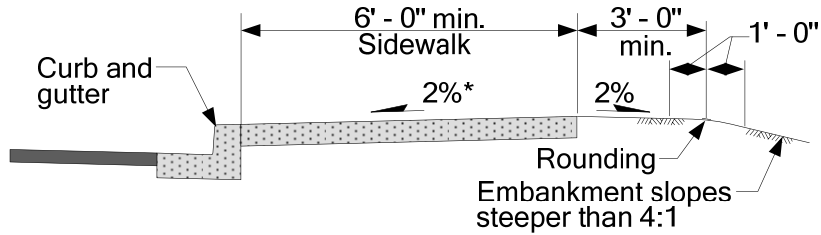
ADA Requirements
Figure 1025-2



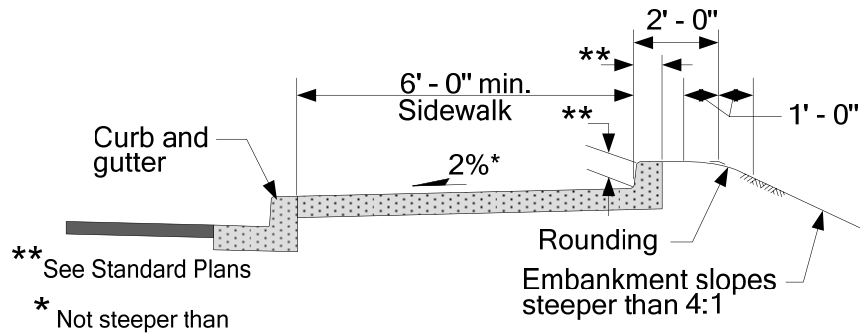
Case A



Case B

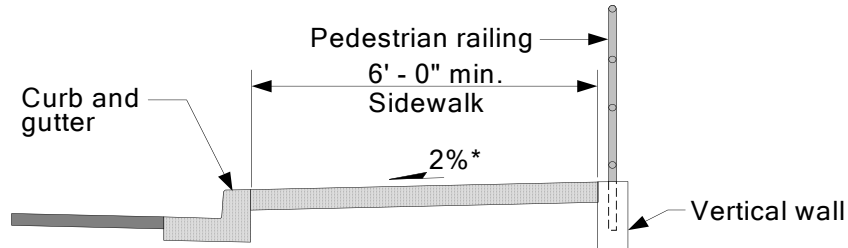


Case C

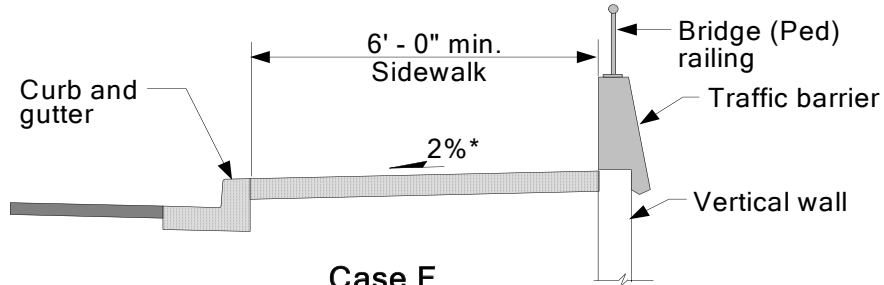


Case D

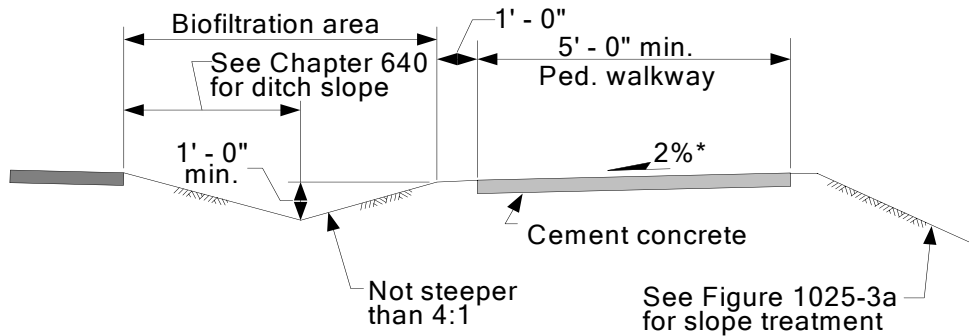
Pedestrian Walkways
Figure 1025-3a



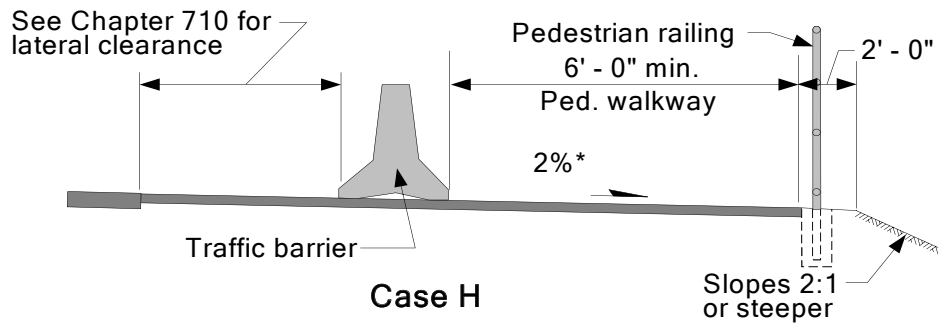
Case E
When the wall is outside of the Design Clear Zone



Case F
When the wall is within the Design Clear Zone



Case G



Case H

* Not steeper than

Pedestrian Walkways
Figure 1025-3b

Roadway Classification & Land Use Designation	Sidewalk Recommendations
Rural highways (outside urban growth areas)	No sidewalk recommended. 4-foot-wide shoulders adequate.
Suburban highways (one or less dwelling unit per acre)	Sidewalk on one side desirable. 4-foot-wide shoulders adequate.
Suburban highway (two to four dwelling units per acre)	Sidewalks on both sides of roadway desirable. Sidewalk on one side recommended.
Major arterial in residential area	Sidewalks on both sides of roadway recommended.
Collector or minor arterial in residential area	Sidewalks on both sides of roadway recommended.
Local street in residential area with less than one dwelling unit per acre	Sidewalk on one side desirable. 4-foot-wide shoulders adequate.
Local street in residential area with one to four dwelling units per acre	Sidewalks on both sides of roadway desirable. Sidewalk on one side recommended.
Local street in residential area with more than four dwelling units per acre	Sidewalks on both sides of roadway recommended.
Streets in commercial area	Sidewalks on both sides of roadway recommended.
Streets in industrial area	Sidewalks on both sides of roadway desirable. Sidewalk on one side recommended.

Sidewalk Recommendations
Figure 1025-4

Traffic Volume(ADT)	Posted Speed	Roadway Type			
		2 lanes	2 lanes, raised median ^a	4 lanes, raised median ^{a,g}	6 lanes, raised median ^{a,g}
Less than or equal to 9,000	30 mph and slower	Marked crosswalk	Marked crosswalk	Additional enhancement	
	35 mph to 40 mph	Marked crosswalk	Marked crosswalk	Additional enhancement	
	45 mph and higher	Additional enhancement	Additional enhancement	Active enhancement	
9,000 to 15,000	30 mph and slower	Marked crosswalk	Marked crosswalk	Additional enhancement	
	35 mph to 40 mph	Marked crosswalk	Marked crosswalk	Additional enhancement	
	45 mph and higher	Additional enhancement	Additional enhancement	Active enhancement	
15,000 to 30,000	30 mph and slower	Additional ^b enhancement	Additional enhancement	Additional ^b enhancement	Active ^d enhancement
	35 mph to 40 mph	Additional ^b enhancement	Additional enhancement	Active enhancement	Active ^d enhancement
	45 mph and higher	Active ^e enhancement	Active enhancement	See note 'C'.	See note 'C'.
Greater than 30,000	45 mph and lower	Active ^e enhancement	Active enhancement	Pedestrian ^f traffic signal	Pedestrian ^f traffic signal

* Inside city limits where the population exceeds 22,500, the decision to mark crosswalks resides with the city, subject to approval by WSDOT of the installation and type.

Notes:

- a Raised refuge island, minimum 4 feet wide and 6 feet long. A TWLTL is not considered a median.
- b Consider active enhancement treatment for roadways exceeding 20,000 ADT.
- c Provide alternate routes for pedestrian crossings or construct a grade-separated facility.
- d Location may be approaching the need for a controlled crossing. A pedestrian signal may be appropriate, based on engineering analysis.
- e Raised refuge island required.
- f Refer to region's Traffic Engineer for approval and design of a pedestrian traffic signal.
- g Facilities with four or more lanes that meet the crossing warrants require a raised median.

Minimum Requirements (additive for each level)

“marked crosswalk”

- * Marked and signed in accordance w/MUTCD Section 3B.17 & 2C.41 (signed @ crossing only)
- * Pedestrian-view warning signs
- * Illumination

“additional enhancement”

- * Minimum requirements listed under “marked crosswalk”
- * Stop line in accordance w/MUTCD Section 3B.16
- * Advance signing in accordance w/MUTCD Section 2C.41

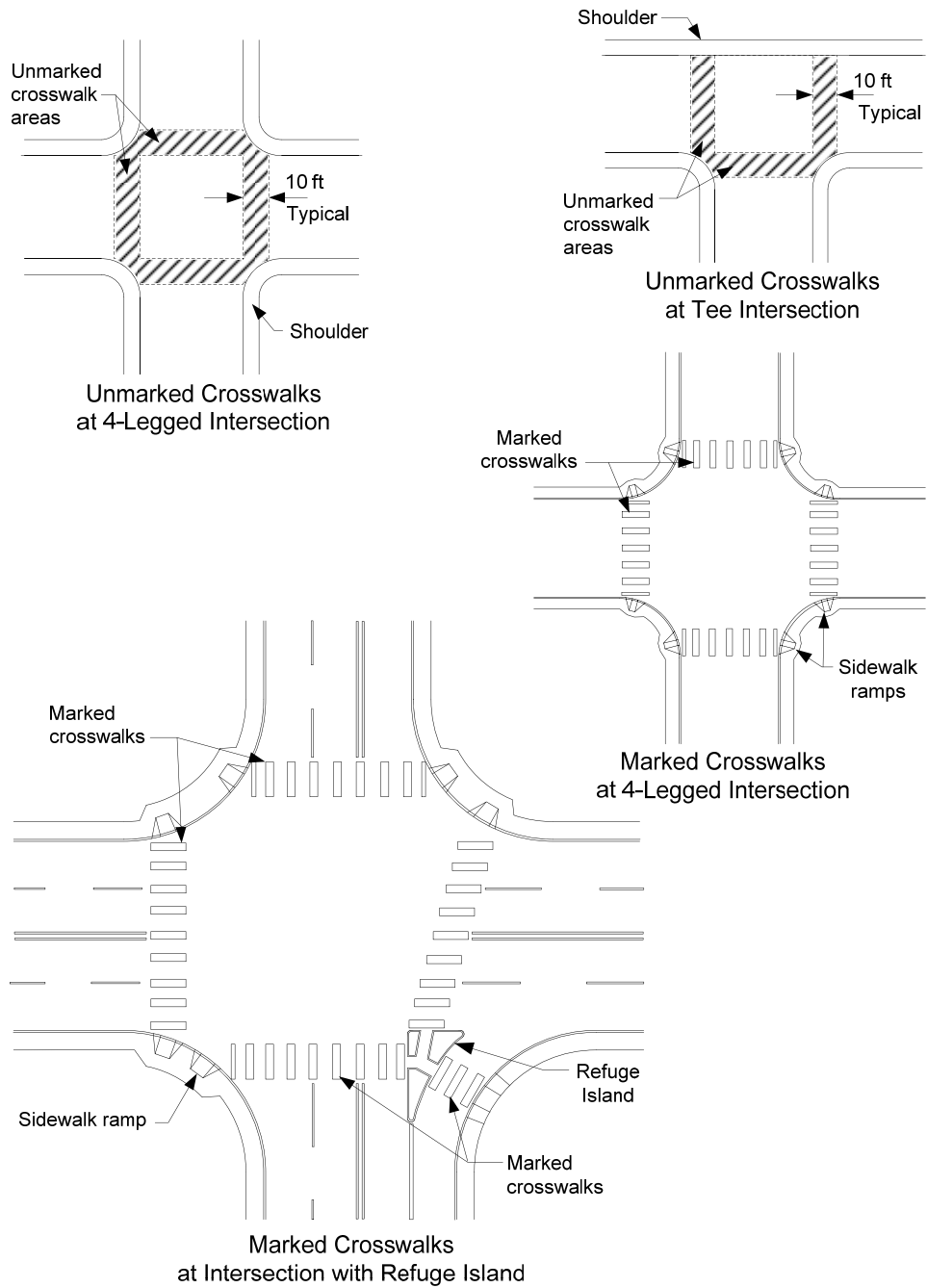
“active enhancement”

- * Minimum requirements listed under “additional enhancement”
- * Pedestrian-actuated warning beacons; overhead for roadway w/4 or more lanes

