Persons with disabilities may request this information be prepared and supplied in alternate forms by calling collect 360-664-9009; deaf and hearing impaired people call 1-800-833-6388 (TTY relay service).
Foreword

This highway *Design Manual* has been prepared as a guide for our engineering personnel. It provides policies, procedures, and methods for developing and documenting the design of improvements to the transportation network in Washington State.

The manual is to supplement the engineering analysis and judgment that must be applied to both new highway construction and reconstruction of specific features of existing highways. It is also intended to provide uniform procedures for implementing design decisions and to assure continuity of the quality of highways throughout the state. It is recognized that the practices suggested in this manual, because of fiscal limitations or other reasons, have been or will be inappropriate for some projects.

Updating the manual is a continuing process and revisions are issued periodically. Questions, observations, and recommendations are invited. The next page is provided to encourage comments and assure their prompt delivery. Use copies of it to transmit comments and attachments, such as marked copies of manual pages. For clarification of the content of the manual, contact the Design Office in the Olympia Service Center.

Donald K. Nelson
State Design Engineer

3:P:DM
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<td>Interagency Agreement</td>
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<td>Interagency Agreement</td>
<td>1440-5</td>
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<td>Application for Permit to Remove or Destroy a Survey Monument</td>
<td>1450-5</td>
<td>October 1995</td>
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<td>1450-3</td>
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<td>Land Corner Record</td>
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<td>1450-4b</td>
<td>Corner Record Index Diagram</td>
<td>1450-9</td>
<td>October 1995</td>
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**Manual Description**

100.01 Purpose
The department has developed the *Design Manual* to reflect policy, outline a uniformity of methods and procedures, and communicate vital information to its employees. When properly used, it will result in the development of a highway system consistent with the needs of the traveling public.

The information, guidance, and reference contained herein are not intended as a substitute for sound engineering judgment. It is recognized that some situations encountered will be beyond the scope of this presentation, as the *Design Manual* is not a comprehensive textbook on highway engineering. Some of the many sources of information otherwise available are listed in Chapter 110.

100.02 Revisions
The *Design Manual* of today cannot remain static. It must be updated and revised to incorporate the advanced designs of tomorrow as these designs develop. The loose-leaf form and the numbering system are intended to facilitate the revision and continual updating of the manual.

It is vital that the user of this manual (1) incorporate the revisions that are periodically provided by the state Project Development Engineer and (2) participate in the revision process by using the form provided at the front of the manual to report flaws and contribute new material so that the Design Manual may present the best and most up-to-date information available.
# 110
## Nomenclature and References

**110.01 Abbreviations**
The following abbreviations are used in this manual:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAR</td>
<td>American Association of Railroads</td>
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<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ACP</td>
<td>Asphalt Concrete Pavement</td>
</tr>
<tr>
<td>ADT</td>
<td>Average Daily Traffic</td>
</tr>
<tr>
<td>AGC</td>
<td>Associated General Contractors</td>
</tr>
<tr>
<td>AIA</td>
<td>American Institute of Architects</td>
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<tr>
<td>AISC</td>
<td>American Institute of Steel Constructors, Inc.</td>
</tr>
<tr>
<td>AMTRAK</td>
<td>National Rail Passenger Corporation</td>
</tr>
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<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>APAW</td>
<td>Asphalt Paving Association of Washington</td>
</tr>
<tr>
<td>APWA</td>
<td>American Public Works Association</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>BIA</td>
<td>Bureau of Indian Affairs</td>
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<td>BM</td>
<td>Bench Mark</td>
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<tr>
<td>BM</td>
<td>Bureau of Mines</td>
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<tr>
<td>BPA</td>
<td>Bonneville Power Administration</td>
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<td>BR</td>
<td>Bridge Replacement</td>
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<td>BST</td>
<td>Bituminous Surface Treatment</td>
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<td>CA</td>
<td>Certification Acceptance</td>
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<tr>
<td>CAB</td>
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<tr>
<td>CADD</td>
<td>Computer Aided Drafting and Design</td>
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<td>Collector-Distributor Road</td>
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<td>Categorical Exclusion</td>
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<td>CE - SEPA</td>
<td>Categorical Exemption</td>
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<td>CEQ</td>
<td>Council on Environmental Quality</td>
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<td>CFR</td>
<td>Code of Federal Regulations</td>
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<td>Commission</td>
<td>Washington State Transportation Commission</td>
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<td>Capital Program Management System</td>
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<td>County Road Administration Board</td>
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<td>CRGC</td>
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<td>DHV</td>
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<td>DNS</td>
<td>Determination of Nonsignificance</td>
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<td>DOE</td>
<td>Department of Ecology</td>
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<td>EA</td>
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<td>ECS</td>
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<td>FEIS</td>
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<thead>
<tr>
<th>Acronym</th>
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<td>FERC</td>
<td>Federal Energy Regulatory Commission</td>
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<td>FHPM</td>
<td>Federal-Aid Highway Program Manual</td>
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<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>FONSI</td>
<td>Finding of No Significant Impact</td>
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<td>GSP</td>
<td>General Special Provisions</td>
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<td>HPA</td>
<td>Hydraulic Project Approval</td>
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<td>HPMS</td>
<td>Highway Performance Monitoring System</td>
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<td>Interstate Commerce Commission</td>
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<td>IDT</td>
<td>Interdisciplinary Team</td>
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<td>IL</td>
<td>Instructional Letter</td>
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<td>ITE</td>
<td>Institute of Traffic Engineers</td>
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<td>L &amp; I</td>
<td>Washington State Department of Labor and Industries</td>
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<td>LOS</td>
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<td>Municipality of Metropolitan Seattle</td>
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<td>MFRS</td>
<td>Mileage and Facilities Reporting System</td>
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<td>MOU</td>
<td>Memorandum of Understanding</td>
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<td>MP</td>
<td>Milepost</td>
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<td>Metropolitan Planning Organization</td>
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<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
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<td>National Ambient Air Quality Standards</td>
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<td>National Electrical Manufacturers' Association</td>
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<td>National Environmental Policy Act</td>
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<td>NG</td>
<td>Negative Declaration</td>
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<td>NGS</td>
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<td>NGVD</td>
<td>National Geodetic Vertical Datum (1929)</td>
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<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
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<td>National Park Service</td>
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<td>NRCC</td>
<td>Natural Resource Coordinating Committee</td>
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<td>PC</td>
<td>Point of Curvature</td>
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<td>PDO</td>
<td>Headquarters Project Development Office</td>
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<td>PE</td>
<td>Preliminary Engineering</td>
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<tr>
<td>PE</td>
<td>Project Engineer</td>
</tr>
<tr>
<td>PM</td>
<td>Project Manager</td>
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<td>PR&amp;PT</td>
<td>Planning, Research and Public Transportation Division (WSDOT)</td>
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<td>PS&amp;E</td>
<td>Plans, Specifications and Estimate</td>
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<td>PT</td>
<td>Point of Tangent</td>
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<td>Public Transfer Facility</td>
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<td>Rural Arterial Program</td>
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<td>Revised Code of Washington</td>
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<td>State Historic Preservation Officer</td>
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<td>UFAS</td>
<td>Uniform Federal Accessibility Standards</td>
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</tbody>
</table>
110.02 REFERENCES
The following is a list of available research materials, portions of which may be of value in the exercise of engineering judgment.
(b) AASHTO
- Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
- Standard Specifications for Highway Bridges
- Guide for Protective Screening of Overpass Structures

(3) Computer
(a) WSDOT
- Washington Computer Manual
- Microcomputer Applications for Highway Engineering (M 22-75)
- Design Engineering Work Station (DEWS) Manual (M 22-76)
- CADD Manual (M 22-32)

(4) Construction
(a) WSDOT
- Standard Plans for Road, Bridge, and Municipal Construction
- Construction Manual
- General Special Provisions
- Standard Specifications for Road and Bridge and Municipal Construction

(b) AASHTO
- Guide Specifications for Highway Construction
- Standard Specifications for Highway Bridges
- Construction Manual for Hwy. Bridges and Incidental Structures
- Standard Specifications for Welding

(5) Design (General)
(a) WSDOT
- Abstract on the Preparation of Plans, Specifications and Estimates for Building Construction and/or Capital Outlay Project
- Annual Traffic Report (year)
- Local Agency Guidelines
- Supplement to MUTCD

(b) AASHTO
- Policy on Design of Urban Highways and Arterial Streets (1973)
- Design Standards-Interstate
- Highway Design and Operational Practices
- Manual on Foundation Investigations
- AASHTO Interim Guide for Design of Pavement Structures
- Guide on Evaluation & Attenuation of Noise
- Guide for Bicycle Routes

(c) TRB

(d) FHWA
- A Guide to Highway Safety Design and Operating Practices
- Manual of Uniform Traffic Control Devices for Streets and Highways
- Traffic Control Devices Handbook

(e) ITE
- Traffic Engineering Handbook
- Traffic Engineering (Magazine)

(f) Others
- Man-Made America, Chaos or Control? Tunnard and Pushkarev
- The Freeway in the City A Report to the Secretary, DOT, by the Urban Advisors to the Federal Highway Administrator

(6) Economics
(a) WSDOT
- Land Economic Studies

(b) AASHTO
- Road User Benefit Analysis for Highway Improvements

(7) General
(a) WSDOT
- Annual Accident Report
- Department Publication Systems
- Operating Instructions
- Quarterly Accident Reports

(b) State of Washington
- Laws of the Washington State Legislature
- Washington Administrative Code

(c) AASHTO
- AASHTO Highway Definitions
- AASHTO Proceedings
- American Highways (Magazine)
- Numerology Map for Interstate System

(d) FHWA
- Federal-Aid Highway Program Manual
- Public Roads (Magazine)

(e) TRB
- Highway Research Bulletins, Abstracts, Records and Reports

(f) ASCE
- Journals, Proceedings, Abstracts, etc.
(8) Hydraulics
(a) WSDOT
   • *Hydraulics Manual*
   • Hydraulic Charts for the Selection of Highway Culverts
(b) FHWA
   • Aesthetics of Highway Drainage Design by Carl F. Izzard
   • Design Charts for Open Channel Flow
   • Design of Roadside Drainage Channels
   • Design of Bridge Waterways
(c) USGS
   • Floods in Washington
   • Miscellaneous Reports on Design Flows and Drainage Area Data
(d) AASHTO
   • Highway Drainage Guidelines

(9) Illumination
(a) AASHTO
   • Guide for Roadway Lighting

(10) Roadside Development
(a) WSDOT
   • Policy on Roadside Development and Highway Beautification
(b) AASHTO
   • Guide for Hwy. Landscape & Environmental Design
   • Policy on Landscape Development — Interstate System
   • Inspection Guide for Landscape Planting
   • Guide on Safety Rest Areas — Interstate
(c) Other
   • American Standard for Nursery Stock
   • Safety Rest Area — Planning, Location and Design (USDOT)

(11) Environmental
(a) FHWA
   • National Environmental Policy Act
   • Council on Environmental Quality Guidelines
   • *Federal Aid Highway Program Manual*
   • Federal Laws and Regulations
(b) WSDOT
   • Policy Directives
   • EIS — Environmental Assessment Outlines
   • *Environmental Procedures Manual* (M 31-11)
(c) State of Washington
   • State Environmental Policy Act
   • Department of Ecology Permit Directory

(12) R/W and Access
(a) WSDOT
   • Limited Access Establishment
   • Relocation Assistance Program Interim Operating Procedures
   • *Right of Way Manual*
   • Road Approaches to State Highways
   • Utilities Accommodation Policy
   • *Utilities Manual*

(b) AASHTO
   • Guide for Accommodating Utilities on Hwy. R/W
   • Info. Guide for Training R/W Personnel
   • Guide on Fencing Controlled Access Hwys.
   • Policy on Accommodation of Utilities — Freeways

(13) Maintenance
   • AASHTO Bridge Maintenance Manual
   • AASHTO Maintenance Manual
   • Maintenance Inspection of Bridges
   • Informational Guide for Methods and Procedures in Contract Maintenance
   • Informational Guide for Physical Maintenance

(14) Materials
(a) AASHTO
   • Standard Specifications for Highway Materials and Methods of Sampling and Testing

(15) Photogrammetry
(a) WSDOT
   • *Manual for Photogrammetry*
   • Standard Specifications for Photogrammetry

(16) Survey
(a) WSDOT
   • *Highway Engineering Field Tables*
   • *Highway Surveying Manual* (M 22-97)

(17) Traffic Control and Operations
(a) WSDOT
   • *Traffic Manual* (M 51-02)
   • Sign Fabrication Manual
   • Supplement to MUTCD

(b) AASHTO
   • Driver Expectancy Checklist
   • Guide for Motorist Aid Systems
   • Report by the Special Freeway Study and Analysis Committee
• Specifications for Design and Construction of Structural Supports for Highway Signs

(c) TRB and FHWA
• Increasing the Traffic Carrying Capacity of Urban Arterial Streets (Wisconsin Ave. Study)
• Manual of Uniform Traffic Control Devices for Streets and Highways
• Report No. FHWA-RD-76-73 "State of the Art on Roadway Delineation Systems"
• Traffic Control Devices Handbook

(d) ITE
• Traffic Engineering Handbook
• Traffic Engineering (Magazine)

(e) ENO Foundation
• Misc. Special Reports
• Traffic Quarterly

(f) Association of American Railroads
• Grade Crossing Protection Unit of Train Operation, Control and Signals
• Railroad-Highway Grade Crossing Warning Systems-Bulletin No. 7
120 Systems Planning

120.01 General
120.02 Statewide Transportation Planning
120.03 Metropolitan Area Transportation Planning
120.04 Designation of Highway Routes
120.05 State Programs for Local Roads and Streets

120.01 GENERAL

The transportation planning process includes a sequence of comprehensive studies which identify goals, objectives, required services and facilities. Major products of this process are short- and long-range policies, plans, programs and projects. Administrators and policy makers then use the information to make decisions for implementation of the plan.