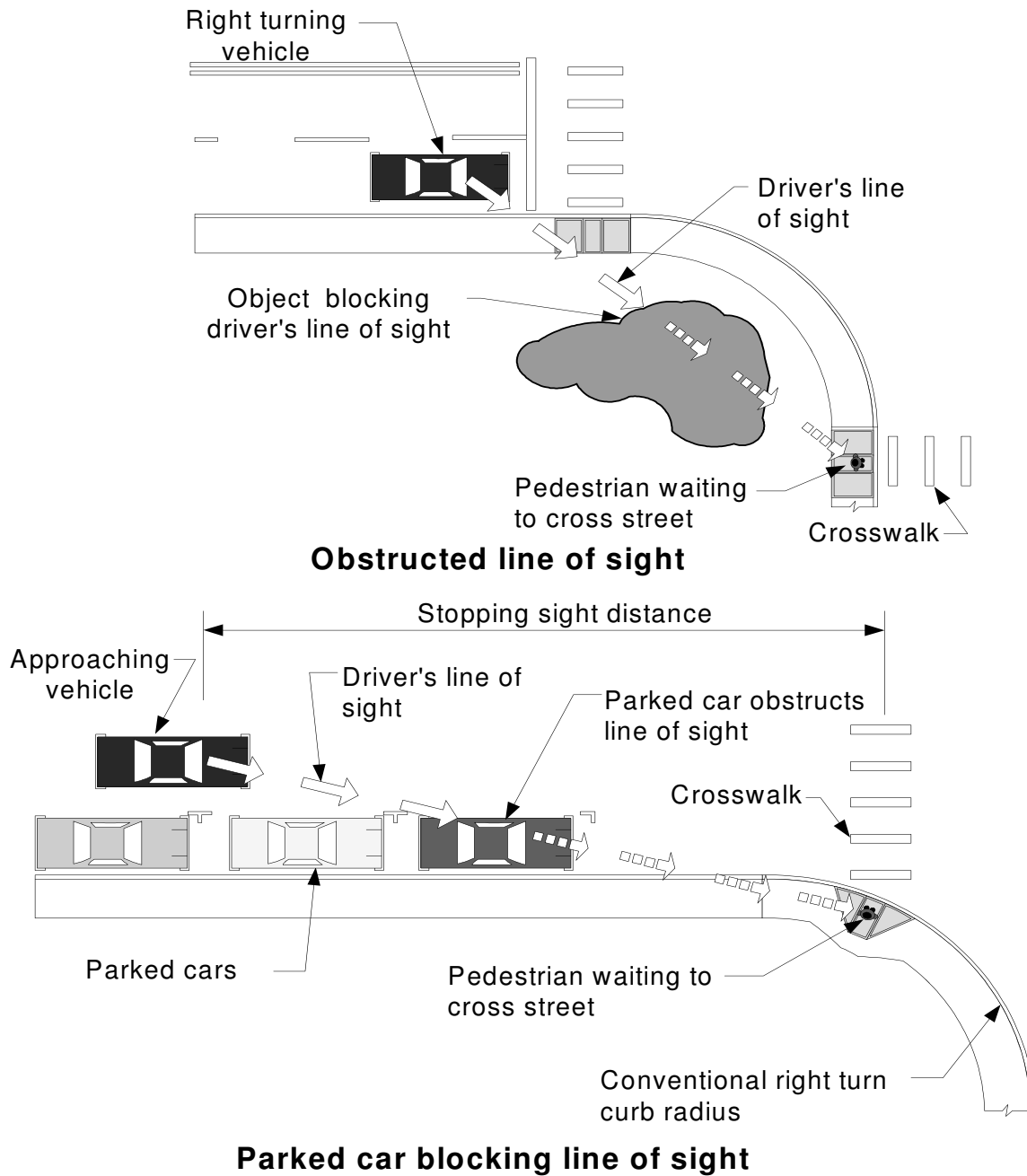
Note: For additional considerations that may be appropriate based on a site-specific engineering analysis, see *Design Manual*, 1025.05(3).

Marked Crosswalk Recommendations at Unsignalized Crossings

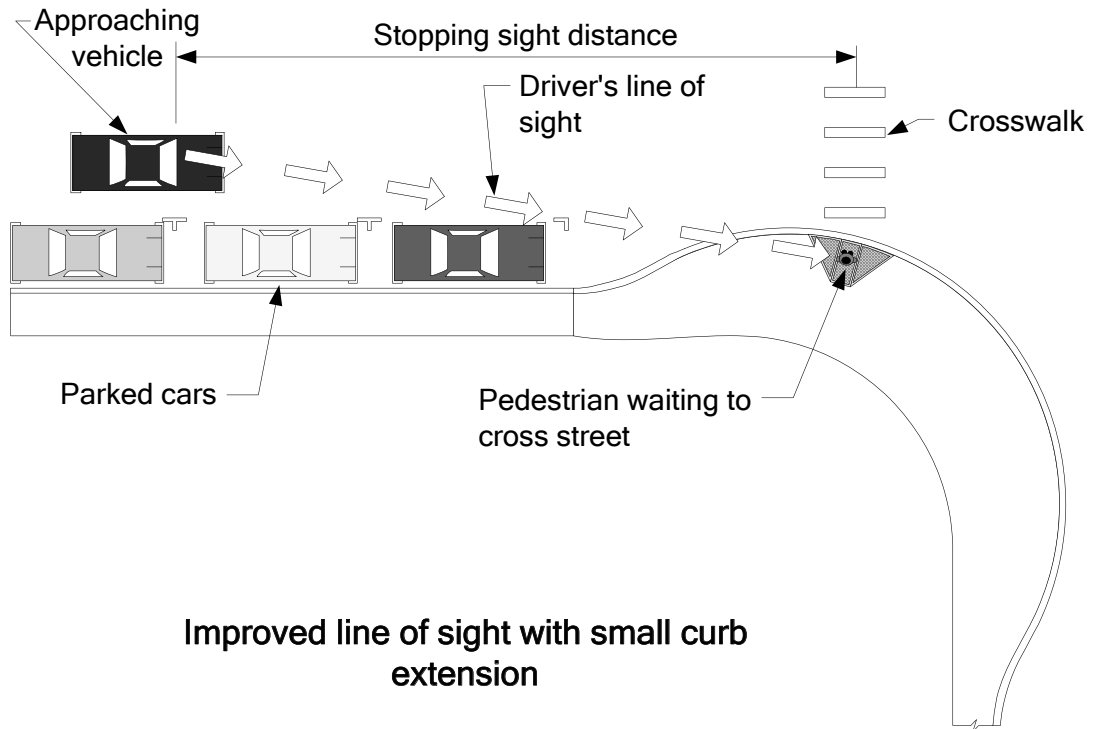
Figure 1025-5



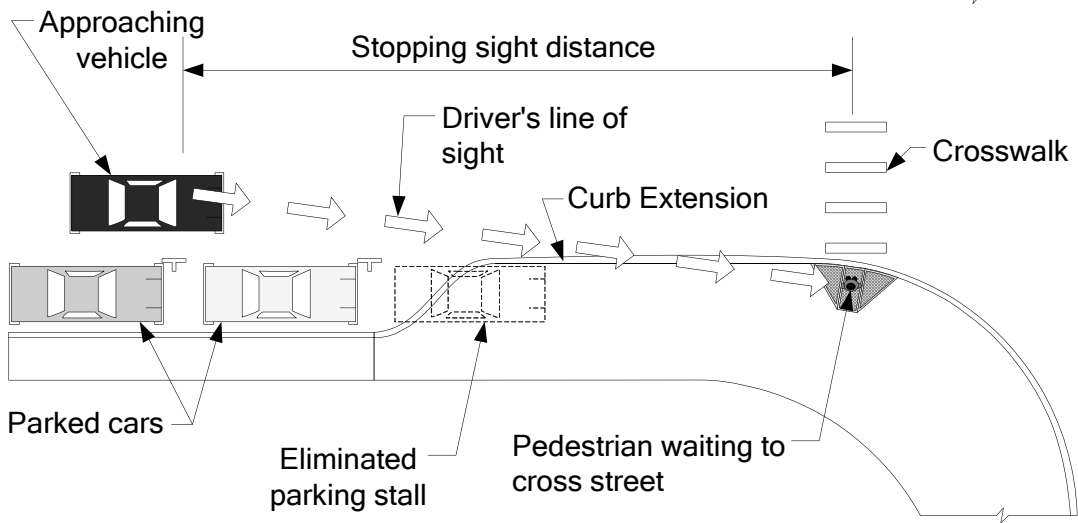
Crosswalk Locations
Figure 1025-6



Sight Distance at Intersections
Figure 1025-7a



Improved line of sight with small curb extension



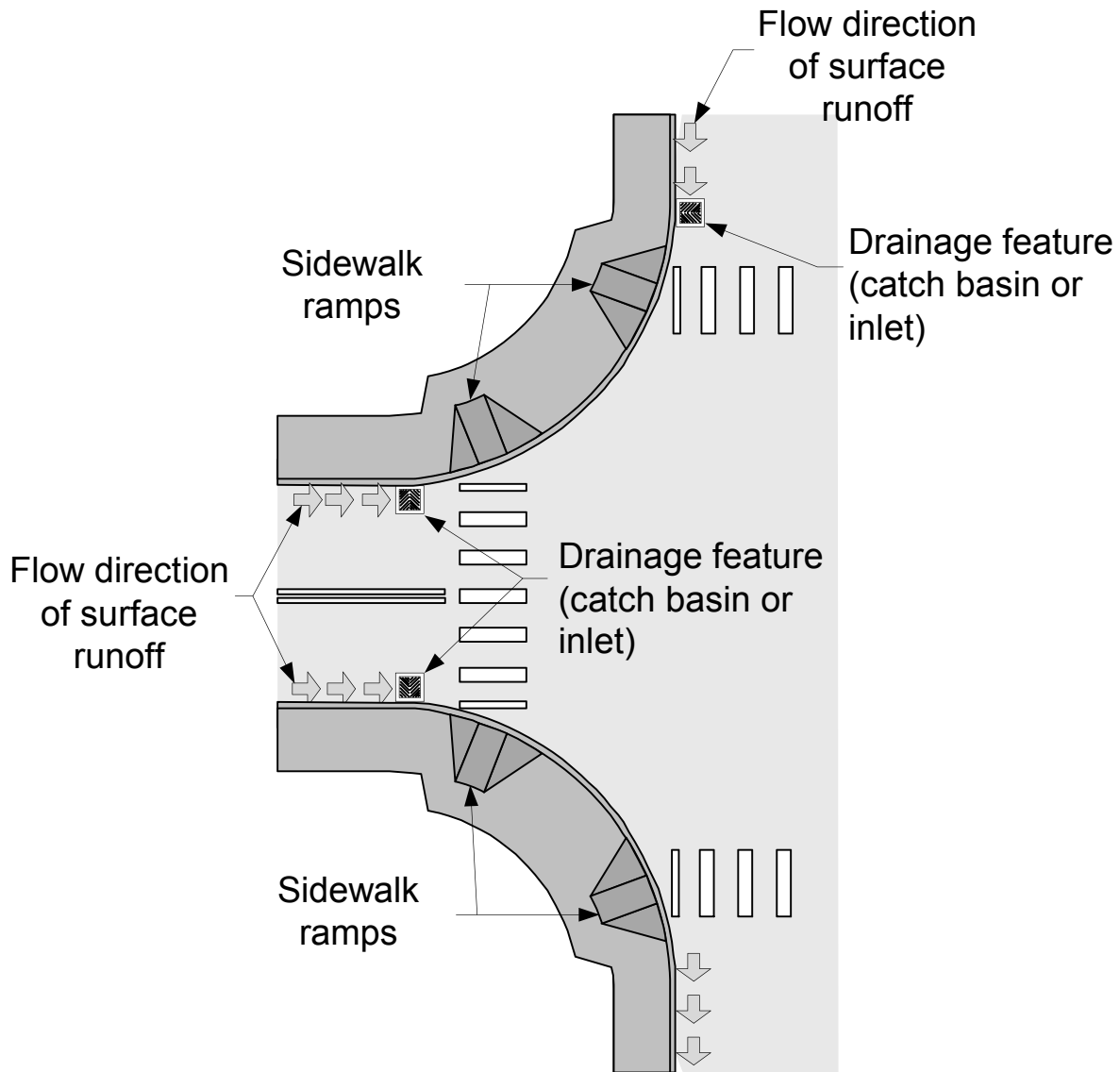
Sight Distance at Intersections
Figure 1025-7b



Curb Extension
Figure 1025-8



Midblock Pedestrian Crossing
Figure 1025-9



Sidewalk Ramp Drainage
Figure 1025-10

- 1410.01 General
- 1410.02 References
- 1410.03 Special Features
- 1410.04 Easements and Permits
- 1410.05 Programming for Funds
- 1410.06 Appraisal and Acquisition
- 1410.07 Transactions
- 1410.08 Documentation

1410.01 General

Real Estate Services personnel participate in the project definition phase of a project to assist in minimizing right of way costs, defining route locations and acquisition areas, and determining potential problems and possible solutions.

Due to the variables in land acquisition, the following categories of right of way costs are considered in the project definition phase.

- Purchase costs (acquisition compensation).
- Relocation assistance benefits payments.
- Other Real Estate Services staff expenses (acquisition services, relocation services, interim property management services).

Right of way cost estimates are made by Real Estate Services specialists. When the parcels from which additional right of way will be acquired are known, title reports (including assessors' land areas) can be requested.

Real Estate Services personnel also “make project field inspections at appropriate times throughout the development of a project to ensure adequate consideration is given to significant right of way elements involved (including possible social, economic, and environmental effects)” in accordance with the *Right of Way Manual*.

During plan development:

- Title reports are examined for easements or other encumbrances that would reveal the existence and location of water lines, conduits, drainage or irrigation lines, etc., that must be provided for in construction.

- Easements that indicate other affected ownerships are added to the right of way/access plan.
- Arrangements are made to obtain utility, railroad, haul road, detour routes, or other essential agreements, as instructed in the *Utilities Manual* and the *Agreements Manual*.
- Right of way acquisition, disposal, and maintenance are planned.
- Easements and permits are planned (to accommodate activities outside of the right of way).

See Chapter 440 concerning design right of way widths. The widths may be modified based on Real Estate Services input but cannot be moved to coincide with property boundaries in anticipation of a total take. Jogs in the final widths of the right of way are held to a minimum. See *Right of Way Manual* Chapter 6 for discussion of remainders.

All acquisition documents are processed through the Headquarters (HQ) Real Estate Services Office except temporary permits that are not shown on the Right of Way Plans and are not needed for the project (such as driveway connections).

1410.02 References

(1) Law

Laws and codes (both federal and state) that may pertain to this chapter include the following:

Code of Federal Regulations 23 CFR Part 710

49 CFR Part 24 Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 as amended

Revised Code of Washington (RCW) RCW 8.26, Relocation Assistance - Real Property Acquisition Policy

Washington Administrative Code (WAC) WAC 468-100, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended

(2) Design Guidance

The following contain guidance that is included by reference within the text:

Agreements Manual, M 22-99, Washington State Department of Transportation (WSDOT)

Plans Preparation Manual, M 22-31, WSDOT

Right of Way Manual, M 26-01, WSDOT

Utilities Manual, M 22-87, WSDOT

1410.03 Special Features

(1) Road Approaches

On managed access highways, the department will reconstruct legally existing road approaches that are removed or destroyed as part of the highway construction. New approaches required by new highway construction are negotiated by the region with the approval of the Regional Administrator. The negotiator coordinates with the region's design section to ensure that new approaches conform to the requirements of Chapter 920 for road approaches. All new approaches will be by permit through the appropriate regional office.

On limited access highways, road approaches of any type must be approved by the State Design Engineer before there is legal basis for negotiation by the Real Estate Services Office. When approved, approaches will be specifically reserved in the right of way transaction and will contain the identical limitations set by the State Design Engineer and as shown on the approved Right of Way and Limited Access Plan.

(2) Cattle Passes

The desirability of, or need for a cattle pass will be considered during the appraisal or negotiation process. A cattle pass will be approved only after complete studies of location, utilization, cost, and safety elements have proved its necessity. Upon approval, such an improvement and appurtenant rights will be established. Future right of access for maintenance is negotiated during acquisition.

On limited access highways, approval of the State Design Engineer and the addition of a traffic movement note on the right of way / limited access plan (refer to *Plans Preparation Manual*) are required.

(3) Pit, Stockpile, and Waste Sites

These sites are investigated and planned as outlined in the *Plans Preparation Manual*. Detour and haul road agreements, approved by the Regional Administrator, are necessary when the state proposes to use city streets or county roads for the purpose of detouring traffic or hauling certain materials. See the *Utilities Manual* for detour and haul road agreement guidelines.

(4) International Boundaries

Construction proposed "within a 20-foot strip, 10 feet on each side of the international boundary," must be coordinated between the department and the British Columbia Ministry of Highways and Public Works.

Permission of the International Boundary Commission is required to work "within 10 feet of an international boundary." Their primary concern is monumentation of the boundary line and the line of sight between monuments. They require a written request stating what will be done, when, and why; sent to 1250 23rd Street NW, Washington DC 20037.

1410.04 Easements and Permits

(1) General

If others request rights within existing WSDOT ownership, they are to contact the region's Real Estate Services Office.

Easements and permits to accommodate WSDOT activities outside the right of way usually fall into one of the categories defined below.

Easements and permits are processed in accordance with the requirements of the *Right of Way Manual*. The region's Real Estate Services Office drafts the legal descriptions for all easements and permits for acquisition of property and property rights. The HQ Real Estate Office drafts the legal description for all easements and permits for disposition of property or property rights. The region's Real Estate Services Office either obtains or assists in obtaining easements and permits. The region is responsible for compliance with and appropriate retention of the final documents. Records of permanent property rights acquired are maintained by HQ Real Estate

Services. Easements and permits are to be shown on the contract plans in accordance with the *Plans Preparation Manual*.

The region's Real Estate Services Office either obtains or assists in obtaining easements and permits. The region is responsible for compliance with and appropriate retention of the final documents. Easements and permits are to be shown on the contract plans in accordance with the *Plans Preparation Manual*.

(2) Perpetual Easements

Perpetual easements are shown on the right of way plans in accordance with the *Plans Preparation Manual*.

(a) **State Maintenance Easement.** Used when the state is to construct a facility and provide all maintenance. Examples are slope and drainage easements.

(b) **Dual Maintenance Easement.** Used when the state is to construct and maintain a facility and the owner is to maintain the remainder. Examples are; the surface area above a tunnel and the area behind a retaining wall or noise wall.

(c) **Transfer Easement.** On occasion an easement must be acquired for transfer to another party. In this case contact the region Real Estate Services Office for early involvement. The right of way and limited access plan is modified to identify the party to whom the easement will be transferred. The department cannot obtain easements for transfer across lands under the jurisdiction of the Department of Natural Resources (DNR), and WSDOT cannot condemn for a transfer easement.

(3) Temporary Easements

Temporary easements are used when the state requires a property right of a temporary nature that involves either more than minor work or construction activities on privately-owned property. In the cases where the rights required or the work to be performed is not beneficial to the property owner, just compensation must be paid.

When we are paying for the rights or when the encroachment is significant, temporary easements are shown on the right of way plans, in accordance with the *Plans Preparation Manual*. Consult the region's Plans and Real Estate Services personnel for exceptions. If the easement is not mapped, mark and submit plans as follows:

The region's Project Coordinator's Office provides a right of way plan with the required temporary easement(s) delineated in red to the region's Real Estate Services Office. These plan sheets provide the following information:

- Ownership boundaries. (Confirmation of ownership and parcel boundaries may be completed by a search of county records and mapping. A formal title report is required for temporary easements.)
- Parcel number assigned to each ownership.
- Sufficient engineering detail to write legal descriptions.
- Statement of the intended use of each temporary easement area.

In limited access areas, contact the HQ Access and Hearings Office.

(4) Construction Permits

Construction permits are used for temporary rights during construction. They are not used when WSDOT needs a perpetual right. A construction permit is only valid with the current owner and must be renegotiated if property ownership changes before construction begins. For private ownerships, a temporary construction easement is recommended. A construction permit is recommended for rights of entry to publicly owned property. Local agencies might require the use of specific forms when applying for these rights of entry. Regardless of the form or its name, the region is responsible for appropriate central storage of the original document.

A construction permit is only valid with the current owner and must be renegotiated if property ownership changes before construction begins. For private ownerships, a temporary construction easement is recommended.

When there is a benefit to the property owner (e.g. driveway or parking lot approach improvements) the construction permit is usually obtained without the payment of compensation (donation or mutual benefits, for example). Consult the region's Plans and Real Estate Services personnel for exceptions.

1410.05 Programming for Funds

In relation to plan development, the phases in Figure 1410-1, apply to the authorization of stage programming.

When federal funds are involved, special attention must be given to Federal Highway Administration (FHWA) requirements. When federal participation in right of way costs is anticipated, specific authorization must be obtained from the FHWA. The rules and procedures provided in RCW 8.26, WAC 468-100, and the *Right of Way Manual* must be followed to ensure federal and state participation. In many cases, for example, federal funds are contingent upon the department setting up a relocation advisory procedure for any owner or tenant who is displaced by an improvement and desires such assistance. Relocation advisory assistance is a function of the HQ Real Estate Services Office.

1410.06 Appraisal and Acquisition

(1) All Highways

In relation to plan development, the phases in Figure 1410-1, also apply to the authorization of right of way acquisition for all access highways.

(3) Exceptions

Exceptions can be made to the requirements in Figure 1410-1 if unusual hardships result for the individual or the state. The approval of right of way hardship action will be based on the individual parcel merit and is processed in accordance with hardship acquisition policy (*Right of Way Manual*).

1410.07 Transactions

(1) Private Ownerships

Right of way is ordinarily acquired from private property owners by region-level negotiation between the owner and the right of way agent.

(2) Utilities

The region ascertains ownership of all utilities and makes arrangements for necessary adjustment, including relocation of portions of the utility, if necessary. Provisions for relocation or adjustment are included in the PS&E plans when:

- The items are normal construction items and the department is obligated for the moving expense.
- The utility requests that relocation be performed by the department and the department has approved the request.

Readjustment may require the department to purchase substitute rights of way or easements for eventual transfer to the utility. Such rights of way or easements must be shown on the right of way plans with the same engineering detail as highway right of way. On limited access highways, if an approach is required for maintenance of a utility, the approach will be shown on the approach schedule. See the *Utilities Accommodation Policy* regarding location of and access to utilities.

The negotiations with the utilities are often done by HQ Real Estate Services. Because of the considerable time required to obtain approvals, processing of utility relocation agreements must begin as soon as possible.

(3) Railways

Right of way is generally not acquired in fee from a railroad company. Instead, the state acquires a perpetual easement for encroachment or crossing. A construction and maintenance agreement may also be required. The easement must be shown on the right of way plan and identified by both highway and railroad stationing.

The HQ Design Office coordinates with the railroad design staff to determine a mutually agreeable location before the proposed easement is sent to Real Estate Services. The negotiations with the railroads are generally done by HQ Real Estate Services. Because of the considerable time required to obtain approvals, processing of railroad agreements must begin as soon as possible.

The perpetual easement document is executed by the Director, Real Estate Services.

(4) Federal Agencies

Acquisition of right of way from most federal agencies must be negotiated and processed through several federal offices. Allow at least one year's time for efficient and economical right of way acquisition. Depending upon the particular federal agency involved, special exhibit maps and other documentation may be required, and the right of way may be acquired as an easement rather than in fee. The negotiations with the federal agencies are generally done by HQ Real Estate Services.

(5) Other State Agencies



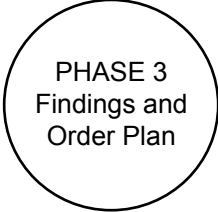


Acquisition from other state agencies must be negotiated and processed through the individual agencies or designees. Negotiations with other state agencies are generally handled by HQ Real Estate Services. As in the case of federal agencies, substantial time must be allowed for compliance with applicable statutes and regulations peculiar to the agency before right of way will be granted.

(6) Condemnations

Condemnation can result from a disagreement between the department and the owner as to a fair settlement or from a faulty title. Since several months might elapse between the filing of a condemnation case and a court decision, the Region Real Estate Services Office can be requested to investigate the possibility of obtaining a negotiated possession and use agreement as in the case of an emergency project, or when a sundry site is required immediately.

1410.08 Documentation

A list of the documents that are required to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site:
<http://www.wsdot.wa.gov/eesc/design/projectdev/>

Plan Approval	Plan Approval	Programming of Funds for Appraisal and Acquisition
Limited Access Highways		
	<p>State Design Engineer* approves Access Report Plan for prehearing discussion with county and/or city officials.</p> <p>The access report plan may be used for preparation of federal-aid program data for appraisals if federal funds are to be used for right of way acquisition. It may be used for requesting advance appraisal funds through the Planning and Capital Program Management for all projects with either state or federal funds.</p>	<p>Program appraisals of total takes. (No acquisition.)</p>
	<p>State Design Engineer* approves Access Hearing Plan for use at a public access hearing. R/W information is complete.</p> <p>The access hearing plan may be used for the preparation of federal-aid program data for negotiations on federally funded projects, and for the preparation of true cost estimates and fund requests.</p>	<p>Program all appraisals and acquisitions.</p> <p>Note: Do not appraise or purchase partial takes in areas subject to controversy. Appraise or purchase total takes only if federal design hearing requirements are met.</p>
	<p>No signature required.</p> <p>Results of Findings and Order Access Hearing are marked in red and green on Access Hearing plan and sent to HQ R/W Plans Branch.</p>	<p>Program appraisals of partial takes where data is available to appraisers.</p> <p>Acquisition of total takes.</p>
	<p>State Design Engineer* Approves final R/W and L/A plans or approves revisions to established R/W and L/A plans</p>	<p>Program all remaining appraisals and all remaining acquisitions.</p> <p>Note: If appeal period is not complete, delay action in areas subject to controversy and possible appeal.</p>
Managed Access Highways		
	<p>R/W plan submitted to HQ R/W Plans Branch for approval.</p>	<p>Program appraisals</p>
	<p>State Design Engineer* approves new R/W plans or approves revisions to established R/W plans.</p>	<p>Program all appraisals and acquisitions.</p>

*Or a designee.

Appraisal and Acquisition
Figure 1410-1

- 1425.01 General
- 1425.02 References
- 1425.03 Definitions
- 1425.04 Procedures
- 1425.05 Interchange Justification Report and Supporting Analyses
- 1425.06 Documentation

1425.01 General

This chapter provides guidance on Interchange Justification Reports (IJR), developing the required documentation for an IJR, and the sequence of an IJR presentation. The guidance is applicable to both Interstate and non-Interstate limited access routes. Engineers in the Washington State Department of Transportation (WSDOT) Headquarters (HQ) Access and Hearings Unit specialize in providing support for meeting the guidance provided in this chapter. They should be consulted early and frequently during the development of projects that require the types of documentation described herein.

Federal law requires Federal Highway Administration (FHWA) approval of all revisions to the Interstate system, including changes to limited access. Both FHWA and WSDOT policy require the formal submission of a request to either break or revise the existing limited access on Interstate and state routes, respectively. An IJR is the document used to request a new access point or access point revision on limited access freeways in Washington State. The IJR is used to document the planning process, the evaluation of the alternatives considered, the design of the preferred alternative, and the coordination that supports and justifies the request for an access revision. The IJR is scalable to the complexity of the proposal (see Figures 1425-1, 2, and 3).

A transportation proposal that requires a break in or revision to the existing limited access control, such as a new interchange, should begin with a study of the corridor to determine existing and future access needs. These needs then become part of the statewide plan, called the *State Highway System Plan*. The *State Highway System Plan* defines

Service Objectives, *Action Strategies*, and costs to plan for, maintain, operate, preserve, and improve the state highway system for the next 20 years. Work that does not fit any of the action strategies will not be authorized or considered in the development of the Statewide Transportation Improvement Program (STIP) or any other budget proposal. (See Chapter 120.) Alternatives should be developed and evaluated. A final preferred alternative is then analyzed, selected, approved, designed, constructed, maintained, and monitored.

The corridor study must evaluate existing local infrastructure and existing access points to determine whether an access point revision is necessary. The evaluation of the proposal begins by studying the corridor throughout the area of influence.

For all complex projects (new or significantly reconfigured interchanges), WSDOT strongly advises that a support team be established to help integrate the planning, programming, environmental, traffic, safety, and design efforts that lead to development of a proposal. When a third party, such as a local agency, is proposing an access point revision, FHWA requires that a study team be formed.

An IJR is a stand-alone document that includes the necessary supporting information needed for a request to break or revise the existing limited access. The IJR includes information about the proposed project, the new access or access point revision, and information about all other local and state improvements that are needed for the access to operate. The complexity of the report varies considerably with the scope of the proposed access point revision. For example, for minor ramp revisions, added on- and off-ramp lanes, and locked gates to sites normally accessed by another route, the approval request may be condensed to a letter format that includes adequate justification. An operational/safety analysis may be required to assure no adverse impacts to the Interstate or crossroad(s). Contact the HQ Access and Hearings Unit to determine the appropriate level of report documentation needed for all access changes.