Systems planning is the initial part of the planning process. In this phase, factors affecting transportation, required service and facilities, and alternative courses of action are analyzed to determine how the movement of people and goods can be accomplished most effectively. This includes all existing modal systems and new technology. The products are a series of reports, plans and recommendations to the management of WSDOT, the State Transportation Commission, the legislature and other state and local officials.

120.02 STATEWIDE TRANSPORTATION PLANNING

Statewide planning is essential to analyze total transportation requirements and evaluate how these needs can best be met by the various transportation modes. Detailed data regarding present and future economic conditions, land use patterns, use of each transportation mode, costs and revenues, changes in technology, service problems and opportunities, and numerous other factors are necessary to satisfactorily evaluate transportation needs. The unique role of each transportation mode and the integration of services to maximize use of available facilities requires detailed study and the development of important policies and plans.

Statewide plans have been developed for those forms of transportation for which WSDOT has direct responsibility. The contents of each of these plans are described briefly in this section.

(1) Washington State Transportation Plan

The Washington State Transportation Plan (WSTP) provides guidance for the development, maintenance and operation of a comprehensive and balanced multimodal transportation system. The WSTP, prepared pursuant to RCW 47.01.071(3), is developed by the Planning, Research and Public Transportation Division (PR&PT) in cooperation with WSDOT districts and divisions, city, county and transit officials and representatives of private carriers.

The Washington State Transportation Plan includes the following subjects concerning all major transportation modes:

- Critical factors affecting transportation.
- Important issues concerning each mode and strategies to resolve the problems.
- Plans for development of the various systems.
- Major improvements in facilities and services.
- Financial resources required to implement the recommendations.

The WSTP is a dynamic plan, updated periodically to address changing conditions. Information and recommendations for the plan are received from WSDOT districts and divisions, local and regional governmental agencies, private transportation operators and the public.

The WSTP includes the Highway Level of Development Plan and the Highway System Plan. These two plans, as described in 120.02(2) and (3) establish the standards to which each highway will be developed and provide a description (such as degree of access control and number of lanes) of the principal highways in the foreseeable future.

In addition to these plans which provide guidelines for the development of the system, the WSTP includes long-term (12 year) projections of maintenance, repair and construction requirements and costs. The construction program includes reconstruction and repair, (Category A), interstate (Category B) and major noninterstate (Category C) programs.

The WSTP lists specific major highway improvements needed during the subsequent 12 year period. Work programmed for highway construction follow guidelines of the WSTP and all major projects recommended to the State Transportation Commission for implementation will normally have first appeared in the plan. The major improvements contained in the WSTP are usually identified by WSDOT districts and then evaluated by personnel from the Highways and PR&PT divisions and the districts. Those major projects considered most essential are then included in the WSTP. Within metropolitan planning areas, major improvements must be on the regional transportation plan before going on the WSTP. Need to provide satisfactory facilities (rather than availability of funds) determines the number and type of improvements to be included in the WSTP.
(2) Highway Level of Development Plan

The various state highways have been classified to provide a realistic description of the function performed by each route. While all highways may be grouped by functional classification, those included within each functional class do not perform identically. Limited financial resources preclude the development of all highways to current design standards for each functional class. Therefore, it is necessary to identify the relative importance of each highway segment and establish a plan that indicates the type of improvements that are essential on each highway. By doing this, the benefits derived from available funds can be maximized.

The Highway Level of Development Plan has been prepared to provide an adequate highway system at the lowest possible cost. The most important highways are designated for development to the highest standard warranted to provide a satisfactory level of traffic service and operational efficiency and safety. The remaining highways receive only improvements necessary to maintain structural integrity and operational safety. To ensure that this plan will reflect changing conditions, it is updated every two years. In accordance with this concept, the state highways have been categorized into three improvement levels:

- **Design Standards Level** - This level includes all interstate highways and other high to moderate volume principal arterial highways which function as the main arteries for interregional and interstate movement of people and goods. Improvements for these sections will be to appropriate design standards to optimize their efficiency and safety.

- **3-R (Resurfacing, Restoration and Rehabilitation) Standards Level** - The highways in this level include moderate volume highways which primarily serve as community or local arterials channeling traffic into and out of activity centers. Improvements at this level will be to standards which preserve and extend the service life of the highway and improve highway safety but which will not necessarily increase highway capacity. Construction is generally limited to minor widening, safety improvements and pavement and bridge repairs at existing grades and within existing rights of way (see Chapter 430).

- **Maintain Structural Integrity and Operational Safety Level** - This level includes all remaining low-volume highways. These sections will be maintained and improved as needed to preserve structural integrity and operational safety.

Transportation System Management (TSM), and 3-R techniques are applicable at all levels of development as interim measures to extend the use of a facility before major reconstruction or improvements are required. The Level of Development Plan represents levels of improvements that are applicable to various sections of highway under "normal conditions." There will be times when natural disasters or other unforeseen events make it necessary to schedule projects leading to a high level of development on sections that otherwise would have 3-R or maintenance types of projects.

(3) Highway System Plan

The purpose of this plan is to provide a description of the type of facility (such as degree of access control and number of lanes) each principal highway will be, as foreseen at this time. This plan provides information that will make it possible to place proposed improvements in context with the type of facilities envisioned for each route. The Highway System Plan supplements the Level of Development Plan which indicates the improvement level for each highway but does not identify the type of facility that will result.

In the Highway System Plan, the principal arterial highways have been placed in the following descriptive categories:

- Freeway - Full Access Control
- Expressway - Partial Access Control
- Other Principal Arterials - Partial or Modified Access Control or No Access Control

These classifications indicate the type of facility that now exists or will be developed, and then the existing and proposed number of through traffic lanes for each route.

Criteria used to determine the configuration of each major route in the plan were:

- Functional Class System for State Highways
- Master Plan for Limited Access Highways
- Implementation Plan for Limited Access Highways
- Level of Development Plan
- Comprehensive Plans Adopted by Metropolitan and Regional Planning Agencies and Cities and Counties

Since the purpose of the Highway System Plan is to indicate the types of development taking place in the foreseeable future, it will be updated by PR&P as required to respond to changing transportation requirements. Implementation of the plan is accomplished through the Six-Year Program for Highway Construction (see Chapter 140).

(4) State Rail Plan

This plan provides the planning base for the administration of the federal Local Rail Service Assistance Program and the state Essential Rail Assistance Account. The plan designates the abandonment status of various rail lines, analyzes the various alternatives to these proposed abandonments, and provides recommendations that are also incorporated into the Washington State Transportation Plan. Federal legislation requires railroads to file future abandonment plans with the Interstate Commerce
Commission (ICC) and appropriate state agencies. WSDOT conducts shipper surveys and analyzes the transportation impacts of the abandonments on shippers, the public, and the affected modes of transportation. The Planning, Research and Public Transportation Division works with the state Utilities and Transportation Commission in identifying impacts and preparing testimony to be presented to the ICC, as well as providing information to those affected by the proposed abandonments. These planning support analyses are included in the State Rail Plan.

(5) Washington State Airport System Plan (WSASP)

This plan, prepared by the Aeronautics Division of WSDOT, provides a continuous planning process for the maintenance of an effective aviation system within the total transportation system of the state. It provides statewide planning data for needed airport improvements and identifies airports eligible for state and federal funds. The recommendations of WSASP are incorporated in the Washington State Transportation Plan.

(6) Long Range Ferry System Plan

Prepared by the Marine Transportation Division, this plan considers recent trends in ferry ridership, systems cost, regional economy, and other system and site factors to develop the four basic plan elements of:

- A set of goals and policies identifying the mission of the ferry system and guide system development.
- A conceptual service plan specifying routes, service types, frequencies, etc., necessary to achieve system goals and meet projected demand level.
- A capital facilities plan indicating vessel and terminal needs required to meet the service plan and policies.
- A financing plan detailing revenue and cost assumptions, and identifying funding sources for construction, operation, and maintenance.

The plan also presents a full range of alternatives for the entire system made up of the three major service areas of the San Juan Islands, Whidbey Island, and Central Puget Sound. The plan is monitored and updated continuously with major updates on an as-needed basis but usually no less than every eight to ten years.

(7) Transportation Systems Management

Transportation Systems Management (TSM) addresses ways to improve overall transportation system performance and efficiency through various low or minimal capital expenditures. The TSM measures utilized for specific highway problems vary considerably, and the feasibility of using such measures are explored before more extensive improvements are made. The following are the more significant measures considered:

- Park and ride and carpool lots - WSDOT works with local agencies to identify locations and assist agencies in developing their overall plan for design and construction.
- Bicycles/Pedestrians/Equestrian facilities - These facilities are developed to maximize use of limited resources and extend additional services to meet these needs. Funding for bicycle, pedestrian, and equestrian facilities is provided by RCW 47.30 which allocates three-tenths of one percent of highway construction.
- High occupancy vehicle lanes, reversible lanes, transit flyer stops, and ramp metering systems - Other TSM measures used to facilitate traffic flow and make it feasible for more people to use transportation facilities.

120.03 METROPOLITAN AREA TRANSPORTATION PLANNING

In Washington, metropolitan planning organizations (MPO) are established as required by federal statutes (23 U.S.C. 134 and 49 U.S.C. 1607). Each urbanized area (population 50,000 or more) must have such an organization to receive federal transportation capital or operating assistance. The purpose of such an organization is to provide a forum for cooperative transportation decision-making by the local governmental units in the area and the state. The products of this continuing, cooperative, and comprehensive transportation process are plans and programs consistent with the comprehensively planned development of the urban area.

Each MPO has a transportation policy committee consisting of elected officials of the general purpose local governments (counties and cities) within the area and may have a technical committee composed of personnel from public works and planning agencies within the area. WSDOT is represented on the policy and technical committees concerning transportation in each MPO.

The MPO is required to prepare a work program each year that describes the transportation and transportation-related activities the organization plans to undertake. Funds to prepare these plans and studies are derived primarily from federal funds (more than 80 percent) with the remainder from local funds.

The products of this urban planning process are:

- Transportation plan for the area describing policies, strategies, and facilities or changes in facilities.
- A transportation improvement program (TIP) that is usually a six year program of projects including an annual or biennial element.
- The annual or biennial element consists of a list of transportation improvement projects proposed for implementation during the first one or two years of the TIP.
The transportation plan should include an analysis of transportation system management strategies to make more efficient use of existing transportation systems.

When the TIP/annual element is submitted, WSDOT and the MPO must certify that the planning process is being carried on in conformance with all applicable federal and state statutes and regulations.

When the need for improvements to existing state highways or the construction of new highways becomes apparent from transportation studies, these are included in the metropolitan transportation improvement plan. When a project becomes a part of the two-year program approved by the State Transportation Commission and the legislature, it is then placed in the annual element of the TIP.

Both headquarters and district officials serve on standing and special committees of the MPOs. The Assistant Secretary for PR&PT or his designated representative is also a member of the Standing Committee on Transportation in the Puget Sound Council of Governments and the Transportation Technical Committee of the Spokane Regional Council. In the other MPOs, the PR&PT Division participates as necessary.

**120.04 DESIGNATION OF HIGHWAY ROUTES**

**(1) State Systems**

The general route of every state highway is established by the state legislature (RCW 47.17) and classified by state route and function.

(a) State Routes. RCW 47.36.095 authorizes the Washington State Department of Transportation to sign state highways with a system of state route numbers assigned to eliminate duplication of numbers. This numbering system follows the system employed by the federal government in the assignment of interstate and U.S. Routes; that is, odd numbers indicate general north-south routes and even numbers indicate general east-west routes.

(b) Functional Classification. The Washington State Department of Transportation was directed by RCW 47.05.021 to conduct an engineering and traffic analysis of the state highway system and, based thereon, to subdivide all state highways other than the National System of Interstate and Defense Highways into three functional classifications:

- Principal Arterials
- Minor Arterials
- Collectors

Highways in each classification generally have a distinct and predominant function in serving different types of traffic and traffic generators. The objective of functional classification is to define appropriate purposes of various highways in providing service and influencing development. The result should be a system that meets needs in an economical and efficient manner.

The functional classification of highways and the updating of such classifications provides management and policy-making bodies a means for the orderly development and maintenance of the highway system.

**(2) Federal Aid Systems**

All state highways that have been functionally classified in accordance with 120.04(1)(b) are also categorized into four federal-aid systems: interstate, primary, secondary and urban. The percentage of federal aid financing for projects in each category is determined by federal statute, subject to the availability of both state and federal funds.

(a) Interstate (FAI): The Interstate System is a network of freeways linking principal metropolitan areas, cities, and border points connecting routes of continental importance. The Interstate System was created by Congress in 1956 as the National System of Interstate and Defense Highways. The Interstate System is part of the Federal Aid Primary System.

(b) Primary (FAP): The Federal Aid Primary System consists of rural arterials or freeways and their extensions through urban areas which are important to interstate, statewide, and regional travel. These highways are selected by the state, subject to approval by the federal Secretary of Transportation.

(c) Secondary (FAS): The Federal Aid Secondary System consists of rural major collector roads, supplementing the Primary System. These highways are selected by the state or county official with concurrence by the state and subject to approval by the federal Secretary of Transportation.

(d) Urban (FAU): The Federal Aid Urban System consists of urban arterials or freeways that are not urban extensions of the Primary System. These highways are designated by county/city officials with concurrence of the state subject to approval by the federal Secretary of Transportation.

(e) Others: There are other federal-aid funds that may be available to the state as part of the above systems and designated as: forest highways, forest development roads and trails, park roads and trails, parkways, Indian reservation roads, public lands highways, and defense access roads.

**120.05 STATE PROGRAMS FOR LOCAL ROADS AND STREETS**

**(1) Urban Program**

The Transportation Improvement Board (TIB) and Transportation Improvement Account (TIA) were
established by the 1988 legislature. (They were formerly called the Urban Arterial Board and Urban Arterial Program.) They are designed to provide additional revenues for use in urban areas and to ensure that these revenues are allocated and expended throughout the state in a logical and systematic manner.

The TIB is directed by the legislation to allocate revenues from the Urban Arterial Trust Account and the Transportation Improvement Account to counties and cities for use on specific urban arterial projects. To ensure that these allocations are systematic, orderly and productive, the TIB requires that systems of arterials shall be established for each city and county in urban areas in accordance with the federal functional classification system.

Functional classification is the process of designating and grouping streets into classes, or systems, each of which has a definably distinct function in serving different categories of traffic. The objective of functional classification is to define relative purposes of streets in providing service and influencing urban development, and to establish the most economic yet beneficial systems to meet street needs. The establishment and updating of such systems provides the TIB and the legislature with knowledge that revenues are spent on those streets that serve the major traffic demands in urban areas. Refer to TIB's Guidelines to Cities and Counties.

(2) Rural Arterial Program

The Rural Arterial Program (RAP) was established by the legislature in 1983 to help counties maintain a rural arterial improvement program that responds to the rural traffic demands of moving agricultural, forest, and industrial goods to market, easing congestion on rural highways near urban centers and adequately and safely serving rural recreational areas and tourist traffic.

The arterials affected by this program are the county roads in rural areas classified as major collectors and minor collectors in accordance with federal functional classification system.

The Rural Arterial Program is administered by the County Road Administration Board (CRAB), which implements the RAP through a six-year construction program developed by county governments. The construction program is approved by CRAB and funded by the legislature through a biennial funding request. The funds are allocated from the rural arterial trust account which accumulates revenue from one-third of a cent of the state fuel tax dedicated to finance the program.
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Systems Data and Services

130.01 Highway Performance Monitoring System
130.02 Travel Data and Traffic Analysis
130.03 Videologging
130.04 Photogrammetry Services

130.01 HIGHWAY PERFORMANCE MONITORING SYSTEM

The Highway Performance Monitoring System (HPMS) is a federal program of data collection and analysis. HPMS was started in 1978, and replaced a variety of reports, including the Mileage and Facilities Reporting System (MFRS). HPMS data furnished by the states forms the data base for a variety of analytical processes. These processes are the basis of the FHWA’s report to Congress on the condition of the nation’s highways. Special legislative requests and reports are also furnished using HPMS capabilities.

The Planning, Research and Public Transportation (PR&PT) Division’s first responsibility to HPMS is to construct, maintain, and update the data base for the FHWA. Yearly data updates are due to the FHWA on June 15 of the following year.

The PR&PT Division is also upgrading the rate of sampling on the state highway system. This process is intended to result in valid planning information at the state and even the district level. This capability will be realized in future years.

(1) The HPMS, using its computerized modeling ability, can furnish the following types of information:

(a) Forecast of Highway System Needs. An analysis of projected highway needs. The output is a summary of highway needs over time in the form of mileage, improvement type, and cost. Needs are defined by comparing existing conditions to minimum tolerable condition tables.

(b) Simulate Highway System Conditions. The HPMS data base contains information on existing highway system conditions (the base year). The models simulate change in condition over time in the areas of pavement deterioration and volume/capacity. Improvements are simulated based upon deficiencies and the program then updates pavement condition and volume/capacity parameters. Future system conditions are then calculated, based on physical condition, safety ratings, and level of service.

(c) Analyze Investment Strategies. The HPMS will estimate highway needs and predict future system condition for any given funding level. The relative impact of different funding levels will show up in the form of changing highway condition ratings over the analysis period.

(d) Estimate User Costs. User costs can be estimated for base year and future year conditions. The difference between base year and target year user costs is an indicator of efficiency trends for the highway system.

(e) Deficiency Analysis. The miles of each type of deficiency can be generated for both base and target years. Deficiencies are listed for pavement condition, geometric elements (rural only), roadway cross section, and others. These deficiencies are identified by comparing existing and projected conditions to minimum tolerable condition tables. Trends can be identified by comparing base and target year deficiencies.

(f) Deferred Costs. Sometimes a project that is deferred due to funding limits will be more expensive when done later. This process calculates costs that were initially selected but not simulated, and costs for a later improvement which was simulated. The difference is an indicator of the cost involved in deferring projects. Inflation is not considered.

The above types of analysis can be done for each urbanized area, the total of all urban areas, and total rural area. Results are also stratified by functional class.

(2) The data base for HPMS consists of three types:

(a) Universe Data. A complete inventory of roadway mileage, broken down by functional classification and jurisdiction.

(b) Area-wide Data. Consists of statistical data for mileage, travel, accidents, land area and population, broken out for each urbanized area, total small urban areas, and rural areas.

(c) Sample Section Data. A comprehensive inventory of specific sections of highway. The sample data includes horizontal and vertical alignment, roadway geometry, annual average daily traffic, pavement condition, right of way width, access control, capital improvement costs, and others.

Sample sections are established by a random selection process based on statistical methods. The higher functional classifications require a greater degree of precision, and therefore a higher sample rate. Samples are taken only from those highways with higher functional classification than local access.
Sample sections are the basic data used by HPMS in its modeling programs. The sample sections are first analyzed, then the results are expanded to represent conditions of the total system from which the sample was drawn.

**130.02 TRAVEL DATA AND TRAFFIC ANALYSIS**

The Travel Data Branch of PR&PT provides many types of travel data and traffic analyses for use in developing plans, programs, and projects. These data and analyses are used by WSDOT and other agencies in preparing environmental, operational, and design reports. Travel surveys are used to collect operational data not available from existing files. Traffic analyses can provide design data on present and future average daily traffic (ADT); present and future design hourly volumes (DHV); directional splits of traffic; percentages of trucks; and for air quality, noise, and other environmental studies. In addition, capacity analyses can be conducted for roadways, interchanges, ramps, structures, or intersections on existing or proposed facilities.

**130.03 VIDEOLOGGING**

Video cassettes of the state highway system are available for viewing in each district and in the headquarters Highways Division. Three districts are videologged each year, which results in a completed cycle every two years. Only the latest video cassette version is maintained in the districts. A complete history is maintained in the Roadway Data Branch at the Planning Annex in Olympia. History tapes are available for viewing at the Annex, or if requested, may be sent to the districts for viewing.

Special projects may also be videologged by request. If the project is extensive, there may be some time required for scheduling. In addition to the video van, a portable video taping system with a self-contained power pack is also available for use in areas which may otherwise be inaccessible. Video taping is a service provided by the Roadway Data Branch. Roadway Data personnel will operate the video equipment. The equipment will not be loaned separately. Special projects may require a charge number.

**130.04 PHOTOGRAMMETRY SERVICES**

The type and scale of mapping required for the initial planning are dictated by the terrain and land use intensity of the route corridor area. The maps must be complete, current and give full details of topography and physical features.

Mosaic reproductions or photographic prints may be used to show routes or portions of routes. The route plan should be made to the same scale as the mosaic copies. If oblique photographs are used, they should show the route in contrasting lines and be legibly annotated. The date of photography should appear on the maps.

The Program and Geographical Services Branch of PR&PT will make available to district and division offices, upon request, planimetric and topographic maps, halftone photography and strip maps, regular photography at any scale desired, and all types of photogrammetric mapping and related by-products, using the Computer Aided Drafting and Design (CADD) system.
Program Development and Federal Aid Financing

140.01 General
140.02 Federal Aid Financing

140.01 GENERAL

RCW 47.05 Priority Programming for Highway Development, defines the requirements for highway construction prioritization, programming, and funding. The Programming and Operations Manual, Highway Construction Program (M 12-51) defines the processes that are used in the development of priorities and of construction program approval.

The following processes form the basis for the initiation of a project.

(1) Program Approval

The Transportation Commission is responsible for approval of the six-year financial plan and for approval of the program of projects. The program is utilized as support for the request for highway construction appropriations from the legislature. The performance on each project is subject to review by each of these bodies.

The state legislature appropriates funds to implement the biennial program as presented. The appropriation identifies specific levels of state and federal funds. These levels are both maximums and objectives for construction expenditure.

The Program Development Office publishes the priority array, provides allocation of funds to the district and compiles the statewide construction program. That office also monitors district and department performance in program delivery. The computer systems supporting program development and management are enhanced by the Capital Program Management System (CPMS).

The district is responsible for proposing projects which meet the priority array and for constructing those projects according to the scope, schedule, and cost outlined in the approved program.

The headquarters Project Development Office is responsible for assuring that each project is designed in accordance with the department's design criteria and that federal criteria is utilized where needed.

(2) Project Definition

Each project proposed by the district has a formal definition which establishes an agreement between the district and headquarters as to the work to be done, the estimated cost, work force, and project schedule. The definition documents include the project prospectus, full estimate schedule, and work force needs as defined in CPMS. CPMS provides a single data base for more responsive and efficient operations. Accurate definition of each project is essential and delivery of these elements for each project is necessary to implement the program.

(3) Program Review, Approval, and Monitoring

The approved program is an accumulation of the approved projects as submitted by each district. It is department policy to deliver the program as approved, with flexibility to adapt to changing conditions. The goal of initial program reviews, subsequent reviews, and project monitoring is to ensure that the approved program is delivered as committed. The Program Development Office coordinates reviews, monitors the program, and initiates reports on the performance of the program.

CPMS will facilitate these operations.

140.02 FEDERAL AID FINANCING

(1) Federal-State Relationship

The present federal-state relationship in constructing federal aid highways was influenced to a great extent by legislation enacted by Congress in 1916 and 1921. This legislation established the federal aid highway program and since that time additional legislation has expanded the federal impact on transportation.

The U.S. Department of Transportation (USDOT) through the Federal Highway Administration (FHWA) provides guidance and funding to WSDOT for developing transportation facilities. WSDOT selects and initiates the projects, but FHWA is responsible for review and approval at key stages when federal aid highway funds are to be used in the financing.

FHWA has delegated to WSDOT, through Certification Acceptance (CA), the authority to approve design, PS&E and advertisement for federal aid projects except for those projects on the Interstate System, forest highway projects and public lands projects. For Category A projects headquarters has further delegated to the district the authority to approve design and PS&E.

CA does not replace or impact the other basic provisions of Title 23 U.S.C. regarding apportionments, programs, or authorization of funds.

(2) Annual Federal Aid Program

Since the development of highway projects must be related to available funds, FHWA requires that a grouping or program of projects be prepared. The program of projects identifies those projects and their estimated cost for which federal assistance will be requested during the coming calendar year and also which phase (preliminary
engineering, right of way, or construction) will be requested for authorization.

(3) Rates of Federal Participation

The basic rate of participation of the several federal programs is determined by statute. However, each state actually receives a slightly higher federal share adjusted by the ratio of the area of public lands and nontaxable Indian lands to the total area of the state.

(4) Project Authorization

Following approval of the Statewide Annual Federal Aid Program, FHWA must review and approve each project phase prior to the work being started. This authorization obligates the federal funds and establishes the date of eligibility for funding preliminary engineering, right of way, and construction projects.

(5) Project Agreements

The federal aid highway program is basically a reimbursement program. It is WSDOT's responsibility to fund each project initially. Progress vouchers are submitted, requesting reimbursement for the federal share of actual expenditures. In order to be reimbursed, the costs must have been incurred in accordance with applicable federal and state laws and regulations.

The project agreement is the contractual document between FHWA and WSDOT which stipulates that WSDOT will be reimbursed. Once the project agreement is executed, changes in the project that alter the design concept or the termini must have prior approval from the Program Development Office and the headquarters Project Development Office and the consent of FHWA.

(6) Project Funding Procedures

Detailed requirements and procedures for fund authorization of individual projects are available in the Programming and Operations Manual, Highway Construction Program, M 12-51. Guidance on processing local agency projects can be obtained from Local Agency Guidelines, M 36-63.
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General

160.01 Design Principles
160.02 Design Standards
160.03 Design Items

160.01 DESIGN PRINCIPLES

The major design controls within a functional class are traffic volume, character or composition of traffic, design speed, and control of access. These determine the principal geometric features of the highway. Other design controls such as topography and physical features, capacity, safety, and economics, which are of paramount importance, are reflected in the major controls indicated above.

The overall objective is to provide for the movement of the greatest number of vehicles possible at the highest speed possible consistent with state laws, economic reality, and maximum safety. The standards used in the design of any highway should allow future improvements with minimum investment loss. When funding is limited, reduce improvement length or economize on secondary design features, but do not economize on the principal geometrics or safety features. Roadway sections and surfacing can be improved and widened at reasonable cost at any future date when funding permits, but the geometric features of alignment, tied down by right of way, are expensive and often impossible to correct.

Design criteria for the application of controls are given in Division 4. The basic and secondary geometric elements of highway design are covered in Divisions 5 through 9. Miscellaneous features are covered in Divisions 10 through 14.

160.02 DESIGN STANDARDS

Standard plans have been and will continue to be developed for guidance in specific design situations, based on design specifications, laws, regulations, safety, strength, availability of materials, uniformity, cost, and aesthetics. Many AASHTO and FHWA design guides and recommendations have been adopted into these plans to ensure uniformity with other state systems.