An IJR cannot be approved prior to the approval of the project environmental document. For example, a project environmental document might be an Environmental Impact Statement (EIS) or an Environmental Assessment (EA). Approval of these documents is signified by a Record of Decision for an EIS, or a Finding of No Significant Impact might be issued for an EA document indicating an EIS is not required. (Chapter 220 provides further discussion on project environmental documentation.)

If the new or revised access proposal is found to be acceptable prior to the environmental approval, a finding of engineering and operational acceptability is granted by FHWA. Final approval of the IJR is granted concurrently with the appropriate environmental documentation. If the proposal is found to be acceptable after the project environmental document is approved, the IJR can be approved. On Interstate projects, a submittal letter shall be sent by the region through the WSDOT Access and Hearings Unit requesting final FHWA approval of the IJR. On non-Interstate projects, a similar process is followed, except that the WSDOT Assistant State Design Engineer grants the final approval, not the FHWA.

Recognizing that the time period between the approval of the IJR, the environmental documentation, and the construction contract commonly spans several years, the approved IJR will be reviewed and updated if significant changes have occurred during this process. A summary assessment will be submitted to the HQ Design Office and FHWA for evaluation to determine whether the IJR needs to be updated. Contact the HQ Access and Hearings Unit to coordinate this summary assessment.

1425.02 References

(1) Law

Laws and codes (both federal and state) that may pertain to this chapter include the following:

Code of Federal Regulations (CFR) 23 CFR Part 450 (implementing 23 USC Section 111)

40 CFR Parts 51 and 93 (regarding federal conformity with state and federal air quality implementation plans)

United States Code 23 USC Section 111 (requires the U.S. Secretary of Transportation to approve access revisions to the Interstate System), 134 (Metropolitan Planning), and 135 (Statewide Planning)

(2) Design Guidance

The following contain guidance that is included by reference within the text:

Highway Capacity Manual, Special Report No 209 (HCM), Transportation Research Council

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

(3) Supporting Information

The following were used in the development of this chapter or contain additional information:

Forecasting and Methods Matrix (when available), WSDOT

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 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”)

1425.03 Definitions

access A means of entering or leaving a public road, street, or highway with respect to abutting property or another public road, street, or highway.

access break Any point from inside or outside the state limited access right of way limited access hachures that crosses over, under, or physically through the plane of the limited access, is an access break or “break in access” (including, but not limited, to locked gates and temporary construction access breaks).

access point Any point from inside or outside the limited access hachures that allows entrance to or exit from the traveled way of a limited access freeway, including “locked gate” access and temporary construction access.

access point revision A new access point or a revision of an existing interchange/intersection configuration. Locked gates and temporary construction breaks are also access point revisions.

accident rate Accidents per one million vehicle miles traveled.

alternatives Possible solutions to accomplish a defined purpose and need. These include local and state transportation system 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.

area of influence The area that will be directly impacted by the proposed action: freeway main line, ramps, crossroads, immediate off-system intersections, and local roadway system.

assumptions document A document developed at the beginning of the study phase to capture access study assumptions and criteria such as traffic volumes, design year, opening year, travel demand assumptions, baseline conditions, and design year conditions. The document also serves as a historical record of the processes, dates, and decisions made by the team.

baseline The existing transportation system configuration and traffic volumes for a specific year against which to compare possible alternative solutions.

break See “access break” above.

design year 20 years from the beginning of construction.

ECS Environmental Classification Summary (Documented Categorical Exclusion).

FONSI Finding of No Significant Impact (Environmental Assessment).

freeway A divided highway that has a minimum of two lanes in each direction, for the exclusive use of traffic, and with full access control.

limited access Full, Partial, or Modified access control is planned and established for a corridor and then acquired as the right to limit access to each individual parcel.

need A statement which identifies the transportation problem(s) that the proposal is designed to address and explains how the problem will be resolved. An existing or anticipated travel demand that has been documented through the study process to require a change in access to the state’s limited access freeway system.

no-build condition The baseline, plus state transportation plan and comprehensive plan improvements expected to exist, as applied to the year of opening, or the design year.

proposal The combination of projects/actions selected through the project study process to meet a specific transportation system need.

purpose General project goals such as: (1) improve safety, (2) enhance mobility, or (3) enhance economic development.

Record of Decision Under the National Environmental Policy Act, the Record of Decision (ROD) accompanies the Final Environmental Impact Statement; explains the reasons for the project decision; discusses alternatives and values considered in selection of the preferred alternative; and summarizes mitigation measures and commitments that will be incorporated in the project.

study area The transportation system area to study in both step one of the study process and for an IJR. The study area is a minimum of one interchange upstream and downstream from the proposal.

support team An integral part of the IJR process consisting of an assemblage of people organized to develop and analyze solutions to meet the need of a proposal.

Transportation Management Area (TMA) Urbanized areas with populations of 200,000 or greater are federally designated as Transportation Management Areas.

travel demand Local travel demand constitutes short trips that should be made on the local transportation system, such as intracity roads and streets. Regional travel demand constitutes long trips that are made on the regional transportation system, such as Interstate, regional, and/or intercity/ interregional roads, streets, or highways.

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.

trips Short trips are normally intracity. Long trips are normally interstate, regional, or interregional.

1425.04 Procedures

Figures 1425-1 and 2 list the project types most likely to affect freeway safety and operations, requiring the submission of an Interchange Justification Report. Figure 1425-3 lists project types least likely to require the submission of an IJR. Consult the HQ Access and Hearings Unit early in the process for specific direction.

Gaining concurrence and approval for an access point revision is a multistep process. The first step consists of a study. If the study shows that the purpose and need of the proposal cannot be achieved with improvements to the local infrastructure only, the next step would normally be an IJR. (See the IJR Flow Chart, Figure 1425-4.)

(1) The First Step

Study the transportation systems in the area. This study will identify the segments of both the local and regional network that are currently experiencing congestion or safety deficiencies, or where planned land use changes will prompt the need to evaluate the demands on and the capacity of the transportation system. The study area includes the affected existing and proposed adjacent interchanges/intersections upstream and downstream from the proposed access point revision. If it is documented that the proposal creates no impacts to the adjacent interchanges/intersections, then analyze only through the

area of influence. When the area of influence extends beyond the one interchange upstream and downstream, extend the analysis far enough to include the extent of the traffic impacts.

Segments of the local and regional network within the study area will be evaluated for system improvements. Part of the study process is to identify local infrastructure needs and develop a proposal. The study must consider investments in local infrastructure improvements to meet the needs of the proposal, because those improvements may provide the desired solution.

During the study process and while developing a proposal, it is important to use the data and analysis methods required for an IJR. If the study indicates that an IJR is warranted, the study data can be utilized in the IJR. Establish a support team for the study. This same support team would also be involved with the IJR process if the study shows that either a revision or a new access point is needed to meet the proposal purpose and need. The support team normally consists of the following:

- FHWA Area Engineer for Interstate Projects
- Region's Design or Project Development Engineer or Designee
- HQ Assistant State Design Engineer
- HQ Access and Hearings Unit Engineer
- HQ Traffic Office Representative
- Representative From Local Agencies (city, county, port, or tribal government)
- Recorder

The support team is encouraged to call upon specialists as needed; for example:

- Metropolitan Planning Organization (MPO)
- Regional Transportation Planning Organization (RTPO)
- WSDOT Region
 - Planning
 - Design
 - Environmental
 - Maintenance
 - IJR writer

- WSDOT Headquarters
 - Design
 - Bridge
 - Traffic
 - Geotechnical
- Project Proponent Specialists
- Transit Agencies

The support team's role is to:

- Develop a charter that includes the processes for reaching agreement, resolving disputes, and assigning responsibility for final decisions when consensus is not reached.
- Develop purpose, need, and vision statements for the study. This should be consistent with the project environmental document.
- Expedite the study step (and, if needed, the IJR development and review process) through early communication and agreement.
- Agree on area of influence and travel assumptions for the study and, if an IJR is needed, for each of the alternatives being considered.
- Develop the access assumptions document.
- Provide guidance and support.
- Evaluate data and identify possible alternatives for the proposal during the study and, if needed, for an IJR.
- Contribute material for the report that documents the discussions and decisions.
- Review results and determine whether an IJR is warranted.
- Ensure the compatibility of data used in various studies.
- Ensure integration of the Project Definition process, Value Engineering studies, public involvement efforts, environmental analyses, operational analyses, safety analyses, other analyses for the study (and, if needed, to prepare an IJR). This encourages the use of consistent data.
- Address design elements. Status of known deviations must be noted in Policy Point 4. Deviations are discouraged on new accesses.

(2) The Second Step

Prepare a detailed IJR using the guidance in 1425.05, "Interchange Justification Report and Supporting Analyses," and Figure 1425-4.

The IJR addresses eight specific policy topics. (See Figures 1425-1 and 2 for exceptions.) In order of presentation, the topics are:

1. Need for the Access Point Revision
2. Reasonable Alternatives
3. Operational and Accident Analyses
4. Access Connections and Design
5. Land Use and Transportation Plans
6. Future Interchanges
7. Coordination
8. Environmental Processes

The IJR is initiated early in the environmental process. Traffic analyses help define the area of impact and the range of alternatives. Since the traffic data required for the National Environmental Policy Act (NEPA) or the State Environmental Policy Act (SEPA) and the operational/safety analyses of the decision report are similar, these documents are usually developed together using the same data sources and procedures.

(3) The Third Step

Concurrence and approval of a new or revised access point is based on the IJR. The IJR contains sufficient information about and evaluation/analysis of the proposal to provide assurance that the safety and operations of the freeway system are not adversely impacted.

The region, with the help of the support team, prepares the IJR and submits four draft copies, including backup traffic data, for review. For a final IJR submittal, contact the HQ Access and Hearing Unit for the necessary number of copies. All IJR's are submitted to the HQ Access and Hearings Unit for review. Interstate IJR's are submitted by Headquarters to FHWA for concurrence and approval.

Interstate access point revisions are reviewed by both Headquarters and FHWA. If they are found to be acceptable to FHWA, they are given a finding of engineering and operational acceptability. Some Interstate IJR are reviewed and approved by the local FHWA Division Office. Other Interstate IJR are reviewed and approved by the Federal Highway Administration in Washington, DC. Additional review time is necessary for reports that have to be submitted to Washington DC. (See Figure 1425-1.)

If the IJR is finalized prior to the completion of the environmental process, it can be submitted for concurrence. Concurrence with the proposed Interstate access point revision can be made by FHWA in the form of a finding of engineering and operational acceptability. Final IJR approval by FHWA is provided concurrently with the appropriate final environmental decision: ECS, FONSI, or ROD (see definitions). For non-Interstate routes, the Assistant State Design Engineer's approval is given concurrently with environmental approval. (See Figure 1425-4.)

1425.05 Interchange Justification Report and Supporting Analyses

Begin the IJR 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. Formatting for the IJR includes (1) providing numbered tabs in the decision report for the policy points and appendices, and (2) numbering all pages including references and appendices. A suggestion for page numbering is to number each individual section, such as "Policy Point 3, PP3-4" and "Appendix 2, A2-25." This allows for changes without renumbering the entire report. The IJR must be assembled in the policy point order noted in this chapter.

On the bottom left of each page, place the revision date for each version of the IJR. As an individual page is updated, this revision date will help track the most current version of that page. Also, include the title of the report on the bottom left of each page. The use of comb binding is not allowed.

The eight policy points, which apply to both urban and rural areas, are presented below. Guidance is provided 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), and ramp terminals (freeway or local road).

(1) Policy Point 1: Need for the Access Point Revision

What are the current and projected needs? Why are the existing access points and the existing or improved local system unable to meet the proposal needs? Is the anticipated demand short or long trip?

Describe the need for the access point revision and why the existing access points and the existing or improved local system do not address the need. How does the proposal meet the anticipated travel demand? Provide the analysis and data to support the need for the access request.

(a) **Project Description.** Describe the needs being addressed and the proposal.

Demonstrate that improvements to the local transportation system and the existing interchanges cannot 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 in the design year.

The access point revision is primarily to meet regional, not local, travel demands. Describe the local and regional traffic (trip link and/or route choice) benefiting from the proposal.

(b) **Analysis and Data.** The proposal analysis, data, and study area must be agreed upon by the support team. The assumptions document captures the specific items.

Show that a preliminary (planning level) analysis, comparing build to no-build (baseline) data, was conducted for the current year, year of opening, and design year, comparing baseline, no-build condition, and build alternatives. Include the following steps:

- Define the study areas. The study area normally includes one interchange upstream and downstream from the proposed system revision. If the proposal's area of influence extends beyond those interchanges, the study area will be expanded accordingly.
- Collect and analyze current traffic volumes to develop current year, year of opening, and design year peak hour traffic estimates for the regional and local systems in the area of the proposal. Use regional transportation planning organization-based forecasts, refined 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. Modeling must include increased demand caused by anticipated development.
- Using existing information, 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 local system (widen, add new surface routes, coordinate the signal system, control access, improve local circulation, or improve parallel roads or streets).
 - The existing interchanges (lengthen or widen ramps, add park and ride lots, or add frontage roads).
 - The freeway lanes (add collector-distributor roads or auxiliary lanes).
- Transportation system management and travel demand management measures.
- Describe the current, year of opening, and design year level of service at all affected locations within the study area, including local systems, existing ramps, and freeway lanes.

(2) Policy Point 2: Reasonable Alternatives

Describe the reasonable alternatives that have been evaluated.

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 and that meet the proposal design year needs.

After describing each of the alternatives that were proposed, explain why reasonable alternatives were omitted or dismissed from further consideration.

Future projects must be coordinated as described in Policy Point 7.

(3) Policy Point 3: Operational and Accident Analyses

How will the proposal affect safety and traffic operations at year of opening and design year?

Policy Point 3 documents the procedures used to conduct the operational and accident analyses and the results that support the proposal.

The preferred operational alternative is selected, in part, by showing that it will not have a significant adverse impact on the operation and safety of the freeway and the affected local network, or that the proposal impacts will be mitigated.

Document the results of the following analyses in the report:

- “No-Build” Analysis – An operational analysis of the current year, year of opening, and design year for the existing limited access freeway and the affected local roadway system. This is the baseline “no-build” condition, including state transportation plan and comprehensive plan improvements expected to exist. All of the alternatives will be compared to the no-build condition.
- “Build” Analysis – An operational analysis of the year of opening and design year for the proposed future freeway and the affected local roadway system.

- An accident analysis for the most current data year, year of opening, and design year of the existing limited access freeway and the affected local roadway system for the “no-build.” An accident analysis should also be performed for the “build” as well.

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 local roadway system. If there are proposal impacts, explain how the impacts will be mitigated.

Document the selected operational analysis procedures. For complex urban projects, a refined model might be necessary. As a minimum, an analysis using the current version of the latest accepted *Highway Capacity Manual* (HCM) is necessary. Any procedure used must provide a measure of effectiveness compatible with the HCM. WSDOT currently supports the following traffic analysis and traffic simulation software:

- HCS
- Synchro
- Vissim
- Corsim

Refer to *Design Manual* Chapter 610, “Highway Capacity,” for more detail.

FHWA must conduct its independent analysis using HCS. In those instances where HCS is not the appropriate tool to use and a simulation-type software is chosen, early coordination with FHWA is necessary.

All operational analyses shall be of sufficient detail, and include sufficient data and procedure documentation to allow independent analysis during FHWA and HQ evaluation of the proposal. For Interstates, HQ must provide concurrence before it transmits the proposal to FHWA with its recommendation.

Prepare a layout displaying adjacent interchanges/intersections and the data noted below. The data should show:

- Distances between intersections or ramps of a proposed interchange, and that of adjacent existing and known proposed interchanges.
- Design speeds.
- Grades.
- Truck volume percentages on the freeway, ramps, and affected roadways.
- Adjustment factors (such as peak hour factors).
- Affected freeway, ramp, and local roadway system traffic volumes for the “no-build” and each “build” option. This will include: A.M. and P.M. peaks (noon peaks, if applicable); turning volumes; average daily traffic (ADT) for the current year; and forecast ADT for year of opening and design year.
- Affected main line, ramp, and local roadway system lane configurations.

The study area of the capacity analysis on the local roadway system includes documenting that the local network is able to 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. Record the limits of the analysis as well as how the limits were established in the project assumptions document.

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 local roadway system. In the 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. Note 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 local roadway network conditions that will affect traffic entering or exiting the freeway. If entering traffic is to be metered, explain the effect on the connecting local system (for example, vehicle storage).
- When the existing local and freeway network 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 no-build condition in the year of opening and the design year.

(b) **Accident Analysis.** The Accident Analysis identifies areas where there may be a safety concern. The study limits are the same as for operational analyses.

Identify and document all safety program (I2) locations. Identify and document accident histories, rates, and types for the freeway section and the adjacent affected local 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.

Demonstrate (1) that the proposal does not have a significant adverse impact on the safety of the freeway or the adjacent affected local surface system, or (2) that the impacts will be mitigated. The safety analysis for both existing and proposed conditions should include the following:

1. Type of Accidents
 - What types of accidents are occurring (overturns, rear-ends, enter-at-angle, hitting fixed object)?
 - What types of accidents are most prevalent?
 - Are there any patterns of accident type or cause?
2. Severity of Accidents (fatalities, disabling, evident injuries, property damage)

3. Accident Rates and Numbers

- Document the number and rate of accidents within the study limits for existing and proposed conditions.
- What are the existing and anticipated crash/serious injury/fatality rates and numbers by proximity to the interchange exit and entrance ramps?
- How do these rates compare to similar corridors or interchanges?
- How do these rates compare to the future rates and numbers?
- What are the existing and anticipated crash/serious injury/fatality rates and numbers for the impacted adjacent and parallel road system (with and without the access revision)?

4. Contributing Factors and Conclusions

- Document contributing causes of accidents and conclusions. What are the most prevalent causes?
- Evaluate and document the existing and proposed roadway conditions for geometric design standards, stopping sight distance and other possible contributing factors. Would the proposal reduce the frequency and severity of accidents?

(4) Policy Point 4: Access Connections and Design

Will the proposal provide fully directional interchanges connected to public streets or roads, spaced appropriately, and designed to full design level geometric control criteria?

Wherever possible, provide for all directions of traffic movement. The intent is to provide full movement at all interchanges, whenever possible. Partial interchanges are discouraged. 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 new or revised interchange access must connect to a public freeway, road, or street and be endorsed by the local governmental agency or tribal government having jurisdiction over said public freeway, road, or street.

Explain how the proposed access point relates to present and future proposed interchange configurations and the *Design Manual* spacing criteria. Note that urban and rural interchange spacing for crossroads also includes additional spacing requirements between the noses of adjacent ramps, as noted in Chapter 940.

Develop the proposal in sufficient detail to conduct a design and operational analysis. Include the number of lanes, horizontal and vertical curvature, lateral clearance, lane width, shoulder width, weaving distance, ramp taper, interchange spacing, and all traffic movements. This information is presented as a sketch or a more complex layout, depending on the complexity of the proposal.

The status of all known or anticipated project deviations must be noted in this policy point, as described in Chapter 330.

(5) Policy Point 5: 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 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.) The proposed access point revision will affect adjacent land use and, conversely, land use will affect the travel demand generated. Therefore, reference and show compatibility with the land use plans, zoning controls, and transportation ordinances in the affected area.

Explain the consistency of the proposed access point revision with the 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 urbanized areas, the plan refinement must be adopted by the metropolitan planning organization (MPO) before the project is designed. The action must also be consistent with the *State Transportation Plan*.

(6) Policy Point 6: Future Interchanges

Is the proposed access point revision compatible with a comprehensive network plan? Is the proposal compatible with other known new access points and known revisions to existing points?

The report must demonstrate that the proposed access point revision is compatible with other known new access points and known revisions to existing points.

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.

(7) Policy Point 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, 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, if the local circulation system is necessary for the proposal to operate, it must be in place before new ramps are opened to traffic. 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 are encouraged to include a fiscal commitment and an anticipated time for completion. If the project is to be constructed in phases, it must be demonstrated in Policy Point 3 that each phase can function independently and does not affect the safety and operational efficiency of the freeway. Note the known funding sources, the projected funding sources, and the estimated time of completion for each project phase.

(8) Policy Point 8: Environmental Processes

What is the status of the proposal's environmental processes? This section should be something more than just a status report of the environmental process; it should be a brief summary of the environmental process.

All requests for access point revisions on freeways must contain information on the status of the environmental approval and permitting processes.

The following are just a few examples of environmental status information that may apply:

- Have the environmental documents been approved? If not, when is the anticipated approval date?
- What applicable permits and approvals have been obtained and/or are pending?
- Are there hearings still to be held?
- Is the environmental process waiting for an engineering and operational acceptability decision?

1425.06 Documentation

A list of documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/EESC/Design/projectdev/>

Project Type	Support Team	Policy Point								Concurrence	Approval
		1	2	3	4	5	6	7	8		
Interstate Routes											
New freeway-to-crossroad interchange in a Transportation Management Area ⁽¹⁾	Yes	✓	✓	✓	✓	✓	✓	✓	✓	FHWA and HQ	FHWA DC
New partial interchange	Yes	✓	✓	✓	✓	✓	✓	✓	✓	FHWA and HQ	FHWA DC
New HOV direct access	Yes	✓	✓	✓	✓	✓	✓	✓	✓	FHWA and HQ	FHWA DC
New freeway-to-freeway interchange	Yes	✓	✓	✓	✓	✓	✓	✓	✓	FHWA and HQ	FHWA DC
Revision to freeway-to-freeway interchange in a Transportation Management Area ⁽¹⁾⁽²⁾	Yes	✓	✓	✓	✓	✓	✓	✓	✓	FHWA and HQ	FHWA DC
New freeway-to-crossroad interchange not in a Transportation Management Area ⁽¹⁾	Yes	✓	✓	✓	✓	✓	✓	✓	✓	HQ	FHWA
Revision to freeway-to-freeway interchange not in a Transportation Management Area ⁽¹⁾⁽²⁾	Yes	✓	✓	✓	✓	✓	✓	✓	✓	HQ	FHWA
Revision to interchange ⁽²⁾⁽³⁾	Yes	✓	✓	✓	✓	✓	✓	✓	✓	HQ	FHWA
Revision to existing interchange—no adverse impacts to main line	No	(6)	(6)	✓	✓	(6)	(6)	(6)	(6)	HQ	FHWA
Transit flyer stop on main line	Yes	✓	✓	✓	✓	✓	✓	✓	✓	HQ	FHWA
Transit flyer stop on an on-ramp	No			✓	✓					HQ	FHWA
Addition of entrance or exit ramps that complete basic movements at an existing interchange	Yes	✓	✓	✓	✓	✓	✓	✓	✓	HQ	FHWA
Abandonment of a ramp ⁽⁴⁾	Yes	✓	✓	✓	✓	✓	✓	✓	✓	HQ	FHWA
Locked gate ⁽⁷⁾	No	✓			(5)					HQ	FHWA
Access breaks that do not allow any type of access to main line or ramps	No	✓	✓		(5)					HQ	FHWA
Pedestrian structure	No	✓			(5)					HQ	FHWA
Construction/emergency access break	No	✓	✓	✓	✓					Region	FHWA

Notes:

- (1) In Washington, designated Transportation Management Areas include Clark, King, Kitsap, Pierce, Snohomish, and Spokane Counties.
- (2) “Revision” 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 “revision.” If the revision 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, a modified IJR will be the acceptable document, meaning fewer than the eight policy points will be required. Consult the HQ Access and Hearings Unit for direction.
- (3) Revisions that might adversely affect the level of service of the through lanes. Examples include: 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. If the revision does not have adverse impacts to the Interstate main line, and the spacing and geometric control criteria requirements will be met, a modified IJR will be the acceptable document.
- (4) Unless it is a condition of the original approval.
- (5) Update the right-of-way/limited access plan as necessary.
- (6) If the results of the operational analysis show an adverse impact to the main line, the remaining policy points must be fully, not briefly, addressed.
- (7) As part of Policy Point 1, include a narrative stating that all other alternatives are not feasible.

Interstate Routes – Interchange Justification Report Content and Review Levels
Figure 1425-1

Project Type	Support Team	Policy Point								Concurrence	Approval
		1	2	3	4	5	6	7	8		
Non-Interstate Routes											
New freeway-to-crossroad interchange on a predominately grade-separated corridor	Yes	✓	✓	✓	✓	✓	✓	✓	✓	Region	HQ
New freeway-to-freeway interchange	Yes	✓	✓	✓	✓	✓	✓	✓	✓	Region	HQ
Revision to freeway-to-freeway interchange	Yes	✓	✓	✓	✓	✓	✓	✓	✓	Region	HQ
New freeway-to-crossroad interchange on a predominately at-grade corridor	No			✓	✓					Region	HQ
Revision to interchange ⁽¹⁾	No			✓	✓					Region	HQ
Addition of entrance or exit ramps that complete basic movements at an existing interchange	No			✓	✓					Region	HQ
Abandonment of a ramp ⁽²⁾	No			✓						Region	HQ
Locked gate ⁽⁴⁾	No	✓			(3)					Region	HQ
Pedestrian structure	No	✓			(3)					Region	HQ
Construction/emergency access break	No	✓	✓	✓						Region	HQ

Notes:

- (1) Revisions that might adversely affect the level of service of the through lanes. Examples include: doubling lanes for an on-ramp with double entry to the freeway, adding a loop ramp to an existing diamond interchange, and replacing a diamond ramp with a loop ramp. If the revision does not have adverse impacts to the main line, and the spacing and geometric control criteria requirements will be met, a modified IJR will be the acceptable document.
- (2) Unless it is a condition of the original approval.
- (3) Update the right-of-way/limited access plan as necessary.
- (4) As part of Policy Point 1, include a narrative stating that all other alternatives are not feasible.

Non-Interstate – Interchange Justification Report Content and Review Levels
Figure 1425-2

Interstate actions that *may not* require an IJR or FHWA action.

Project Type	Examples/Comments
Minor revision to existing freeway-to- freeway interchange	To bring to standard
Increasing the length of an exit ramp deceleration lane or entrance ramp acceleration lane	To meet current geometric control criteria
Relocating entrance or exit ramp gore points along the main line	
Adding an auxiliary lane between two adjacent interchange ramps	
Ramp terminal revision at the terminal connection with the crossroad, with no effect to the main line lanes of the interstate.	New turn pocket(s), through lane(s), signalization, roundabout(s)
Converting a one-lane ramp to two lanes with no effect on the through lanes of the Interstate	If there are impacts to the main line, an IJR is required. Contact the HQ Access and Hearings Unit for direction.
Transit flyer stops near the ramp terminals of on-ramps	

Complete Policy Point 3 first for all proposals. If Policy Point 3 shows impacts to the main line, complete the remaining Policy Points.

Notes:

The table above shows some, but not all, of the types of access revisions that normally do not require an Interchange Justification Report.

All changes to limited access routes must receive the approval of the Assistant State Design Engineer.

All access changes on Interstate routes must be approved by FHWA.