The standard plans to be used for highway design in conjunction with this manual are contained in the Standard Plans for Road, Bridge, and Municipal Construction, M 21-01. The standard plans are the current design standards. Any deviation from these standards for an individual job must be approved by the State Project Development Engineer. If a standard plan is found to need revision, bring this fact to the attention of the State Project Development Engineer and request a change, rather than preparing special designs on individual projects. Submit recommendations for revisions to existing standard plans and include a copy of the existing plan or specification showing all proposed changes. Submit proposals for new standard plans with a complete plan and specification.

Refer to the publications listed in Chapter 110 for additional guides to highway design.

160.03 DESIGN ITEMS

(1) References

(a) RCW 43.19.190, State purchasing and material control director - powers and duties.

(b) RCW 47.01.071, Commission - functions, powers and duties.

(c) RCW 47.28.030, Contracts - State Forces - monetary limits - small contractors - rules and regulations.

(2) Patented or Proprietary Items

WSDOT uses competitively acquired materials that fulfill the functional requirements of an item of work except where the use of a proprietary material or item can be shown to be in the public interest. A specification for a single source (patented, trademark, or copyright) item is a proprietary specification. This does not restrict the use of replacement parts of identical nature for maintenance or refurbishing purposes.

Along with, or prior to, the submittal of the PS&E (see Plans Preparation Manual) or prior to processing a purchase order, the district must request approval from the State Project Development Engineer for the use of proprietary items. All pertinent facts pertaining to the reasons for using proprietary items shall be included in the request.

(3) WSDOT Furnished Items

The use of WSDOT furnished items in a contract is as follows:

(a) WSDOT may furnish to contractors new or used material that will expedite relief in an emergency situation. An emergency situation must be declared by the District Administrator and the circumstances of the emergency situation warranting the furnishing of specific items to a contractor must be documented.

(b) WSDOT may require a contractor to remove, refurbish, stockpile, or reinstall any existing item on any specific project.

(c) WSDOT may furnish salvaged items from other projects for installation. The circumstances of furnishing salvaged items must be documented by the District Administrator.
(d) WSDOT may furnish new or used materials to expedite contract completion or use up surplus stores items. The circumstances of furnishing new or used materials must be documented by the District Administrator.

The district’s PS&E submittal to the headquarters Project Development Office shall include specific information as to what, if any, items are to be removed, refurbished, stockpiled, or reinstalled by the contractor. Any items to be furnished by WSDOT (new, used, or salvaged from other projects) must be clearly identified in the PS&E submittal and receive the State Project Development Engineer’s approval except that the District Administrator may approve WSDOT furnished items for emergency situations.
210 General

It is the goal of the Washington State Department of Transportation (WSDOT) that decisions be made in the best overall public interest and that other agencies and the public be involved early enough to ensure that the decisions that are made are responsive to the public’s interests.

Public involvement is used to place issues before the public; to gather, and assimilate comments; and to inform the public of the final decisions, construction schedules, and project results. As part of the public involvement activities, hearings are held when major decisions are being made. Other, less formal methods are also used because they are the best way to elicit comments and communicate proposals.

Current laws and regulations provide general guidelines that allow considerable flexibility. The environmental policies and procedures (SEPA and NEPA) are intended to ensure that environmental information is available to public officials, agencies, and citizens and that public input is considered before decisions are made.

The role of local elected officials in the project development process is emphasized, and consistency with community planning goals and objectives is required.

210.02 References

USC Title 23 — Highways, Sec. 128 Public Hearings
combined hearing  A hearing that is held when there are public benefits to be gained by any combination of the environmental, corridor, design, and access hearings.

corridor hearing  A formal or informal hearing that presents the corridor alternatives to the public for review and comment before a commitment is made to any one route or location.

design hearing  A formal or informal hearing that presents the design alternatives to the public for review and comment before a commitment is made to any one alternative.

environmental hearing  A formal or informal hearing that ensures that social, economic, and environmental impacts have been considered.

court reporter  A person with a license to write and issue official accounts of judicial or legislative proceedings.

findings and order  A document containing the findings and conclusions of a limited access hearing that is approved by the Assistant Secretary for the Environmental and Engineering Service Center.

Hearing Coordinator  The Access and Hearings Specialist within the Olympia Service Center (OSC), Design Office, Access and Hearings Unit, who is assigned the responsibility for coordination of all functions relating to hearings.

hearing examiner  An Administrative Law Judge (ALJ) from the Office of Administrative Hearings, or a WSDOT designee, appointed to moderate a hearing.

NHS projects  Projects on the National Highway System for which FHWA has delegated approval authority for design, contract administration, and construction to WSDOT. (See Chapter 330.)

opportunity for a hearing  An advertised offer to hold a hearing if so requested.

résumé  An official notification of action taken by WSDOT following adoption of a findings and order.

210.04 Public Involvement

Developing an effective public involvement program is a strategic effort that involves selecting techniques that will meet the unique needs of a given transportation plan, program, or project. An effective public involvement program:

- Informs the public of the need or proposed action.
- Informs the public about the process that will be used to make decisions.
- Ensures that the public has ready access to relevant and understandable information.
- Identifies and resolves issues early in the process.
- Gains public support.
- Assists the project development process.

Public involvement begins during the system planning phase when the public is given opportunities to help solve short and long term transportation problems.

The public involvement effort continues into the project definition phase when a project is proposed to fulfill an identified need. When the study area for a project is identified, the region frequently notifies the public that the department is initiating a project and invites them to participate in a project definition or environmental evaluation meeting.

The region develops a public involvement plan that identifies all the methods proposed for the project. Methods are selected to ensure that public opinion is considered throughout the planning, environmental, location, and design phases of the project. Follow-up activities sometimes continue through construction, and even after completion, to provide ongoing public outreach or notifications.

For simple projects, the region develops a public involvement plan for their own use and guidance. To inform the public, communicate the decision-making process, identify the issues, and possibly resolve concerns, the region communicates with
the affected community through newspaper articles, fliers, community group presentations, open house meetings, or other methods. Public involvement on minor projects is not intended to be an open forum on the proposed design; however, public comments received during project development are evaluated and, if appropriate, included in the project.

It may become necessary to revise the public involvement plan as the project evolves, the community changes, or new issues arise.

(1) Public Involvement Plan

The regions develop the public involvement plans for WSDOT projects. For projects requiring an environmental impact statement (EIS), a public involvement plan and OSC approval are required as part of the preparation of the Study Plan. (See Chapter 220.) For all other projects, the region may consult the Access and Hearings Unit for assistance or concurrence.

The public involvement plan includes:

- List of proposed activities.
- Time schedule to do each task keyed to the environmental process schedule, if applicable.
- Methods to be used in considering comments in the decision-making process, including follow-up procedures.
- Personnel, time, and funds needed to carry out the plan.
- Identification of the project stakeholders as the public to be involved.

The public to be involved (affected directly or indirectly) might include any or all of the following:

- Staff and elected officials of local governments
- Other state and federal agencies and officials
- Indian tribes
- Adjacent property owners and tenants
- Adjacent billboard owners and clients
- Community groups; clubs, civic groups, churches
- Special interest groups
- Environmental Justice stakeholders (low income and minority groups)
- Service providers; emergency, utility
- Others expressing interest
- Others known to be affected
- The general public

The department recognizes the role of local, state, and federal staff and elected officials as active sponsors of proposed projects who might effectively assist in developing and implementing the public involvement plan. Early and continued contact with these resources is a key to the success of the project.

(2) Public Involvement Methods

Effective public involvement is flexible, innovative, multifaceted, and ongoing. There are many methods available to gain public participation. Any of the following methods might be appropriate to a project.

- Formal hearings (210.04(2)(a))
- Informal hearings (open format hearings) (210.04(2)(b))
- Public meetings and open house meetings (210.04(2)(c))
- Prehearing presentations
- Drop-in information centers or booths
- Advisory committee meetings
- Design workshops
- Meetings with public officials
- Individual (one-on-one) meetings
- Meetings with special interest groups
- Presentations at local group meetings
- Surveys and questionnaires/paper or electronic mail
- Hot lines
- Follow-up procedures (210.04(2)(d))
There are many communication tools available for use when announcing and holding public involvement events. See the following for lists of ideas.

- Notification techniques (210.04(2)(e))
- Handouts 210.04(2)(f)
- Graphics and Audio-Visual Aids 210.04(2)(g)

Agency representatives are conveying the department’s image. They should be conscious of their roles, be well informed and confident, and communicate skillfully. When the event is well planned and the conductor is sensitive to the needs of the audience and objective about the needs of the project, meetings and hearings are usually productive efforts. See the FHWA publication *Public Involvement Techniques for Transportation Decision-Making*.

(a) **Formal Hearings.** The following are required of all formal hearings.

- Prehearing packet (210.05(5)(a))
- A hearing notice with a fixed time and date (210.05(2))
- Fixed agenda
- Hearing moderator (may be the hearing examiner)
- Hearing examiner
- Comment period
- Summary (210.05(6))

In addition to the oral comment period, people can write opinions on comment forms at the time of, or after, the hearing and submit them before the announced deadline.

See 210.06, 7, 8, and 9 for specifics related to the various types of hearings.

(b) **Informal Hearings (Open Format Hearings).**

An informal hearing must have the characteristics of a formal hearing listed in (a) above except for the fixed agenda. These events are usually scheduled for substantial portions of an afternoon or evening so people can drop in at their convenience and fully participate. People are directed to attend a presentation, visit the exhibits, and then submit their comments.

The following items are features of an open format hearing, which is the most common format for an informal hearing.

- In areas where people work in shifts, open format hearings can be scheduled to overlap the shift changes.
- Brief presentations about the project and hearing process, at preset times, are advertised in the hearing notice. They can be live, videotape, or computerized.
- Agency or technical staff are present to answer questions and provide details of the project.
- Information is presented buffet style and participants shop for information.
- Graphics, maps, photos, models, videos, and related documents are frequently used.
- People get information informally from exhibits, presentations, and staff.
- People have a chance to clarify their comments by reviewing materials and asking questions before commenting.
- People can comment formally before a court reporter, or they can write opinions on comment forms and submit them before the announced deadline.
- People are encouraged to give opinions, comments, and preferences to the examiner in the presence of a court reporter.

(c) **Public Meetings and Open House Meetings.** Meetings are less formal than hearings. Public meetings range from large informational and workshop meetings to small groups and one-on-one meetings with individuals. The region evaluates what is desired from a meeting, and how the input will be tracked, and then plans accordingly.

- Open house meetings are very effective for introducing a project to the public and stimulating the exchange of ideas.
• Small meetings are useful for gaining information from special interest groups, neighborhood groups, and advisory committees.

• Workshop formats, where large groups are organized into small discussion groups, serve to maximize participation of all attendees while discouraging domination by a few individuals.

(d) **Follow-Up Procedures.** Effective public involvement is an on-going two-way exchange and it may be necessary to provide follow-up information several times during a large project to maintain a continuing exchange of information with the community.

At significant stages, the region responds to input with general information about the project. Follow-up information conveys, as accurately as possible, how public input was used to develop the project. Follow-up for larger projects might include newsletters, reports, individual contacts, or other activities related to the public’s contribution to the project.

Follow-up measures can continue through construction and after project completion. The construction schedule is useful information and project accomplishments (such as noise abatement) are of interest.

Follow-up for smaller projects or for specific comments might simply be timely responses to individual requests.

(e) **Notification Techniques.** For hearings, see 210.05 for requirements regarding advertising for hearing interest and hearing advertisements. For other public involvement methods, develop notification techniques to attract a cross-section of the public. Provide special notices to those directly affected. Design the notifications to catch the public’s attention and encourage people to attend or become involved. Consider the following techniques:

• Handouts
• News Releases — TV or newspapers
• Display ads in newspapers

• Web sites
• Electronic mail
• Faxboards
• Fact sheets
• Billboards
• Project notebooks at public places
• Project display boards at public places
• Fliers
• Newsletters
• Posters
• Local bulletin board announcements
• Personal contacts
• Radio announcements — AM, FM, CB
• On-site tours.
• Project office located close to the project

(f) **Handouts.** A well designed and informative handout can serve as an ongoing link between the department and the public.

Handouts have no set format. Make them as clear, relevant, up-to-date, easily understood, and self-explanatory as possible. Use handouts in foreign languages when appropriate. The following are handout possibilities:

• Special project newspapers
• Pamphlets
• Brochures
• Booklets (large, complicated projects)
• Charts
• Tables
• Graphs
• Project maps (aerial photographs or line drawings)
• Project development schedules
• Reports
• Right-of-way brochures (or other general information)
• Questionnaires
• Surveys

(g) **Graphics and Audio-Visual Aids.** The department normally uses slide shows or graphic exhibits to present project information. These presentations are informal and responsive to questions and concerns. Consider the following presentation techniques:

- Slide, slide-tape presentation
- Videotape
- Models
- Maps — large, simple
- Artistic renderings
- Photomontage
- Aerial photographs
- Computer visualizations

### 210.05 Hearings

Environmental documents address the social, economic, and environmental effects as described in Chapter 220. The project environmental documentation is the first step in the hearing procedures sequence. Each step of the hearing procedures is dovetailed into the environmental process and is important in achieving the appropriate project documentation. Corridor and design hearings are not normally required for Environmental Assessment, SEPA Checklist, and categorically excluded projects, but the opportunity for an environmental hearing might be required. When environmental hearings are not required, an informational meeting may serve as a useful forum for public involvement in the environmental process.

For all projects, the region reviews the requirements for a hearing or notice of opportunity for a hearing during the early stages of project development and before completion of the draft environmental documents.

If a hearing or notice of opportunity for a hearing is required, see Figure 210-1 for a summary of the event and timing requirements.

### (1) Hearing Requirements

A hearing or notice of opportunity for a hearing is required by federal and state law (USC Title 23 §771.111 and RCW 47.52) and by WSDOT policy if one or more of the following occurs. (When in doubt, consult the Hearing Coordinator.)