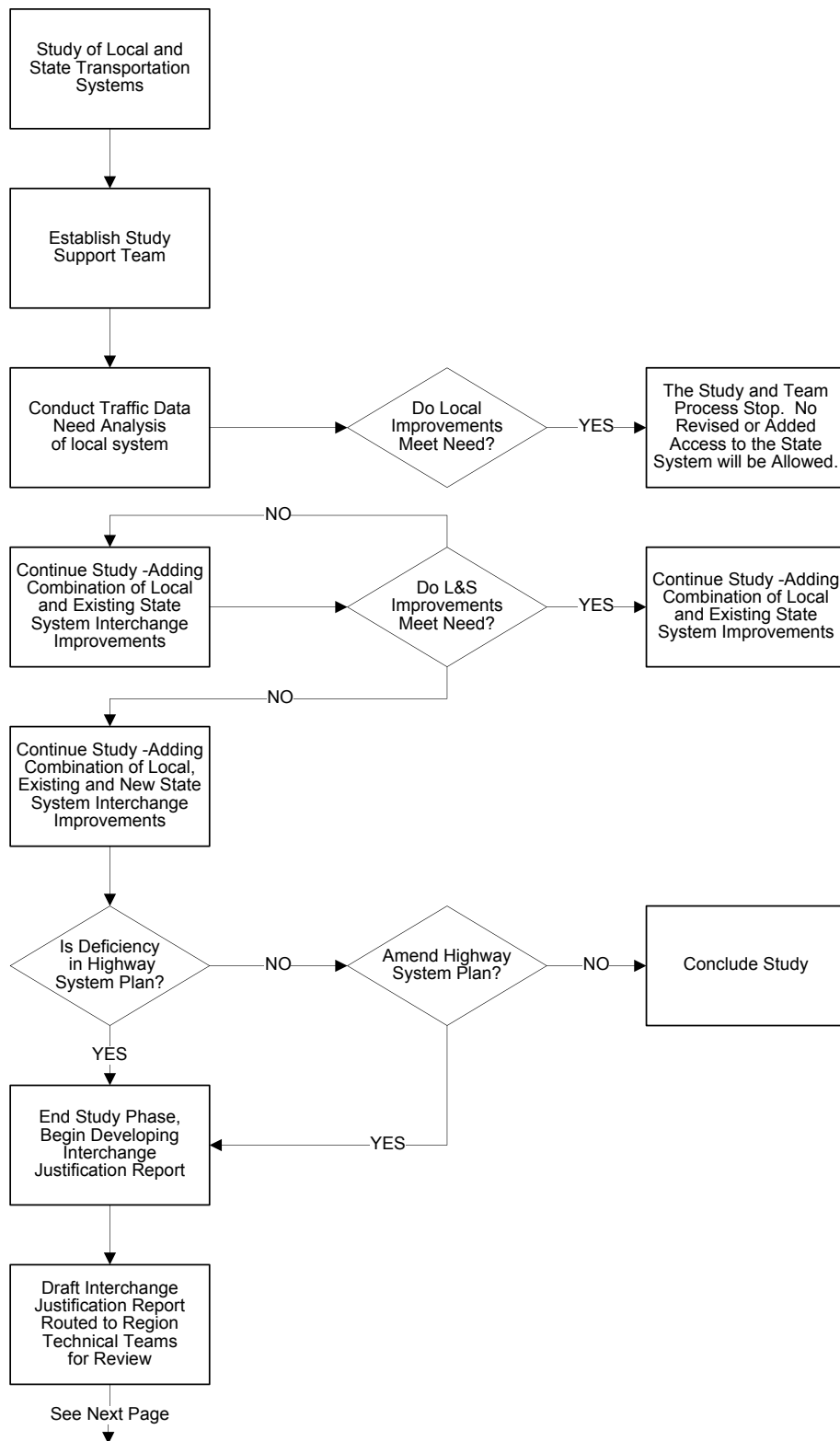
If the following conditions are met, the proposal may be considered under lesser documentation:

- A traffic analysis documents that there will be no adverse impact to the freeway main line.
- 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.

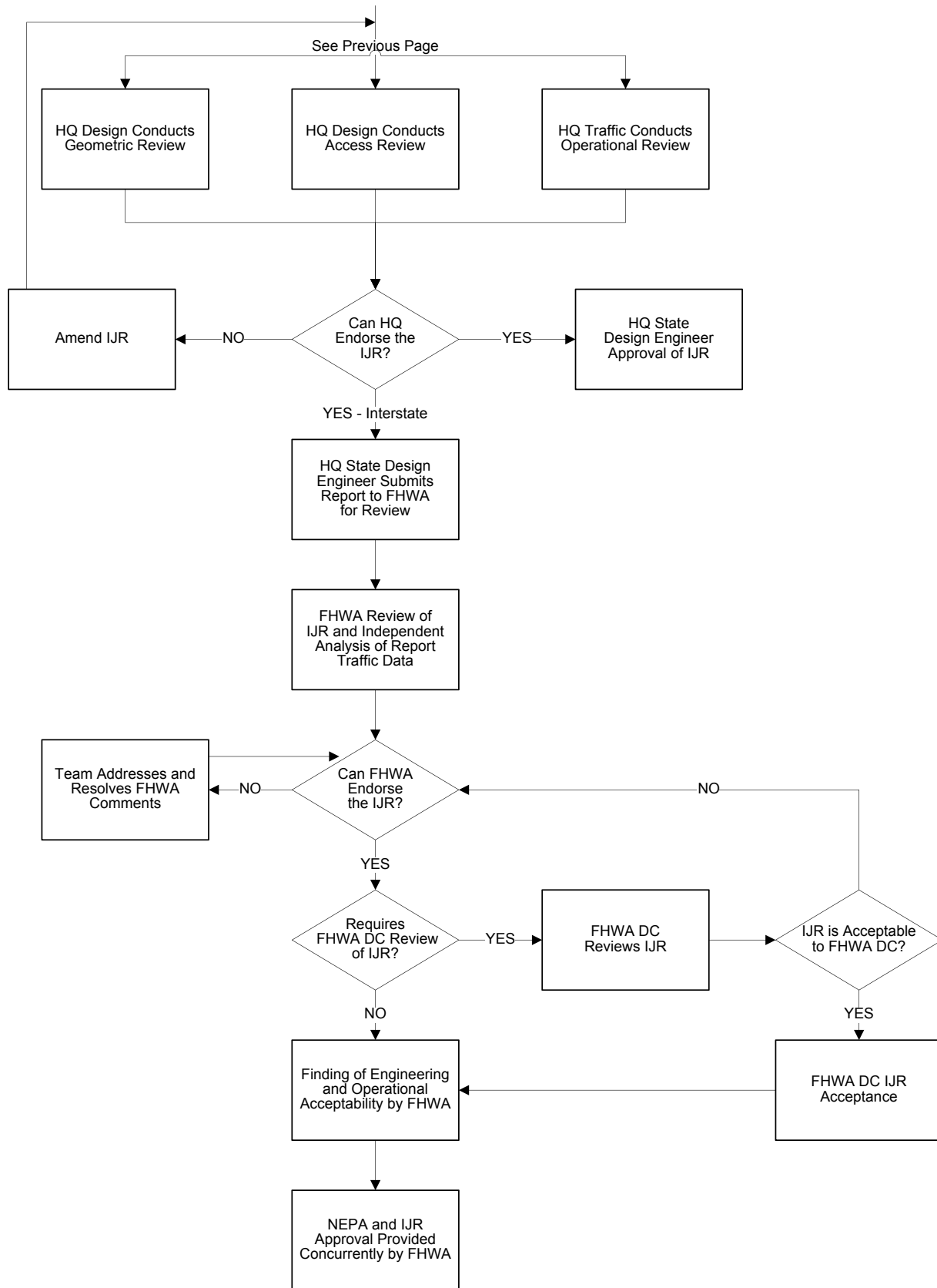
The omission of the IJR is justified in the Design Documentation Package, with a copy sent to the state Access and Hearings Engineer after the Assistant State Design Engineer has concurred in writing. If Interstate, FHWA must concur.

Interchange Justification Report Possibly Not Required

Figure 1425-3



Interchange Justification Report Process Flow Chart
Figure 1425-4



Interchange Justification Report Process Flow Chart
Figure 1425-4 Continued

- 1440.01 General
- 1440.02 References
- 1440.03 Procedures
- 1440.04 Datums
- 1440.05 Global Positioning System
- 1440.06 WSDOT Monument Database
- 1440.07 Geographic Information System
- 1440.08 Photogrammetric Surveys
- 1440.09 Documentation

1440.01 General

The Washington State Department of Transportation (WSDOT) is permitted, by an agreement with the Board of Registration for Professional Engineers and Land Surveyors, to practice land surveying “under the direct supervision of a licensed professional land surveyor OR a licensed professional engineer.” (See Figures 1440-1a and b, Interagency Agreement.)

1440.02 References

Revised Code of Washington (RCW) 58.09, “Surveys – Recording”

RCW 58.20.120, “System designation – Permitted uses”

RCW 58.24.040(8), “. . . temporary removal of boundary marks or monuments”

Washington Administrative Code (WAC) 332-120, “Survey Monuments – Removal or Destruction”

WAC 332-130, “Minimum Standards for Land Boundary Surveys and Geodetic Control Surveys and Guidelines for the Preparation of Land Descriptions”

Interagency Agreement Between the Washington State Department of Transportation and the Board of Registration for Professional Engineers and Land Surveyors (1990)

Construction Manual, M 41-01, WSDOT

Highway Surveying Manual, M 22-97, WSDOT

Plans Preparation Manual, M 22-31, WSDOT
WSDOT Monument Database:
<http://www.wsdot.wa.gov/monument/>

1440.03 Procedures

For WSDOT projects, it is recommended that surveying activities include (if appropriate) but not be limited to the following items.

(1) During the Project Definition Phase

(a) Record any pertinent surveying information as detailed in the Design Documentation Check List at:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

(b) Research for recorded survey monuments existing within the project area.

(c) Determine and prioritize project survey needs and tasks to be completed. Needs and tasks may include:

- Cadastral issues
- Right of way issues
- Geodetic control issues
- Photogrammetry issues
- Other issues as needed

(2) During Design and Development of the Plans, Specifications, and Estimates

(a) The project manager and project surveyor hold a preliminary survey meeting, covering:

- Project schedule
- Anticipated survey requests

For preliminary survey meeting specifics and roles and responsibilities of the project manager and project surveyor, see the *Highway Surveying Manual*.

(b) Perform field reconnaissance, mark existing recorded survey monuments, and determine the location of possible new survey monuments. Also, mark found unrecorded monuments for preservation if practical.

(c) Determine the impact to geodetic monuments and notify the Headquarters (HQ) Geographic Services Office.

(d) Refer to the *Highway Surveying Manual* to:

- Convert Washington State plane coordinates to project datum.
- Document the procedure and combined factor used for converting between datums.
- Determine survey collection methods.
- Collect primary, secondary, and tertiary survey data.
- Process and import secondary, tertiary, or other survey data into design software for use by designers.

(e) Apply to the Department of Natural Resources (DNR) for permits for monuments that will be disturbed or removed (Chapter 1450).

(f) Archive new primary and secondary survey control data in the WSDOT Monument Database and GIS, as appropriate, for future retrieval.

(g) Ensure that all survey monuments within the project right of way are shown on the contract plans in order to avoid accidental damage.

(h) Develop a Record of Survey (RCW 58.09) or a Monumentation Map as required (Chapter 1450).

(3) After Construction is Completed

(a) Complete a “Post Construction” survey as described in the *Highway Surveying Manual* and the *Construction Manual*.

(b) Have the DNR Completion Report signed and stamped by the appropriate professional in direct charge of the surveying work, then file with DNR as described in Chapter 1450.

1440.04 Datums

A datum is a geometrical quantity (or set of quantities) that serves as a reference, forming the basis for computation of horizontal and vertical control surveys in which the curvature of the earth is considered. Adjusted positions of the datum, described in terms of latitude and longitude, may be transformed into state plane coordinates.

All engineering work (mapping, planning, design, right of way, and construction) for WSDOT projects is based on a common datum.

(1) Horizontal

WAC 332-130-060 states, “The datum for the horizontal control network in Washington shall be NAD83 (1991) [the North American Datum of 1983] as officially adjusted and published by the National Geodetic Survey of the United States Department of Commerce and as established in accordance with chapter 58.20 RCW. The datum adjustment shall be identified on all documents prepared; i.e., NAD83 (1991).” For further information, see the *Highway Surveying Manual*.

(2) Vertical

The North American Vertical Datum of 1988 (NAVD88) as defined by the National Geodetic Survey (NGS) is the official civilian datum for surveying and mapping activities in the United States. WSDOT has adopted this datum. For further information, see the *Highway Surveying Manual*.

1440.05 Global Positioning System

A Global Positioning System (GPS) uses a constellation of satellites and earth stationed receivers to determine geodetic positions (latitude and longitude) on the surface of the earth. WSDOT personnel use this survey technology. (See the *Highway Surveying Manual* for more detailed discussions.)

GPS technology is changing rapidly. The key point is for the designer and surveyor to select the best tool (GPS or conventional applications) for doing the survey fieldwork. Oftentimes a combination of GPS and conventional (Total Station) surveying is appropriate.

1440.06 WSDOT Monument Database

The WSDOT Monument Database provides storage and retrieval capabilities for data associated with survey control monuments set by WSDOT. This database supports and tracks the Report of Survey Mark and aids in fulfilling WSDOT's obligation to contribute to the body of public record, thereby minimizing the duplication of survey work. The Report of Survey Mark provides data on specific GPS stations. (See Figure 1440-2 for an example of a Report of Survey Mark.)

To access the WSDOT Monument Database, see the following web site:

<http://www.wsdot.wa.gov/monument/>

1440.07 Geographic Information System

The Geographic Information System (GIS) is a collection of information from many sources. Its purpose is to assemble data into a central database for the common good. The data is stored on many levels so that the desired information can be selected and combined to achieve the desired product. Surveying and photogrammetric data are vital elements of this system.

1440.08 Photogrammetric Surveys

Photogrammetric surveys are performed to furnish topographic or planimetric maps and cross sections for use in the reconnaissance, location, and preliminary design phases of highway work. To use photogrammetric surveys for final design and construction requires that the ground be nearly bare to obtain the necessary accuracy. By using well-planned aerial photography in stereoscopic plotters, contours and other physical features are delineated on map sheets to a scale consistent with the accuracies or detail required.

The usefulness of aerial photography is not limited to mapping. Taking the form of enlargements, mosaics, and digital images, it can be used as a visual communication tool (displays and exhibits) for planning, design, property acquisition, engineering, construction, litigation, and public relations.

To obtain information on preparation, procedure, and programming of aerial photography and photogrammetric mapping and applications, contact the HQ Geographic Services Office. When requesting a photogrammetric survey, specify the desired units and check the units of the product. Allow for the time required to communicate the complex and detailed work request, develop the service, and accomplish the product.

1440.09 Documentation

For documentation related to monuments, see Chapter 1450.

Primary and secondary survey control data are archived in the WSDOT Monument Database and GIS when available.

The documents required to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

**INTERAGENCY AGREEMENT BETWEEN
THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
AND THE BOARD OF REGISTRATION FOR PROFESSIONAL
ENGINEERS AND LAND SURVEYORS**

THE FOLLOWING Interagency Agreement is hereby entered into between the Washington State Department of Transportation (hereafter referred to as "WSDOT") and the Washington State Board of Registration for Professional Engineers and Land Surveyors (hereafter referred to as "BOARD").

I

DECLARATIONS OF THE PARTIES

- A. WHEREAS the BOARD has the exclusive authority to regulate the practice of engineering and land surveying in Washington; and
- B. WHEREAS WSDOT employees are required to practice land surveying as defined by RCW 18.43.020 in carrying out the program of said agency; and
- C. WHEREAS WSDOT is exempted from necessarily using a licensed land surveyor to perform said surveys in accordance with the provisions of the Survey Recording Act, RCW 58.09.090; and
- D. WHEREAS both the BOARD'S and WSDOT'S goals include the performance of land surveys in conformance with recognized standards of practice and relevant laws and administrative codes in order to safeguard life, health, and property; and
- E. WHEREAS the parties to the Agreement agree to the following Principles of Agreement.

II

PRINCIPLES OF AGREEMENT

- A. The practice of land surveying performed by WSDOT employees shall be under the direct supervision of a licensed professional land surveyor OR licensed professional engineer. Said licensee shall hold a valid Washington license issued in conformance with RCW 18.43.
- B. All surveys performed by WSDOT employees shall be performed in accordance with the Survey Standards promulgated under Chapter 332-130 WAC.
- C. When a survey has been performed by WSDOT employees a survey map shall be prepared and filed with the county engineer in compliance with RCW 58.09.090(1)(a). Said map's contents shall be in conformance with the requirements of RCW 58.09.060 and WAC 332-130. Furthermore, said map shall contain the stamp and signature of the licensee who was in direct responsible charge of the work.

Interagency Agreement
Figure 1440-1a

- D. A record of corner information shall be filed in accordance with RCW 58.09.040(2) and 58.09.090(2) where WSDOT employees replace or restore an existing or obliterated general land office corner. Said record of corner information shall be signed and stamped by the professional land surveyor or professional engineer responsible for said work.
- E. The temporary removal or destruction of any section corner or any other land boundary mark or monument shall be permitted if performed in compliance with RCW 58.24.040(8).
- F. Whether performed by a licensed professional engineer or a licensed professional land surveyor, any surveys performed by WSDOT shall be in accordance with the standards generally expected of those practicing professional land surveying.

IN WITNESS WHEREOF: The Washington State Department of Transportation and the Board of Registration have signed this Agreement.

/s/ Ed W. Ferguson

Ed W. Ferguson, PE
DEPUTY SECRETARY
Department of Transportation

January 5, 1990
Date

This Agreement approved by motion of the Board dated January 19, 1990.

/s/ Wesley E. Taft

Wesley E. Taft, PE
CHAIRMAN, Board of Registration

January 19, 1990
Date

Interagency Agreement
Figure 1440-1b

SURVEY INFORMATION SYSTEM

Report of Survey Mark

GENERAL MONUMENT INFORMATION

Designation: GP29530-21	T.R.S: 31N, 5E , 2	<p>ACCOUNTS INFORMATION BOOK PROJECT INVOICE 49 0L2030 23-94042</p>
Monument ID: 8	Corner Code:	
State: WASHINGTON	State Route: 530	
County: SNOHOMISH	Mile Post: 20.590	
Region: NW	Station:	
Nearest Town: ARLINGTON	Offset:	
Usgs Quad: ARLINGTON WEST	Owner: GS	
	Bearing: M	

Description

TO REACH THE STATION FROM THE INTERSECTION OF SR 530 AND SR 009 AT ARLINGTON, GO WEST 0.2 MILES ALONG SR 530 TO THE STATION ON THE RIGHT. IT IS LOCATED 1.1 METERS SOUTH OF A WITNESS POST, 33.5 METERS WEST OF THE APPROXIMATE CENTERLINE OF DIKE ROAD AND 1.2 METERS NORTH OF A GUARD RAIL. THE STATION IS A STANDARD WSDOT BRASS DISK SET IN A ROUND CONCRETE MONUMENT PROJECTING 0.2 FEET ABOVE THE GROUND. NOTE: 'POSITION UP-DATE BY OCCUPYING WITH G.P.S.' NOTE: TIED TO HPN 4/94. THIS IS A NAVD88 UPDATE.



CURRENT SURVEY CONTROL

<u>DATUM</u>	<u>LATITUDE</u>	<u>UNIT</u>	<u>LONGITUDE</u>	<u>UNIT</u>	<u>NETWORK</u>	<u>METHOD</u>	<u>ACCURACY</u>
NAD 83/91	48 11 54.567381	N	122 08 03.530464	W	PRIMARY	GPS	2 CM

Report of Survey Mark
Figure 1440-2

- 1450.01 General
- 1450.02 References
- 1450.03 Definitions
- 1450.04 Control Monuments
- 1450.05 Alignment Monuments
- 1450.06 Property Corners
- 1450.07 Other Monuments
- 1450.08 Documentation
- 1450.09 Filing Requirements

1450.01 General

Proper monumentation is important in referencing a highway's alignment, which is used to define its right of way. The department can contribute to the body of public records and minimize duplication of survey work by establishing and recording monuments that are tied to a state plane coordinate system and to a standard vertical datum. The department is required by law to perpetuate existing recorded monuments. (See RCW 58.09.) The department provides monuments for realignments and new highway alignments and perpetuates existing monuments impacted by a project.

The Department of Natural Resources (DNR) is designated as the official agency for surveys and maps. New monuments set to establish property corners, highway alignment, etc., shall be recorded on a Record of Survey or Monumentation Map and filed with the DNR Public Land Survey Office and the appropriate county auditor or county engineer. All Records of Survey and Monumentation Maps are retained at DNR. Geodetic monuments are established and the Headquarters Geographic Services Office retains their placement records. Geodetic monuments are recorded on a Report of Survey Mark. These records are made available to the public on the internet by viewing: <http://www.wsdot.wa.gov/monument>

Existing monuments are not to be disturbed without first obtaining the DNR permits required by state law. DNR allows the temporary covering of a string of monuments under a single permit. State law requires replacement of land boundary monuments after temporary removal according to permit procedures. Washington State Department of Transportation (WSDOT) control and alignment monuments may not be removed without replacement, unless the location of the original position is perpetuated by reference and the appropriate document(s) prepared and filed with the county and the WSDOT Right of Way Plans Branch. Other requirements pertaining to specific monuments are discussed below.

Figure 1450-1 summarizes the documentation requirements for new and existing monuments.

The region is responsible for identifying and locating all existing monuments; obtaining all required permits before any existing monument is disturbed; and the research to locate existing monuments as required by WAC 332-120-030, as follows:

(2) *Any person, corporation, association, department, or subdivision of the state, county or municipality responsible for an activity that may cause a survey monument to be removed or destroyed shall be responsible for ensuring that the original survey point is perpetuated. It shall be the responsibility of the governmental agency or others performing construction work or other activity (including road or street resurfacing projects) to adequately search the records and the physical area of the proposed construction work or other activity for the purpose of locating and referencing any known or existing survey monuments.*

1450.02 References

Revised Code of Washington (RCW) 18.43
“Engineers and Land Surveyors,”

RCW 58.09 “Surveys – Recording,”

RCW 58.24 “State Agency for Surveys and Maps – Fees,”

Washington Administrative Code (WAC) 332-120
“Survey Monuments – Removal or Destruction,”
WAC 332-130 “Minimum Standards for Land
Boundary Surveys and Geodetic Control Surveys
and Guidelines for the Preparation of Land
Descriptions,”

Highway Surveying Manual, M 22-97, WSDOT

“Manual of Instructions for the Survey of the
Public Lands of the United States 1973 BLM,
U.S. Department of Interior”

1450.03 Definitions

monument As defined for this chapter, a monument is any physical object or structure which marks or references a survey point.

This includes but is not limited to a point of curvature (P.C.), a point of tangency (P.T.), a property corner, a section corner, a General Land Office (GLO) survey point, a Bureau of Land Management (BLM) survey point, and any other permanent reference set by a governmental agency or private surveyor.

removal or destruction The physical disturbance or covering of a monument such that the survey point is no longer visible or readily accessible.

1450.04 Control Monuments

Horizontal and vertical control monuments are permanent references required for the establishment of project coordinates tied to the Washington State plane system and elevations tied to a standard vertical datum. By establishing and recording permanent control monuments, the department eliminates duplication of survey work and contributes to the body of public records.

Horizontal and vertical control monuments are required for highway projects requiring the location of existing or proposed alignment

or right of way limits. Monuments set by other agencies may be used if within 1 mile of the project, and the required datum and accuracy were used.

When control monuments are required for a given project, show the existing and proposed control monuments on the contract plans.

For horizontal control:

- Use North American Datum 1983, revised 1991 (NAD83/91).
- Use a minimum of second order, Class II procedures as defined in the *Highway Surveying Manual* (M 22-97).
- Provide two monuments near the beginning of the project. Where possible, when setting horizontal control, set points to act as azimuth points. Place points so that line of sight is preserved between them and in an area that will not be disturbed by construction.
- Provide two monuments near the end of the project.
- Provide a pair of monuments at about 3-mile intervals throughout the length of the project.

For vertical control:

- Use North American Vertical Datum 1988 (NAVD88). (See the *Highway Surveying Manual* for orders of accuracy required.)
- Use at least second order procedures for primary vertical control within project limits as defined in the *Highway Surveying Manual*. Use third order for secondary control throughout the project.
- Provide vertical control throughout the length of the project. Desirable spacing is at or near each milepost. Maximum spacing is 3 miles apart.

All control monuments that are established, reestablished, or reset must be filed with the county engineer and the Department of Natural Resources (DNR). Submit a Record of Survey or a Monumentation Map that has been signed by the supervising, licensed, professional engineer or licensed, professional land surveyor; if the monument is not used to reference right of way or land corners, submit a Report of Survey Mark. (See the Highway Surveying Manual for more detailed guidance on Control Monuments.)

1450.05 Alignment Monuments

Alignment monuments are permanent references required for the establishment or reestablishment of the highway and its right of way. Placing monuments at random points, in safe locations and tied to the Washington State plane coordinate system is recommended. (See the *Highway Surveying Manual*.)

Establishment, reestablishment, or resetting of alignment monuments is required on the following highway projects:

- New highway alignment projects
- Highway realignment projects involving new right of way (monuments are only required for the realigned highway section)
- Highway projects where alignment monuments already exist

Before an existing alignment monument is reestablished or reset, a DNR permit is required.

All alignment monuments that are established, reestablished, or reset must be filed with the appropriate county auditor or county engineer. The Record of Survey is filed with the county auditor in the county in which the monument is located and a recorded copy is sent to the Headquarters (HQ) Right of Way Plans Branch. The original Monumentation Map is filed with the county engineer of the county in which the monument is located and a recorded copy, with the filing signatures, is sent to the HQ Right of Way Plans Branch. The HQ Right of Way Plans Branch will forward a copy to DNR.

1450.06 Property Corners

A new property corner monument will be provided where an existing recorded monument has been invalidated as a direct result of a right of way purchase by the department. The new property corner monument shall be set by or under the direct supervision of a licensed professional engineer or licensed professional land surveyor.

The licensed land surveyor files the Record of Survey with the county auditor. A recorded copy of the Record of Survey is sent to the HQ Right of Way Plans Branch, and the HQ Real Estate Services Office. The licensed professional engineer files a Monumentation Map with the county engineer of the county in which the monument is located and a recorded copy is sent to the HQ Right of Way Plans Branch and the HQ Real Estate Services Office.

1450.07 Other Monuments

A DNR permit is required before any monument may be removed or destroyed.

Existing section corners and BLM or GLO monuments impacted by a project shall be reset to perpetuate their existence. After completing the work, a DNR Land Corner Record is required.

Other permanent monuments established by any other governmental agency must not be disturbed until the agency has been contacted to determine specific requirements for the monument. If assistance is needed to identify a monument, contact the HQ Geographic Services Office.

Resetting monuments must be done by or under the direct supervision of a licensed professional engineer or a licensed professional land surveyor. If a Record of Survey is prepared, it will be filed with the county auditor in the county in which the monument is located. If a Monumentation Map is prepared, it is filed with the county engineer of the county in which the monument is located and a recorded copy is sent to the HQ Right of Way Plans Section. The HQ Right of Way Plans Branch will forward a copy to DNR for their records.

1450.08 Documentation

The documents required to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

1450.09 Filing Requirements

(1) DNR Permit

When a DNR permit is required, use the application form shown in Figure 1450-2a. The completed application must be signed by a licensed professional engineer or a licensed professional land surveyor and submitted to DNR. The DNR permit applications can be down loaded in TIFF, PDF, or Word format at the following web site:
<http://www.dnr.wa.gov/htdocs/plso/download.htm>.

Monumentation work cannot be done until DNR has approved the permit. In extraordinary circumstances, verbal authorization may be granted by DNR pending the issuance of a written permit.

After resetting the monument, the survey method used must be filed with DNR using the completion report form shown in Figure 1450-2b. The form must be signed by a licensed professional engineer or a licensed professional land surveyor.

(2) Documentation Map

When a Monumentation Map is required, a plan sheet is prepared. Generally, the plan sheet is based on a right of way plan obtained from the HQ Right of Way Plans Branch. A Monumentation Map contains a description of all new and existing monuments indicating their kind, size, and location. In addition, it must contain the seal and signature of a licensed professional engineer or a licensed professional land surveyor. (See the *Plans Preparation Manual*.)