(a) **Corridor Hearing**

- The proposed route is on a new location.
- There will be substantial social, economic, or environmental impacts.
- There will be a significant change in the layout or function of connecting roads or streets.

(b) **Design Hearing**

- Acquisition of a significant amount of right of way will result in relocation of individuals, groups, or institutions.
- There will be substantial social, economic, or environmental impacts.
- There will be a significant change in the layout or function of connecting roads or streets or of the facility being improved.

(c) **Access Hearing**

- Access control is established or revised

(d) **Environmental Hearing**

- An EIS is required for the project or a hearing is requested for an EA.
- There will be substantial social, economic, or environmental impacts.
- There will be a significant adverse impact upon abutting real property.
- There is significant public interest or controversy regarding the project.
- Other agencies (Coast Guard or Corps of Engineers, for example) have hearing requirements that could be consolidated into one hearing process.
(c) **Follow-up Hearings**

A new hearing or the opportunity for a hearing is required for any previously held hearing when any one of the following occurs. (See USC 23, §771.111.)

- Corridor or design approvals have not been requested within three years after the date the last hearing was held or the opportunity for a hearing was afforded.
- An unusually long time elapsed since the last hearing or opportunity for a hearing.
- A substantial change occurs in the area affected by the proposal (due to unanticipated development, for example).
- A substantial change occurs in a proposal for which an opportunity for a hearing was previously advertised or a hearing was held.
- A significant social, economic, or environmental effect is identified that was not considered at earlier hearings.

(2) **Hearing Notice**

The OSC Access and Hearings Unit provides sample hearing notices to the regions upon request. These include items that are required by state and federal statutes. Some important elements of a notice are:

- To promote public understanding, the inclusion of a map or drawing is encouraged.
- For a notice of an opportunity for a hearing, include the procedures for requesting a hearing and the deadline, and note the existence of the relocation assistance program for persons or businesses displaced by the project.
- For a corridor, design, or combined corridor-design hearing or a notice of an opportunity for a hearing, announce the availability of the environmental document and where it may be obtained and/or reviewed.
- If there is involvement in wetlands, flood plains, prime and unique farmlands, Section 4(f) lands, or endangered species, include this information in the notice.
- Include information on any associated prehearing presentation (210.05(5)(d)).

Hearing notices and notices of opportunity for a hearing are advertised as described in 210.05(3) and Chapter 220. Hearing notices are also circulated as described in 210.05(5)(b)

(3) **Advertise a Hearing or the Opportunity for a Hearing**

To advertise a legal notice of a hearing or a notice of an opportunity to request a hearing, use the following procedure:

- The region transmits the proposed notice, and a list of the newspapers in which the notice will appear, to the OSC Hearing Coordinator for concurrence prior to advertisement.
- Upon receiving concurrence, the region advertises the notice.
- Advertisement must be published in a newspaper having general circulation in the vicinity of the proposed project or the impacted population and in any newspaper having a substantial circulation in the area concerned, such as foreign language newspapers and local newspapers.
- The advertisement may be in the legal notices section or, preferably, as a paid advertisement in a prominent location.
- Additional means (such as display ads, direct mail, fliers, posters, or telephoning) may also be used to better reach interested or affected groups or individuals.
- A copy of the published hearing notice is sent to the Hearing Coordinator at the time of the publication.
- For access and environmental hearings, the notice must be published at least 15 days prior to the hearing. The timing of additional publications is optional.
- For corridor and design hearings, the first-notice publication must occur at least 30 days before the date of the hearing. The second publication must be 5 to 12 days before the date of the hearing.
• In no case shall a first notice for a corridor or design hearing be advertised prior to public availability of the draft environmental document.

• For a notice of opportunity for a hearing, the notice must be published once each week for two weeks. The deadline for requesting a hearing must be at least 21 days after the first date of publication and at least 14 days after the second date of publication.

(4) **No Hearing Interest**

When the region is not aware of specific hearing interest, the region can satisfy project hearing requirements by advertising a notice of opportunity for a hearing.

If no requests are received for a corridor or design hearing, the region transmits a package (which contains the notice of opportunity for a hearing, the Affidavit of Publication of the hearing notice, and a letter stating that there were no requests for a hearing) to the OSC Access and Hearings Unit.

When a notice of opportunity for a hearing is used to fulfill the requirements for a limited access hearing and there are no requests for a hearing, the region must secure waivers from every abutting property owner and affected local agency.

- The region obtains sample waiver forms from the OSC Access and Hearings Unit.
- The Project Engineer must contact every affected property owner of record (not tenant) and local agency to explain the plan and project to them. This explanation must include access features, right of way take (if any), and the right to a hearing.
- The region transmits the original signed waivers to OSC Access and Hearings Unit for processing.
- The Access and Hearings Unit prepares a package for review and approval by the State Design Engineer. This package consists of the signed waivers and Affidavit of Publication of the access hearing notice of opportunity for a hearing along with a recommendation for approval of the right of way plan.

(5) **Hearing Preparation**

The Deputy State Design Engineer sets the hearing date. Final arrangements for the hearing date can be handled by telephone between the Hearing Coordinator and the region.

The region proposes a hearing date based on the following considerations:

- Convenient for community participation. Contact local community and government representatives to avoid conflict with local activities.
- When Commission members can attend if they so desire. Check with the Hearing Coordinator to avoid conflict with other commission business if possible.
- For corridor and design hearings, at least 30 days after circulation of the DEIS or the published notice of availability of any other environmental document.
- In most cases, more than 45 days after submittal of the prehearing packet.

The region makes other arrangements as follows:

- The location of the hearing hall is to be accessible from public transportation if possible, convenient for community participation, and accessible to the disabled.
- Arranges for a court reporter.
- Arranges for a the Hearing Coordinator to provide a hearing examiner for all access hearings and for other hearings if desired.
- Develops a hearing agenda for all access hearings and for other hearings if desired.
- If requested in response to the hearing notice, interpreters for the deaf, audio equipment for the hearing impaired, language interpreters, and Braille or taped information for people with visual impairments are required.
(a) **Prehearing Packet.** When it is determined that a hearing must be held, the region prepares a prehearing packet.

Include the following in the prehearing packet:

- Vicinity map
- Capsule project description
- Brief project history
- Public support or opposition to the project
- Plans for corridor and design alternatives with descriptions
- Hearing plans (access hearing only)
- News release
- Hearing notice tailored to the needs of the project. (For access hearing, indicate number of notices, plans, and Notices of Appearance needed for mailing.) See 210.05(2).
- List of legislators
- List of government agencies
- List of property owners (access hearing only)
- List of newspapers
- Hearing agenda if applicable
- Hearing arrangements, date, time, place
- Hearing format: formal or open format

Three copies of the prehearing packet are furnished to the OSC Access and Hearings Unit at least 45 days before the proposed hearing date. Concurrence with the prehearing packet takes about two weeks after receipt of the information. This assumes that all necessary information has been submitted to the Access and Hearings Unit.

(b) **Circulate Hearing Notice.** The Hearing Coordinator sends a copy of the notice of hearing to the Commission, the Attorney General’s Office, the Public Affairs Office, and the FHWA (if applicable).

The region circulates copies of the hearing notice as follows:

- Send a copy of the hearing notice and a capsule description to the appropriate legislators and local officials about one week before the first publication of a hearing notice.
- Include in the cover letter to the news media a statement such as: “This material may have been released by a local legislator. If not, we will appreciate any coverage you care to give the project at any time prior to the hearing.”
- Distribute the news release to all reasonable news media, as well as the newspapers that will carry the formal advertisement of the hearing notice, about 3 days before the first publication of a hearing notice.
- Advertise the hearing notice in the appropriate papers as described in 210.05(3) within a week of the mailing to the legislators.

(c) **Presentation of Material for Inspection and Copying.** The information outlined in the hearing notice, other engineering studies, and information that will be presented at the hearing is made available for inspection and copying throughout the period between the first advertisement and approval of the hearing summary or findings and order. The information need not be in final form, but must include every item that is included in the hearing presentation. The environmental document must also be available for public review.

The information presented for inspection and copying is made available in the general locality of the project. The region reviews the variables (locations of the regional office, the project office, the project site, and the interested individuals, and the probability of requests for review) and selects a mutually convenient site for the presentation of the information. The region keeps a record of who came in, when, and what data they reviewed and copied.

(d) **Hearing Briefing.** On controversial projects, the Hearing Coordinator arranges for a briefing (held before the hearing) for those interested in the project. Attendants include appropriate OSC, regional, and FHWA personnel, with special notice to the Secretary of Transportation. Regional personnel present the briefing.
(e) **Prehearing Presentations.** The region is encouraged to hold an informal presentation to the public for display and discussion of the project and plans. Holding this presentation on projects where local feeling runs high promotes rapport, brings out community reaction to the project, and identifies trouble spots prior to the hearing.

A prehearing presentation is informal, with ample opportunity for exchange of information between the department and the public. Prehearing presentations can be open house meetings, drop-in centers, workshops, or other formats that promote public participation.

The prehearing presentation is usually held approximately one week before the hearing for the more controversial projects. Other dates may be used depending on the desires of the region and the nature of the project.

Include notice of the date, time, and place in the hearing notice and ensure that the hearing notices are mailed in time to give adequate notice of the prehearing presentation.

(f) **The Hearing.** The hearing is moderated by the Regional Administrator or his designee. Normally, a hearing examiner is used when significant controversy or significant public involvement is anticipated. A hearing examiner is required for access hearings.

A word-for-word transcript of the proceedings is made by a court reporter.

Hearings are generally more informative and gain more public participation when an informal format is used so the public’s views and opinions are openly sought in a casual and personal way. The open format hearing may be used for all hearings except access hearings. At least one court reporter is required to take testimony on a one-on-one basis. Use display tables and enough knowledgeable staff to answer specific questions about the project.

It is the responsibility of the hearing moderator and other department representatives to be responsive to all reasonable and appropriate questions, if possible. If a question or proposal is presented at the access hearing, which necessitates an answer at a later date, the region reserves an exhibit to respond to the comment. The hearing moderator must not allow any person to be harassed or subjected to unreasonable cross-examination.

(g) **Hearing Agenda Items.** For all access hearings and for other hearings, as desired, the region prepares a hearing agenda to ensure that all significant items are included. A hearing agenda includes:

1. **Opening Statement:**
   - Highway and project name
   - Purpose of hearing
   - Introduction of elected officials
   - Federal/State/County/City relationship
   - Statutory requirements being fulfilled by the hearing
   - Status of the project with regard to NEPA/SEPA documents
   - Description of information available for inspection and copying
   - For an environmental, corridor, design, or corridor-design hearing, statement that written statements and other exhibits can be submitted during the open record period following the hearing.
   - Statement that all who want to receive written notification of the department’s action as a result of the hearing may add their names to the interest list or file a Notice of Appearance for access hearings.
   - Description of how the hearing will be conducted

2. **Project History.** Present a brief project history, including need for the project, public involvement program, hearing opportunities afforded, and hearings held.
3. Presentation of Plans. Develop alternatives studied to comparable levels of detail and present them equally. Include the no-action alternative. Refer to any supporting studies that are publicly available.

Advise if one corridor or design is preferred by the department for more detailed development. When a preferred alternative exists, stress that it is subject to revision and re-evaluation both during and after the hearing, based on public comments, additional studies, and other information that may become available.

4. Social, Economic, and Environmental Discussion. Discuss all social, economic, and environmental effects or summarize the major impacts and refer to the environmental document.

5. Statements, Plans, or Counter-Proposals from the Public. Accept public views or statements regarding the plans presented, the alternatives to those plans, and the social, economic, and environmental effects of any plan.

6. Relocation Assistance Program. Explain the relocation assistance program and relocation assistance payments available. The Relocation Assistance brochure must be available for free distribution at all hearings. Right of way and relocation personnel should be available.

If the project does not require any relocations, the relocation assistance discussion may be omitted. Make a simple statement to the effect that relocation assistance is provided when needed but that no relocation is required by the project under discussion. The brochure and personnel should still be available to the public at the hearing.

7. Acquisition. Discuss right of way acquisition, estimated cost, and construction schedules. Discuss current schedules of critical activities that may involve or affect the public.

8. Closing. Summarize the hearing and what will follow.


(6) Hearing Summary Contents

The hearing summary includes the following elements:

1. Transcript.

2. Copy of the Affidavit of Publication of the hearing notice.

3. Hearing material:
   - Copies of the letters received before and after the hearing
   - Copies or photographs of, or references to, every exhibit used in the hearing.

4. Summary and analysis of all oral and written comments. Include consideration of the social, economic, and environmental effect of these comments.

210.06 Environmental Hearing

Projects requiring an EIS must use an evaluation process (called scoping in the NEPA and SEPA requirements) to identify the significant issues and alternatives to be studied in the DEIS and must follow the public involvement plan included in the Study Plan for the project. After the project has been thoroughly discussed within the community through the environmental evaluation process and informal public involvement methods, a hearing is held to present and gather testimony. The hearing is timed to fall within the comment period of the draft EIS for the project.

Responses to comments on the DEIS must be addressed in the FEIS. See Chapter 220 for the approval process.

The environmental hearing summary includes the items outlined in 210.05(6) above.

210.07 Corridor Hearing

When a Corridor hearing is held, the region must provide enough design detail on the proposed alignment(s) within the corridor(s) so that an informed presentation can be made at the hearing. Justification must also be presented to abandon an existing corridor.
After the hearing, the region reviews the hearing transcript, responds to all questions or proposals submitted at or subsequent to the hearing, compiles a hearing summary, and transmits three copies (four copies for Interstate projects) to the Access and Hearings Unit. When appropriate, the hearing summary may be included in the final EIS.

The corridor hearing summary includes the items outlined in 210.05(6) above.

The Access and Hearings Unit prepares a package that contains the corridor summary and a formal document that identifies and describes the project, and forwards it to the Assistant Secretary for Environmental and Engineering Service Center for adoption.

Federal approval of a corridor on existing alignment is not required unless a substantial social, economic, or environmental impact is involved or unless the project substantially changes the layout or function of connecting roads or streets.

Submit the complete corridor hearing summary to the Access and Hearings Unit within approximately two months following the hearing if it is not part of an EIS.

**210.08 Design Hearing**

When a design hearing is held for an improvement on existing alignment, and no other corridors are being considered, sufficient data must be presented to clearly document the decision to retain the existing corridor.

(1) **Design Hearing Summary**

The design hearing summary includes the items outlined in 210.05(6) above.

Submit the complete hearing summary to the Access and Hearings Unit within approximately two months following the hearing.

If new studies or additional data are required subsequent to the hearing, the region compiles the data in coordination with the OSC Design Office.

(a) **NHS Projects.** After the hearing, the region reviews the hearing transcript, responds to all questions or proposals submitted at or subsequent to the hearing, compiles a hearing summary, and transmits three copies (four copies for Interstate projects) to the Access and Hearings Unit. When appropriate, the design hearing summary may be included in the final environmental document. The Access and Hearings Unit prepares a formal document that identifies and describes the project and submits it to the State Design Engineer for approval. One approved copy is returned to the region. The Hearing Coordinator notifies the region that adoption has occurred.

(b) **Interstate Projects.** Following the design hearing summary approval, the Deputy State Design Engineer submits the approved design hearing summary to FHWA for approval. If possible, this submittal is timed to coincide with the submittal of the Design Decision Summary to the FHWA.

(2) **Public Notification of Action Taken**

The region prepares a formal response to the individuals who had questions not answered at the hearing. The region keeps the public advised as to the eventual result of the hearing process (project adoption, revision to the plan, or project cancellation, for example). A region newsletter sent to those on the interest list is an effective method of notification.

**210.09 Access Hearing**

Access hearings are required by law (RCW 47.52) whenever limited access is established or revised on new or existing highways. Decisions concerning access hearings are made on a project by project basis by the State Design Engineer based on information that includes the recommendations submitted by the region. (See Chapters 1410, 1420, 1430, and 1435.) Access hearing procedures generally follow the procedures identified in 210.05.

Prior to the access hearing as per RCW 47.52.131, conferences with the local jurisdictions shall be held on the merits of the access report and the plans.

The following supplemental information applies only to access hearings and procedures for approval of the Findings and Order.
(1) Hearing Examiner
The OSC Access and Hearings Unit hires an Administrative Law Judge from the Office of Administrative Hearings to conduct the access hearing.

(2) Order of Hearing
The Order of Hearing officially establishes the hearing date. The Hearing Coordinator calendars the Order of Hearing on the same calendar as the access hearing plan. The Hearing Coordinator then notifies the region, the Attorney General’s Office, and the hearing examiner of the official hearing date.

(3) Access Hearing Information to Abutters
The region prepares an information packet for mailing that must be mailed at least 15 days before the hearing (concurrent with advertisement of the hearing notice). If some of the access hearing packets are returned as undeliverable, the region must make every effort to locate the addressees.

The access hearing packet consists of:
• The Access Hearing Plan
• The Access Hearing Notice
• The Notice of Appearance

The region sends the access hearing packet to the following:
• The county and/or city
• The owners of property listed on the county tax rolls as abutting the section of highway, road, or street being considered at the hearing as a limited access facility.
• Local public officials and agencies who have requested a notice of hearing or who, by the nature of their function, interest, or responsibility, are interested in or affected by the proposal
• Every agency, organization, official, or individual on the interest list

And, if applicable, to the following:
• State resource, recreation, and planning agencies
• Tribal governments
• Appropriate representatives of the Department of Interior and the Department of Housing and Urban Development
• Other federal agencies
• Public advisory groups

The region prepares an Affidavit of Service by Mailing. This affidavit states that the access hearing packet was mailed at least 15 days prior to the hearing and that it will be entered into the record at the hearing.

(4) Access Hearing Plan
The region prepares an Access Hearing Plan to be used as an exhibit at the formal hearing and forwards it to the OSC Plans Engineer for review and approval about 45 days before the hearing. This can be a Phase 2 or Phase 2A plan. (See Chapter 1410.) The OSC Plans Engineer puts the Access Hearing Plan on the Deputy State Design Engineer’s calendar for approval.

(5) Access Hearing Plan Revisions
The Access Hearing Plan cannot be revised after the Deputy State Design Engineer approves the plan without rescheduling the hearing. If significant revisions to the plan become necessary during the period between approval and the hearing, they can be made and must be entered into the record as a revised (red and green) plan at the hearing.

(6) Access Hearing Notice
The hearing notice must be published at least 15 calendar days before the hearing. This is a legal requirement and the hearing must be rescheduled if the advertising deadline is not met. Publication and notice requirements are the same as those required in 210.05 except that the statutory abutter mailing must be mailed after notification of the appropriate legislators.
(7) **Notice of Appearance**

The Hearing Coordinator transmits the Notice of Appearance to the region. Anyone wanting to receive a copy of the Findings and Order and the adopted Limited Access Plan must complete a Notice of Appearance form and return it to the department either at the hearing or by mail.

(8) **Reproduction of Plans**

The Hearing Coordinator submits the hearing plans for reproduction at least 24 days prior to the hearing. The reproduced plans are sent to the region, at least 17 days before the hearing, for mailing to the abutters at least 15 days before the hearing. (See 210.09(3) above.)

(9) **Access Hearing Exhibits**

The region retains the access hearing exhibits until preparation of the draft Findings and Order is complete. Then the region submits all the original hearing exhibits, and three copies, to the Access and Hearings Unit as part of the Findings and Order package (210.09(11)). Any exhibits submitted directly to OSC are sent to the region for inclusion with the region’s submittal.

(10) **Access Hearing Transcript**

The court reporter furnishes the original access hearing transcript to the region. The region forwards the transcript to the hearing examiner, or presiding authority, for signature certifying that the transcript is complete. The signed original is returned to the region for inclusion in the Findings and Order package.

(11) **Findings and Order**

The Findings and Order is based entirely on the evidence in the hearing record. The region reviews a copy of the transcript and prepares a Findings and Order package. The package is sent to the Access and Hearings Unit.

A Findings and Order package contains:

- The draft Findings and Order
- Draft responses to comments (reserved exhibits)
- A draft Findings and Order Plan (as modified from the hearing plan)
- All access hearing exhibits (originals and 3 copies)
- The access hearing transcript (original and 3 copies)
- The Notice of Appearance forms
- A number indicating how many copies of the final Findings and Order Plan and text that the region will need for the mailing.

(12) **Adoption of Findings and Order**

The Assistant Secretary for Environmental and Engineering Service Center adopts the Findings and Order, or refers it to the Commission for adoption, based on the evidence introduced at the hearing and on any supplemental exhibits.

Following adoption of the Findings and Order, the OSC Plans Section makes the necessary revisions to the Access Hearing Plan, which then becomes the Findings and Order Plan.

The Access and Hearings Unit arranges for reproduction of the Findings and Order Plan and the Findings and Order text and transmits them to the region.

The region mails a copy of the Findings and Order Plan and the Findings and Order text to all parties filing a Notice of Appearance and to all local governmental officials. Subsequent to this mailing, the region prepares an Affidavit of Service by Mailing and transmits it to the Access and Hearings Unit.

At the time of mailing, but before publication of the resumé, the region notifies the appropriate legislators of the department’s action.

(13) **Resumé**

The Access and Hearings Unit provides the resumé to the region. The region must publish the resumé once each week for two weeks not to begin until at least 10 days after the mailing of the Findings and Order.
(14) **Final Establishment of Access Control**

When the Findings and Order is adopted, the Findings and Order Plan becomes a Phase 4 plan. (See Chapter 1410.) The establishment of access control becomes final 30 days from the date the Findings and Order is mailed by the region as documented by the Affidavit of Service by Mailing.

An appeal from the county or city must be in the form of a written disapproval, and request for a hearing before a board of review, submitted to the Secretary of Transportation.

An appeal from abutting property owners must be filed in the Superior Court of the state of Washington, in the county where the limited access facility is to be located, and shall affect only those specific ownerships. The plan is final for all other ownerships.

### 210.10 Combined Hearings

When deciding whether to combine hearings, consider:

- Whether there is controversy.
- Whether alternative corridors are proposed.
- The nature of the environmental concerns.
- The benefits to the public of a combined hearing.

A combined hearing often alleviates the need to schedule separate hearings close together to cover the same material. A combined EIS-corridor-design hearing is desirable only when the timing for circulation of the draft environmental document is simultaneous with the timing for corridor and design hearings and all alternative designs are available for every alternative corridor.

### 210.11 Administrative Appeal Hearing

When implementing access management statutes, the region is required to use the public involvement process to communicate the principles and standards of access management to the abutting property owners, business owners, and emergency services providers that might access the affected properties.

The department, as applicable, applies the Highway Access Management statutes to control access to the state highway system in order to avoid congestion and functional deterioration of the system. (See Chapters 1420 and 1430.)

After the public involvement process, if a decision has been made to restrict or delete access to a specific property, the property owner may appeal the decision by requesting a hearing.

#### (1) Hearing Procedure

An administrative appeal hearing does not follow the hearing procedures described earlier in this chapter. The procedure is as follows:

- The department notifies the property owner, in writing, that an access management action has been taken. The letter explains the appeal process.
- The property owner may write a letter to the department requesting an administrative appeal hearing.
- OSC hires an Administrative Law Judge and sets the hearing date, time, and place.
- The department notifies the property owner of the date, time, and place (in writing).
- Testimony is given.
- The ALJ renders a decision.

#### (2) Further appeals.

- The property owner may appeal the ALJ’s decision by writing the State Design Engineer.
- The State Design Engineer reviews the appeal and renders a decision (in writing, to the property owner).
- The property owner may appeal the State Design Engineer’s decision to the Superior Court of the state of Washington.

### 210.12 Documentation

All documents generated by hearings are retained in Archives by the Office of the Secretary of State.
**Sequence for a Hearing**

<table>
<thead>
<tr>
<th>Min. From Hearing</th>
<th>For Access Hearings</th>
<th>For Corridor, Design, and Environmental Hearings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine need for a hearing or an opportunity for a hearing 210.05(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop hearing notice 210.05(2) + exhibits, develop Access Hearing Plan 210.09(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 days Send prehearing packet 210.05(5)(a), send Access Hearing Plan 210.09(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calendar Order of Hearing &amp; Access Hearing Plan for access hearings 210.09(2)</td>
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<tr>
<td>30 days Draft EIS becomes available and its comment period begins for corridor and design hearings</td>
<td></td>
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</tr>
<tr>
<td>Send notice to legislators and local officials within a week of first ad 210.05(5)(b)</td>
<td></td>
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</tr>
<tr>
<td>Send letter with news release to media about 3 days before ad 210.05(5)(b)</td>
<td></td>
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</tr>
<tr>
<td>24 days Reproduction of plans 210.09(8)</td>
<td>30 days Advertise a hearing * 210.05(3) Environmental hearing</td>
<td></td>
</tr>
<tr>
<td>Mail information packet 210.09(3) and advertise a hearing * 210.09(6)</td>
<td>5-12 days Presentation of material to copy, hearing briefing, prehearing presentations 210.05(5)(c) - (e)</td>
<td></td>
</tr>
<tr>
<td>Confer with local jurisdictions 210.09</td>
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<tr>
<td>Hearing 210.05(5)(f)</td>
<td>Hearing 210.05(5)(f)</td>
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<tr>
<td>Access Hearing Transcript 210.09(10)</td>
<td>Address comments</td>
<td></td>
</tr>
<tr>
<td>Final Access Hearing Plan 210.09(11)</td>
<td>Summary 210.05(6) within two months of the hearing</td>
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</tr>
<tr>
<td>Findings and Order and Resumé 210.09(11) - (13)</td>
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</table>

*If the advertisement is for the opportunity for a hearing, the deadline for requests must be at least 21 days after the first ad. If there are no requests, see 210.05(4).*
220.01 GENERAL

Federal and state regulations require WSDOT to document the environmental impacts of a transportation project. When appropriate, other public and governmental agencies are involved in the decision-making process.

The project must comply with the following state legislation:

- State Environmental Policy Act (SEPA) of 1971, as supplemented in 1983, RCW 43.21C.
- SEPA Rules, Chapter 197-11 WAC.
- WSDOT Environmental Policy Act Rules, Chapter 468-12 WAC.

When the project involves only state funds or state permits, its documentation is governed only by state legislation.

When the project involves federal funds or federal permits, its environmental documentation is also governed by the:


Environmental documentation starts with project classification, which is normally the initial step of project development. WSDOT requires the use of an interdisciplinary approach to assess the social, economic, and environmental impacts of the project. Activities such as budgeting, prospectus development, and legislative or feasibility studies may already have been completed. At the discretion of the district, other activities such as preliminary engineering and surveys, soil survey, or location decisions could be done in conjunction with or prior to preparing the environmental document.

A flow chart (Figure 220-1) of the environmental process is included at the end of this section.

220.02 DEFINITIONS

Categorical Exclusions (CE) - NEPA or Categorical Exemptions (CE) - SEPA  Actions that do not individually or cumulatively have a significant effect on the environment.

Commitment File A file established by the district that identifies department commitments incorporated into the design and construction of a project.