A copy of a Monumentation Map is filed with the county engineer of the county in which the monument is located and a recorded copy is sent to the HQ Right of Way Plans Branch. The HQ Right of Way Plans Branch will forward a copy to DNR for their records.

(3) Land Corner Record

When a Land Corner Record is required, use the forms shown in Figures 1450-3a and 3b. The completed forms must be signed and stamped by a licensed professional engineer or a licensed professional land surveyor and submitted to the county auditor for the county in which the monument is located.

SET NEW

WSDOT Control Monument

Before: No permit required.

After: File a copy of the Monumentation Map with the county engineer. Send the original to the HQ Right of Way Plans Branch.

Alignment Monument

Before: No permit required

After: File a Record of Survey with the county auditor or a Monumentation Map with the county engineer. Send a copy to the HQ Right of Way Plans Branch.

Property Corner Monument*

Before: Engage a licensed professional land surveyor

After: Licensed professional land surveyor files Record of Survey with county auditor or a licensed professional engineer files a Monumentation Map with the county engineer and sends a copy to the HQ Right of Way Plans Branch.

DISTURB EXISTING*

Control Monument

Before: Obtain DNR permit.

After: File a copy of the Monumentation Map with the county engineer. Send the original to the HQ Right of Way Plans Branch.

Alignment Monument

Before: Obtain DNR permit.

After: File a copy of a Monumentation Map with the county engineer. Send the original to the HQ Right of Way Plans Branch.

Section Corner, BLM, or GLO Monument

Before: Obtain DNR permit.

After: File Land Corner Record with the county engineer. Send a copy to the HQ Right of Way Plans Branch.

All Other Monuments

Before:

- Obtain DNR permit.
- Contact governmental agency

After: File a copy of a Monumentation Map with the county engineer. Send the original to the HQ Right of Way Plans Branch.

*Property corner monuments must be filed within 90 days of establishment, re-establishment, or restoration.

Monument Documentation Summary

Figure 1450-1

APPLICATION FOR PERMIT TO REMOVE OR DESTROY A SURVEY MONUMENT

PERMIT NO.

You are hereby authorized to remove or destroy
the described survey monument(s):

AUTHORIZING SIGNATURE/DATE
(DNR or Other Authorizing Agency)

APPLICANT INFORMATION:

NAME:

TELEPHONE NO:

DATE:

COMPANY OR AGENCY NAME AND ADDRESS:

I estimate that this work will be finished by (date)_____.

_____I request a variance from the requirement to reference to the Washington Coordinate System. (Please provide your justification in the space below.)

The variance request is approved; not approved. (FOR DNR USE ONLY) Reason for not approving:

MULTIPLE MONUMENTS:

_____Check here if this form is being used for more than one monument. You must attach separate sheets showing the information required below for each monument affected. You must seal, sign and date each sheet.

INDEXING INFORMATION FOR AN INDIVIDUAL MONUMENT:

1) THE MONUMENT IS LOCATED IN: SEC TWP RGE 1/4-1/4

2) ADDITIONAL IDENTIFIER: (e.g., BLM designation for the corner, street intersection, plat name, block, lot, etc.)

MONUMENT INFORMATION: Describe: 3) the monument/accessories found marking the position, 4) the temporary references set to remonument the position (include coordinates when applicable), and 5) the permanent monument(s) to be placed on completion (if a permanent witness monument(s) is set include the references to the original position).

SEAL/SIGNATURE/DATE SIGNED

(Form prescribed 2/94 by the Public Land Survey Office, Dept. of Natural Resources,
pursuant to RCW 58.24.040 (8).)

DNR Permit Application
Figure 1450-2a

COMPLETION REPORT FOR MONUMENT REMOVAL OR DESTRUCTION

(TO BE COMPLETED AND SENT TO THE DNR AFTER THE WORK IS DONE.)

_____ I have perpetuated the position(s) as per the detail shown on the application form.

SEAL/SIGNATURE/DATE SIGNED

OR

_____ I was unable to fulfill the plan as shown on the application form. Below is the detail of what I did do to perpetuate the original position(s). (If the application covered multiple monuments attach sheets providing the required information. Seal, sign and date each sheet.)

SEAL/SIGNATURE/DATE SIGNED

DNR Completion Record Form
Figure 1450-2b

LAND CORNER RECORD

GRANTOR/SURVEYOR/PUBLIC OFFICER: This corner record correctly represents work performed by me or under my direction in conformance with the Survey Recording Act.

COMPANY OR AGENCY:

ADDRESS:

GRANTEE: PUBLIC

SEAL/SIGNATURE/DATE

LEGAL: TWP: RGE: CORNER CODE:
ADDITIONAL IDENTIFIER: (BLM designation, street or plat names, block, lot, etc.)

COUNTY:

WASHINGTON PLANE COORDINATES: N: E:

ORDER: ZONE: DATUM (Date of adjustment):

CORNER INFORMATION: Discuss the history, evidence found, and perpetuation of the corner. Diagram the references; provide the date of work; and, if applicable, a reference to a map of record and/or the field book/page no. Use the back, if needed.

This form is in compliance with the intent of RCW 65.04.045 and prescribed by the Public Land Survey Office, Department of Natural Resources - 1/97.

Land Corner Record
Figure 1450-3a

MARK THE CORNER LOCATION BELOW AND FILL IN THE CORNER CODE BLANK ON THE OTHER SIDE:
 For corners at the intersection of two lines, the corner code is the alphanumeric coordinate that corresponds to the appropriate intersection of lines.

For corners that are only on one line, the corner code is the line designation and the related line segment; i.e., a corner on line 5 between "B" and "C" is designated BC-5.

For corners that are between lines, the corner code is both line segments; i.e., a corner in the SE1/4 of the SE1/4 of section 18 is designated MN 4-5.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
A																										A
B																										B
C		6					5					4				3				2				1	C	
D																										D
E																										E
F																										F
G		7					8				9				10				11				12	G		
H																										H
J																										J
K																										K
L		18					17				16				15				14				13	L		
M																										M
N																										N
O																										O
P		19					20				21				22				23				24	P		
Q																										Q
R																										R
S																										S
T		30					29				28				27				26				25	T		
U																										U
V																										V
W																										W
X		31					32				33				34				35				36	X		
Y																										Y
Z																										Z

RCW 58.09.060 (2) requires the following information on this form: an accurate description and location, in reference to the corner position, of all monuments and accessories (a) found at the corner and (b) placed or replaced at the corner; (c) basis of bearings used to describe or locate such monuments or accessories; and (d) corollary information that may be helpful to relocate or identify the corner position.

SPACE FOR ADDITIONAL COMMENT:

Land Corner Record
Figure 1450-3b

1460.01	General
1460.02	References
1460.03	Design Criteria
1460.04	Fencing Types
1460.05	Gates
1460.06	Procedure
1460.07	Documentation

1460.01 General

Fencing is provided primarily to discourage encroachment onto the Washington State Department of Transportation's (WSDOT's) highway right of way from adjacent property and to delineate the right of way. It is also used to replace fencing that has been disrupted by construction and to discourage encroachment onto adjacent property from the highway right of way.

Encroachment onto the right of way is discouraged to limit the presence of people and animals that might disrupt the efficient flow of traffic on the facility. Although not the primary intent, fencing does provide some form of separation between people, animals, the traffic flow, or other special features and, therefore, a small measure of protection for each.

1460.02 References

Plans Preparation Manual, M 22-31, WSDOT

Roadside Manual, M 25-30, WSDOT

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

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

1460.03 Design Criteria

(1) General

Fencing on a continuous alignment usually has a pleasing appearance and is the most economical to construct and maintain. The recommended practice is to locate fencing on or, depending on the terrain, 12 inches inside the right of way line.

Where the anticipated or existing right of way line has abrupt irregularities over short distances, coordinate with Maintenance and Real Estate Services personnel to dispose of the irregularities as excess property (where possible), and fence the final property line in a manner acceptable to Maintenance.

Whenever possible, preserve the natural assets of the surrounding area and minimize the number of fence types on any particular project.

(2) Limited Access Highways

On highways with full and partial limited access control, fencing is mandatory unless it has been established that such fencing may be deferred. Fencing is not required for modified limited access control areas, but may be installed where appropriate. Fencing is required between frontage roads and adjacent parking or pedestrian areas (such as at rest areas and flyer stops) and highway lanes or ramps unless other barriers are used to discourage access violations.

On new alignment, fencing is not provided between the frontage road and abutting property unless the abutting property was enclosed prior to highway construction. Such fencing is normally part of the right of way negotiation.

Unless there is a possibility of access control violation, fencing installation may be deferred until needed at the following locations (when in doubt, consult the Headquarters (HQ) Access and Hearings Engineer):

- Areas where rough topography or dense vegetation provides a natural barrier
- Along rivers or other natural bodies of water
- In sagebrush country that is sparsely settled
- In areas with high snowfall levels and sparse population
- On long sections of undeveloped public or private lands not previously fenced

(3) Managed Access Highways

Fencing is not required for managed access highways. When highway construction will destroy the fence of an abutting property owner, originally constructed on private property, the cost of such replacement fencing may be included in the right of way payment. When the fences of several property owners will be impacted, it may be cost effective to replace the fences as part of the project.

If fencing is essential to the safe operation of the highway, it will be constructed and maintained by the state. Examples are the separation of traveled highway lanes, and adjacent facilities with parking or pedestrian areas (such as rest areas and flyer stops).

(4) Special Sites

Fencing may be needed at special sites such as pit sites, stockpiles, borrow areas, and stormwater detention facilities.

Fencing is not normally installed around stormwater detention ponds. Evaluate the need to provide fencing around stormwater detention facilities when pedestrians or bicyclists are frequently present. Document your decision in the Design Documentation Package. The following conditions suggest a need to evaluate fencing:

- Children or persons with mobility impairments are frequently present in significant numbers adjacent to the facility, such as a route identified in a school walk route plan, nearby residential areas, or near a park
- Water depth reaches or exceeds 12 inches for several days' duration
- Side slopes into the facility are steeper than 3H:1V

Fencing proposed at sites that will be outside WSDOT right of way requires that local ordinances be followed if they are more stringent than WSDOT's.

Wetland mitigation sites are not normally fenced. When evaluating fencing for wetland mitigation sites, balance the need to restrict human access for safety considerations (such as the presence of children), with the need to provide animal habitat.

Other special sites where fencing may be required are addressed in the following chapters:

- Chapter 1020, "Bicycle Facilities"
- Chapter 1025, "Pedestrian Design Considerations"
- Chapter 1120, "Bridges" (refers to protective screening)

The type and configuration of the fence is determined by the requirements of each situation.

1460.04 Fencing Types

(1) Chain Link

Installation of chain link fence is appropriate for maximum protection against right of way encroachment on sections of high-volume highways under the following conditions:

- Along an existing business district adjacent to a freeway
- Between a freeway and an adjacent parallel city street
- At locations where existing streets have been cut off by freeway construction
- At industrial areas
- At large residential developments
- At military reservations
- At schools and colleges
- At recreational and athletic areas
- At developed areas at the intersection of two limited access highways
- At any other location where a barrier is needed to protect against pedestrian, bicyclist, or livestock encroachment in limited access areas

For roadway sections in rock cuts, see Chapter 640.

The Standard Plans contains details for the approved types of chain link fence. The recommended uses for each type of fence are as follows:

- (a) Type 3. A high fence for areas of intensified use, such as industrial areas, or school playgrounds. Use this fence for new installations of high fencing. It may be used within the Design Clear Zone.

(b) Type 4. A lower fence for special use, such as between the traveled highway lanes and a rest area or flyer stop, or as a rest area boundary fence if required by the development of the surrounding area. This fence may be used along a bike path or hiking trail to separate it from an adjacent roadway.

Justify why corrective action is not taken when existing fencing with a rigid top rail will be left in place within the limits of a proposed project. For those cases where a more rigid fence is required, contact the HQ Design Office.

Coated galvanized chain link fence is available in various colors and may be considered in areas where aesthetic considerations are important. Coated ungalvanized chain link fence is not recommended.

(2) Wire Fencing

The Standard Plans and the Standard Specifications contain details for the two approved types of wire fence. The recommended uses for each type of fence are as follows:

(a) **Type 1.** This fence is used in urban and suburban areas where improvements along the right of way are infrequent and future development is not anticipated. It may also be used adjacent to livestock grazing areas. The lower portion of this fence is wire mesh and provides a barrier to children and small animals.

(b) **Type 2.** This fence is used in farming areas to limit highway crossings by farm vehicles to designated approaches. These areas include irrigation districts to prevent ditch riders, maintenance personnel, and farmers from making unauthorized highway crossings, and where new alignment crosses parcels previously enclosed by barbed wire.

(3) Other Considerations

Extremely tall fences (7 to 10 feet high) may be used in areas where there are exceptional hazards such as large concentrations of deer or elk. (See the region's Environmental Services Office and the *Roadside Manual* concerning wildlife management.)

Metal fencing can interfere with airport traffic control radar. When locating fencing in the vicinity of an airport, contact the Federal Aviation Administration to determine if metal fence will create radar interference at the airport. If so, use nonmetallic fencing.

Do not straddle or obstruct surveying monuments.

1460.05 Gates

Keep the number of fence gates along limited access highways to a minimum. On limited access highways, all new gates must be approved as described in Chapter 1425.

Usually such gates are necessary only to allow highway maintenance personnel and operating equipment to reach the state right of way without using the highway or freeway main line. Gates may be needed to provide access to utility supports, manholes, and the like, located within the right of way.

Use gates of the same type as the particular fence, and provide locks to deter unauthorized use.

In highly developed and landscaped areas where maintenance equipment is parked outside the fence, provide the double gate indicated in the Standard Plans.

Where continuous fencing is not provided on limited access highways, Type C approaches (see Chapter 920) are normally gated and locked, with a short section of fence on both sides of the gate.

1460.06 Procedure

Fencing is addressed in the access report, in accordance with Chapter 1430, and the Plans, Specifications and Estimates (PS&E), in accordance with the *Plans Preparation Manual*.

1460.07 Documentation

A list of documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:

<http://www.wsdot.wa.gov/eesc/design/projectdev/>

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