Determination of Nonsignificance (DNS) The written decision by the District Administrator that a proposal will not have a significant environmental impact and no EIS is required (WAC 197-11-340).

Determination of Significance The written decision by the District Administrator that a proposal could have significant adverse impact and therefore require an EIS (WAC 197-11-360).

Discipline Report A report documenting findings concerning impacts of the project relative to an individual area of expertise. The report evaluates the impacts of the proposal and, where appropriate, includes recommendations concerning the course of action considered most desirable to fulfill the requirements of environmental laws and regulations addressed by the discipline.

Environmental Assessment (EA) A document prepared for federally funded, permitted, or licensed projects that are not categorical exclusions (CE) but do not appear to be of sufficient magnitude to require an EIS. The EA provides sufficient analysis and documentation to determine if an EIS or a Finding of No Significant Impact (FONSI) should be prepared.

Environmental Checklist A state agency document used to determine if an action will significantly impact the environment. The checklist form contained in WAC 197-11-960 is used for all actions not categorically exempt or not clearly requiring an EIS.

Environmental Classification Summary (ECS) A form (DOT Form 220-010 and 220-010A) used to evaluate and classify projects for the biennial budget or for later addition to the budget. The completed form is submitted by the district to the State Project Development Engineer for approval and FHWA concurrence if federal funds are involved.

Environmental Document A collective term used for any document that identifies the social, economic, and environmental effects of a proposed action.

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Environmental Impact Statement (EIS) A detailed written statement of project environmental effects required by state and/or federal law. This term refers to either a draft or final environmental impact statement, or both, depending on context.

Draft Environmental Impact Statement (DEIS) A document identifying a course of action, alternative actions, analysis of the environmental impacts of alternatives considered, and proposed mitigation of impacts. The DEIS is circulated to other agencies and the public for review and comment.

Final Environmental Impact Statement (FEIS) A document containing an evaluation of the course of action that WSDOT intends to follow. It contains the same information required for the DEIS, with appropriate revisions reflecting comments received from circulation of the DEIS and from public meetings.

Finding of No Significant Impact (FONSI) A federal lead agency document presenting the reasons why a proposal will not significantly affect the environment and therefore will not require an EIS. The FONSI includes the EA and references any other related environmental documents.

Lead Agency A federal or state agency taking primary responsibility for preparing an environmental document.

Public Involvement Plan A plan developed by the district outlining the public involvement activities to be used on a project to present information, obtain comments, and ensure consideration of public opinion.

Record of Decision (ROD) A document prepared by the federal lead agency after an EIS has been completed, outlining the final decision on a proposal. It identifies the decision, alternatives considered, measures to minimize harm, and a monitoring or enforcement program.

Section 4(f) Evaluation A document presenting the consideration, consultations, mitigative measures, and alternatives studied for the use of properties identified in Section 4(f) of the U.S. Department of Transportation Act as amended (49 USC 1653H).

Notice of Intent A federal notice, printed in the Federal Register, advising that an EIS will be prepared and considered for a proposal.

Study Plan An outline of the study process for the development of a project requiring an environmental impact statement.

220.03 PROJECT CLASSIFICATION

(1) Programmed and Unprogrammed Projects

At the program development stage, each project is evaluated and classified according to its magnitude and potential for significant social, economic, and environmental impact. For all projects, the district prepares an Environmental Classification Summary (ECS) and submits it to the headquarters Project Development Office for technical review and approval.

The headquarters Project Development Office submits the approved ECS to the Federal Highway Administration (FHWA) for concurrence for NEPA projects only. If FHWA requests additional information, the headquarters Project Development Office coordinates the request between the district and FHWA. When FHWA concurs with the ECS, the headquarters Project Development Office returns the ECS, along with any comments, to the district.

(2) Category A, B, C Projects - NEPA/SEPA Documentation

(a) The following categories of projects are qualified for federal aid by complying with NEPA regulations. FHWA serves as lead agency.

- All Category A and B projects meeting 3R or full design standards.
- All Category A, B, & C projects eligible for Bridge Replacement (BR) or Discretionary Bridge Replacement (DBR) funds.
- All Category C projects classed as NEPA Categorical Exclusions. When these projects require a Coast Guard permit, the headquarters Project Development Office will obtain NEPA CE concurrence from the permitting agency.

(b) For all other Category C projects which do not qualify for federal aid but do require federal permits, the department completes the SEPA document and the federal permitting agency serves as lead agency for completion of the NEPA document. Document preparation is a coordinated effort between the lead agency and the department.

(3) Classification

All WSDOT projects are classified as follows:

(a) Class I, NEPA/SEPA - Environmental Impact Statement (EIS). Actions likely to have significant impact on the environment by altering land use, planned growth development patterns, traffic volumes, travel patterns, transportation services, or natural resources, or by creating public controversy. An EIS can be prepared without developing an Environmental Assessment. Refer to 220.04.

(b) Class II, NEPA-Categorical Exclusion/ SEPA - Categorical Exemption (CE). Actions that do not have a significant impact on the environment or involve substantial planning time or resources. These actions are specifically identified in 23 CFR 771.115 for federally funded or permitted projects and WAC 197-11-800 and 197-11-860 for state and locally funded projects. Unless specifically requested by other agencies or the public, these actions do not
require an EIS or Environmental Assessment. A SEPA checklist may be required if right of way or state permits are required. Refer to 220.05.

(c) Class III, NEPA - Environmental Assessment (EA)/SEPA - Check list. Actions in which the significance of the impact on the environment is not clearly established. An EA or SEPA checklist is prepared to determine the extent of environmental impact and is used to determine whether an EIS need be prepared. No EIS is required when the EA supports a Finding of No Significant Impact and SEPA Determination of Nonsignificance on a project involving federal funds or permits. Similarly, a SEPA check list supports a Determination of Nonsignificance for a state project and no EIS is required.

220.04 CLASS I, EIS

(1) Project Initiation

The district initiates the project by submitting a Work Order Authorization (DOT Form 120-020) to the Program Development Office for review and approval.

The Program Development Office approves the Work Order Authorization and notifies the district and the headquarters Project Development Office of approval. The headquarters Project Development Office contacts the district to coordinate the project environmental and public involvement requirements.

(2) Notice of Intent

For a project involving federal funds or federal permits, after the Work Order Authorization is approved, the district prepares a Notice of Intent for publication in the Federal Register, advising federal agencies that an EIS will be prepared. The contents and guidelines for preparation of the notice are found in FHWA Notice T6640.8A. The notice is submitted to the headquarters Project Development Office which submits it to the federal lead agency for placement in the Federal Register.

(3) Interdisciplinary Team (IDT) and Project Manager (PM)

The district appoints an IDT, consisting of three to five various disciplines, which functions as an advisory board to the District Administrator. The district may also appoint other support disciplines to do specific expertise studies. These may be appointed from the district and headquarters. The IDT and support disciplines provide objective, in-depth studies, analyses, reports, guidance, and recommendations concerning the proposed improvement as it relates to social, economic, and environmental issues. The District Administrator delegates the administrative responsibilities of the project to a PM and provides support staff to assist in the administration of the project. Which disciplines and personnel are selected for the IDT depends on the nature and magnitude of each project.

WSDOT personnel are assigned when available and may be supplemented by consultants, personnel from other state or local agencies, and disciplines from within the community. Assistant Secretaries, the State Project Development Engineer, the IDT, community groups, and planning agencies may suggest the assignment of additional disciplines. IDT members and support disciplines have expertise in such areas as: acoustics, air quality, archaeology, architecture, biology, botany, communications, economics, geology, hydrology, landscape architecture, meteorology, sanitary engineering, sociology, structural engineering, transportation planning, urban planning, and water quality.

Duties and responsibilities of the IDT include:

- Review and approval of a Study Plan and a Public Involvement Plan.
- Evaluation of alternative courses of action.
- Preparation of reports (data and conclusions of technical studies, views of citizens, officials, and groups).
- Submission of recommendations to the PM.

The PM, in consultation with the various disciplines, prepares a proposal, identifies the affected parties, and outlines environmental concerns and alternatives to be included in the scoping process.

(4) Scoping

Scoping is a process used to identify all significant issues and alternatives for the EIS and to have them presented as early as possible. Specific scoping objectives are:

- To identify the affected public and agency concerns.
- To facilitate an efficient EIS preparation process by identifying the cooperating agencies, ascertaining which related permits and reviews need to be scheduled concurrently, and setting completion time limits.
- To define the issues and alternatives to be examined in detail in the EIS.
- To save time by ensuring that draft statements adequately address relevant issues and that a statement will not have to be rewritten or supplemented.

The beginning of the scoping process usually consists of informal meetings or open houses. Either prior to or during these sessions, the district provides to the affected agencies, Indian tribes, and any other groups, organizations or agencies known to have interest in the project, information about the proposal including a brief description, proposed alternatives, probable environmental impacts and issues, maps, drawings, and a brief explanation of the scoping procedure.
The district also holds an orientation meeting for the IDT and support disciplines providing as much project information as available including maps, profiles, possible R/W requirements for alternatives, traffic for alternatives, draft study plan, and available construction costs. The disciplines will identify any additional information they require.

The scoping process continues through the development of the DEIS. It includes telephone conversations, and written comments involving various agencies, interest groups and individuals. The PM is responsible for development, documentation, and coordination of the scoping process.

(5) Study Plan and Public Involvement Plan

The headquarters Project Development Office reviews and approves the Study Plan/Public Involvement Plan. The approved Study Plan/Public Involvement Plan is then submitted to the district for implementation.

(a) Study Plan. A Study Plan is completed immediately after the issues and alternatives have been identified in the initial stages of the scoping process. The Study Plan, which shows the project environmental studies to be conducted, is prepared by the PM and approved by the IDT, the district, and the headquarters Project Development Office. The Study Plan is an outline of the scope and level of effort intended for identification of interdisciplinary participants, public involvement, alternatives to be studied, and social, economic, and environmental issues.

The following is the general format for the data in the Study Plan:

1. Title sheet:
   a. Project title.
   b. Date.
   c. Approval date and signatures of:
      • Team Chairman
      • District Administrator
      • Assistant Secretary for Highways

2. Vicinity map.

3. Need and purpose:
   a. Need (known deficiencies).
   b. History (if applicable).
   c. Purpose of project.

4. Scope of work:
   a. Interdisciplinary approach. (Briefly describe how the team uses interdisciplinary information to reach decisions.)
   b. Alternatives.
   c. Public involvement summary.

   d. Brief description of areas of primary importance.

5. Studies to be prepared and areas of responsibility:
   a. List of studies to be prepared and disciplines assigned study responsibility.
   b. Identify IDT members, project manager and IDT chairman.
   c. Identify education and experience record of all expertise including only the information required for an EIS.

6. Manpower and budget requirements.
7. Schedule.
8. Appendix: Public Involvement Plan.

   (b) Public Involvement Plan. The Public Involvement Plan is an integral part of the Study Plan. Its objectives are to outline the procedures by which information will be presented to the public, obtain comments, and ensure consideration of public opinion. Details of the Public Involvement Plan are contained in Chapter 210.

(6) Selection of Alternatives

The PM develops preliminary alternatives. The IDT studies all proposed alternatives and determines social, economic, and environmental effects. Generally, each alternative is developed to the same level of detail so comparisons of effects can be made. Alternatives should be openly discussed with all affected groups.

The alternatives to be studied are determined by the PM and the IDT. A listing of the features to be considered for each alternative along with a comparative matrix to assess differences is shown in the WSDOT Environmental Procedures Manual M 31-11.

Alternatives normally include the following:

- The no-action alternative, which could include short-term minor reconstruction activities (safety improvements, etc.) that are part of an ongoing plan for continuing operation of the existing roadway.
- Improve existing facility, which could include resurfacing, restoration, and rehabilitation (3-R) plus reconstruction (4-R) types of activities, high occupancy vehicle lanes (HOV), park and ride facilities, and other minor improvements.
- Multimodal alternatives, include public transit, rail, water, and air transportation, or other modes of transportation dictated by the characteristics of the study area. These may be under the jurisdiction of other lead agencies and require early coordination.
- New transportation routes and locations.
- Multiple alternatives identified above.
(7) Data Collection, Inventory, and Evaluation

The IDT develops an inventory of social, economic, environmental, and engineering data. The information is used to define the environment, predict and analyze impacts of project implementation, help select the least environmentally damaging alternative, serve as a data base for environmental documents, and provide information to other agencies, interest groups, or individuals.

The sources of data include, but are not limited to, field studies, consultation and coordination with other agencies, and the public. The *Environmental Procedures Manual* M 31-11 and FHWA Technical Advisory T6640.8A, are guides to the type of information, depth of study, and procedures used in collection, inventory, and evaluation of required environmental data. The following is a list of expertise areas considered in the development of an environmental document.

- Geology and Soils.
- Topography and Sundry Sites.
- Waterways and Hydrological Systems.
- Water Quality.
- Flood Plains.
- Wetlands.
- Farmlands.
- Vegetation.
- Wildlife and Wildlife Habitat.
- Hazardous Waste.
- Transportation.
- Air Quality.
- Noise.
- Energy.
- Visual Quality.
- Regional and Community Growth-Population Characteristics.
- Land Use.
- Disruptions, Displacements and Relocation - Changes in Community Character.
- Employment.
- Property values.
- Taxes.
- Overall Economic Activity - Output of Goods, Services, and Agricultural Products.
- Services.
- Sites of Recreational, Cultural, Historic, and Archaeological Significance.

(8) Reports and Recommendations

(a) Discipline Reports. After data has been collected, inventories compiled, and analyses completed, each discipline prepares a report. The report documents the technical studies and investigations performed, contains a summary of findings, and lists recommendations. The individual reports are submitted to the Project Manager for review.

Since the report communicates equally with technical and non-technical groups, a summary of the report is written to present the significant findings of the study and the recommendations in non-technical terms. The information is presented in a form suitable for incorporation into the environmental document and for presentation at public hearings or use by management and lay groups in decision making.

The technical portion provides evidence that all the major potential areas of impact have been considered, presents information to support the findings of significance and effect, and demonstrates clearly that the study is in compliance with the requirements of environmental law. The following is a general format for a complete discipline report:

- Summary of report findings, conclusions, and recommendations.
- Background discussion.
- Study methodology.
- Coordination with other groups or agencies.
- Affected environment (existing conditions).
- Prediction of impacts of each alternative.
- Mitigation recommended for construction and operational impacts.
- Bibliography.

(b) Preliminary Recommendations. The Project Manager and the IDT review all discipline reports and develop preliminary recommendations after discussing the various alternative trade-offs. The district submits the preliminary recommendations to the headquarters Project Development Office for review and approval. After approval they are returned to the district.

The preliminary recommendation would normally include:

- A description of alternatives to be considered in the DEIS.
- Identification of a preferred alternative if one exists.
- Identification of significant impacts and possible mitigation.
- A discussion of controversial areas and proposed coordination to resolve.
- Identification of any changes in the proposal as originally defined in the Study Plan.

(c) Draft Environmental Impact Statement (DEIS) and Commitment File. The DEIS is the initial WSDOT project report. It identifies the alternative actions and presents an analysis of their impacts on the environment. It may identify a recommended
course of action but need not if one is not clearly preferred. The DEIS summarizes the early coordination process, including scoping, and identifies the key issues and pertinent information received through these efforts.

For projects requiring federal funds or federal permits, all EIS documentation must comply with the requirements of NEPA and the Council on Environmental Quality (CEQ) guidelines.

Other EIS documentation uses SEPA guidelines as the controlling authority. EIS documentation that meets NEPA requirements satisfies SEPA, but SEPA documents do not necessarily satisfy NEPA.

All EISs are written following the Environmental Procedures Manual M 31-11.

On projects where federal agencies have funding or permitting responsibility, one federal agency is the lead agency. WSDOT and the federal lead agency are mutually responsible for the environmental document. Any other federal agency may be involved as a cooperating agency. Projects jointly developed with a federal agency are prepared to comply with that agency’s regulations and guidelines.

The headquarters Project Development Office prepares a preliminary DEIS using reports and/or data supplied by the IDT, the district, and other sources. The district prepares a commitment file consisting of proposed mitigating measures, commitments made to resource agencies or other agencies with permitting authority, and any other commitment made on behalf of the project. The commitment list is sent to the headquarters Project Development Office. Upon completion of the preliminary DEIS, the headquarters Project Development Office submits the document to the district for review and comment. See 220.08 for other commitment file requirements.

The headquarters Project Development Office coordinates reviews by various headquarters expertise, the Attorney General’s office (on controversial projects), and appropriate federal agencies. Review comments are returned to the district for revision of the preliminary DEIS as appropriate. After reviewing changes made in response to comments on the preliminary DEIS, the district submits the DEIS to the Assistant Secretary for Highways who approves the DEIS by signing the title page and obtains concurrence for circulation by signature of appropriate federal official on the title page. The signed title page and approval to print the DEIS are returned to the district and the document is printed. Required copies of the document are submitted to the headquarters Project Development Office.

If the project involves federal funds or permits, the headquarters Project Development Office submits the DEIS to the federal lead agency for transmittal to the EPA for their processing and placement of a notice in the Federal Register. A comment period of not less than 45 days begins upon publication of the notice in the Federal Register. For state funded projects, the DEIS is submitted to the DOE and a comment period of not less than 30 days is established from the date DOE receives the document.

Circulation of the DEIS is a shared responsibility between the district and the headquarters Project Development Office. The headquarters Project Development Office circulates to WSDOT headquarters offices, the Attorney General, DOE, the Transportation Commission, the State Library, and FHWA. The headquarters Project Development Office requests that the DOE send the DEIS to the Washington State Conservation Commission per Memorandum of Understanding GC 7141. The district makes all other circulation, which is normally to any agency, affected Indian tribe, organization, public official, or person who expresses interest or requests the DEIS, any federal agency having jurisdiction by law or special expertise with respect to an environmental impact, any governmental agency authorized to develop and enforce environmental standards, and any governmental agency authorized to issue permits. When visual impacts are a significant issue, the DEIS should be circulated to officially designated local arts councils and, as appropriate, other organizations interested in design, art, and architecture. Generally, all copies sent out during the circulation of the DEIS are furnished free of charge. After initial circulation a fee may be charged which is not more than the cost of printing.

(d) Draft Section 4(f) Evaluation. When a project involves USDOT funding or USDOT permits and requires the use of any publicly owned land from a park, recreation area, wildlife or waterfowl refuge, or a cultural resource site on or eligible for the National Register of Historic Places, a Section 4(f) evaluation must be included in a separate section of the environmental document. A separate evaluation is prepared for each location within the project where the use of Section 4(f) property is being considered. The Section 4(f) evaluation must include:

- Description and need for the proposed action.
- Description of the Section 4(f) properties.
- Impacts on the resource by each alternative.
- Alternatives that avoid Section 4(f) properties and their impacts.
- Measures to minimize harm.
- Coordination with appropriate agencies.
Also refer to 220.04(10) for additional requirements of a final Section 4(f) evaluation.

The DEIS/Section 4(f) evaluation report must be circulated to the Secretary of the U.S. Department of the Interior for a 45-day review and comment period. When appropriate, the Secretary of Housing and Urban Development and the Secretary of Agriculture (federal) are also given an opportunity to review the proposal. When a Section 4(f) property is identified after the DEIS and/or FEIS has been processed, a separate Section 4(f) evaluation is prepared, circulated for comment, and finalized.

(e) Section 106 Preliminary Case Report. All projects which involve the acquisition of right of way or excavation within existing right of way have potential to be surveyed and inventoried for cultural resources to determine if resources exist and if sites qualify for inclusion in National Register of Historic Places.

When cultural resources are discovered the following steps are taken (headquarters normally takes the lead in these actions):

- Send Determination of Eligibility form and cultural resource report to the State Historic Preservation Officer (SHPO).
- When eligible, send Determination of Effect form to SHPO for concurrence.
- If resource property is affected, apply the Criteria of Adverse Effect and get SHPO's concurrence.
- When there is an adverse effect, prepare a Section 106 Preliminary Case Report as per 36 CFR 800. Report generally identifies any adverse effects and actions taken to mitigate effects.
- Report sent to Advisory Council on Historic Preservation, through SHPO, requesting comments.
- Prior to FEIS preparation, participate in the development of a Memorandum of Agreement with the Advisory Council, SHPO, and FHWA that includes measures to avoid, mitigate, or accept the adverse effects on a resource.

Section 106 property also meets the requirements for Section 4(f) evaluations when the site in question is on or eligible for the National Register of Historic Places and if it has been determined that the proposed project will have an adverse effect upon the site. When this is the case, the Section 106 Preliminary Case Report and Draft Section 4(f) evaluation will be one document to satisfy the requirements of both laws.

(9) Hearings and Notices

When the department advertises notices for corridor, design, or combined corridor-design hearings, or offers a notice of opportunity for public hearing, the notice announces the availability of the environmental document and where it may be obtained and/or reviewed. If there is involvement in wetlands, flood plains, Section 4(f) lands, or endangered species, this information is included in the notice. Where hearings are not required by statute, an informational meeting may serve as a useful forum for public involvement in the environmental process. See Chapter 210 for further hearings requirements.

(a) References:

- Council on Environmental Quality (CEQ) Regulations - 1506.6
- USDOT Order 5610.1C
- 23 CFR Part 771
- WAC Orders 197-11-502, 535
- WAC Order 468-12-510

(b) SEPA.

1. Public Hearings. Public hearings on SEPA projects are held whenever one or more of the following situations occur:

   a. WSDOT determines that a hearing is needed to assist in implementing the requirements of SEPA.

   b. Fifty or more persons reside within the project area or are adversely affected by the environmental impact of the proposal and make a written request for a hearing.

   c. Two or more agencies with jurisdiction over the proposal request a hearing.

2. Public Notice of Availability/DEIS. WSDOT is required to use the public notice procedures detailed in WAC 468-12-510(c) to inform the public that the DEIS is available and the procedures for requesting a public hearing. If a hearing is required to fulfill any legal requirements, include information on the availability of the DEIS in the notice. The public notice requirements include: publication of notice in a newspaper of general circulation in the county, city, or general geographic area where the proposal is located; notifying agencies with jurisdiction, affected Indian tribes, and those groups that are known to be interested in the proposal or who have commented in writing about the proposal; contacting news media and placing notices in appropriate regional, neighborhood, or ethnic periodicals. Publish the notice at least 30 days in advance of the public hearing. The available environmental document continues to be open to consideration and comment.

The DEIS Notice of Availability contains the following basic elements:

- Location of project.
- Brief description.
3. Public Notice of Availability/FEIS. WSDOT notifies the public in the similar manner as for the DEIS excluding the last item. FEIS notification procedures are detailed in WAC 468-12-510(d).

(c) NEPA.
1. Public hearings are required for NEPA projects when:
   a. Substantial environmental controversy exists,
   b. The department has a substantial interest in holding a hearing, or
   c. An agency with jurisdiction over the proposal (permitting agency) requests a hearing.

2. The notices of availability are similar to the SEPA notices with the inclusion of the name of the federal lead agency. If there is involvement in flood plains, wetlands, Section 4(f) land, or endangered species, this information is included in the notice. These notices are printed in the Federal Register by the lead agency at least 30 days in advance of the public hearing.

(10) Final Reports and Approvals
(a) Final Recommendation. The district reviews comments from the hearings and those received from evaluation of the DEIS and prepares a hearing summary that is submitted to the headquarters Project Development Office for review. The district then analyzes and coordinates comments on the DEIS with the IDT and the headquarters Project Development Office, and prepares a final recommendation. The final recommendation contains:
   1. Description of the preferred alternative.
   2. Identification of proposed measures to minimize harm.
   3. Monitoring or enforcement programs required to ensure implementation of mitigation measures. The district submits this recommendation, with appropriate comments, to the headquarters Project Development Office for review and coordination within headquarters. When the headquarters Project Development Office approves the recommendation it becomes the WSDOT recommendation.

(b) Final Environmental Impact Statement and Commitment File. The headquarters Project Development Office prepares the FEIS and coordinates preparation and processing procedures with the district. The document contains the WSDOT final recommendation or preferred alternative, discusses substantive comments received on the DEIS, summarizes citizen involvement, and describes procedures required to ensure that mitigation measures are implemented. The FEIS also documents compliance with environmental laws and Executive Orders.

The district also resubmits the commitment file including new commitments made since the first submittal. Details on establishing and maintaining the commitment file are located in 220.08.

CEQ regulations state that when the DEIS adequately identifies and quantifies the environmental impacts of all reasonable alternatives, and it is apparent that changes in the proposal will be minor, or only minor comments are received from circulation of the DEIS, the FEIS can consist of the DEIS and attachments containing the following:

1. Errata sheets making corrections to the DEIS.
2. A section identifying the preferred alternative and a discussion of the reasons why it was selected and others were not. If applicable, this section also contains the final Section 4(f) evaluation, wetlands findings, flood plain findings, and a list of commitments for mitigation measures.
3. Summary of comments and responses from circulation of the DEIS and public hearings.

The headquarters Project Development Office reviews the preliminary FEIS and obtains reviews by the Attorney General's office (on controversial projects) and the appropriate federal agency. Review comments are provided to the district for use in revising the FEIS. The district prepares a draft Record of Decision (ROD) and submits it to the headquarters Project Development Office along with the FEIS. The headquarters Project Development Office reviews the FEIS, the Assistant Secretary for Highways signs the title page, and approval for printing is obtained from the federal lead agency.

The district prints the FEIS and submits it to the headquarters Project Development Office, which submits the FEIS and the draft ROD to the appropriate federal agency for signature. The State Project Development Office forwards the signed title page to the district for insertion into the FEIS. For state funded projects, the FEIS is submitted to the DOE and other state agencies only for informational purposes.

Circulation, distribution, and coordination of the FEIS is a shared responsibility between the district and the headquarters Project Development Office. The headquarters Project Development Office circulates it to headquarters offices, the Attorney General,
DOE, the State Library, and FHWA if it is a federal aid project. The district circulates the FEIS to any person, organization, or agency that submitted substantive comments, any agency authorized to issue permits, and public institutions for public review.

(c) Final Section 4(f) Evaluation. When the selected alternative involves the use of Section 4(f) property, a Section 4(f) evaluation is included as a separate section in the FEIS. The final evaluation contains:

1. All information required for a draft evaluation found in 220.04(7).

2. A discussion supporting a conclusion that there are no feasible and prudent alternatives to the use of the Section 4(f) property. The discussion must demonstrate that there are unique problems or unusual factors involved in the use of other alternatives and that the cost, environmental impact, or community disruption resulting from such other alternatives reaches extraordinary magnitudes.

3. A discussion documenting that the proposed action includes all possible planning to minimize harm to the Section 4(f) property.

4. A summary of the formal coordination with the Department of Interior, and, as appropriate, the U.S. Departments of Agriculture, and Housing and Urban Development.

4a. A copy of the Memorandum of Agreement with the Council on Historic Preservation. (See 220.04(8)(e.).)

5. Copies of all formal coordination comments received and response to questions.

6. Concluding statement “Based upon the above considerations, it is determined that there is no feasible and prudent alternative to the use of land from the Section 4(f) property and that the proposed action includes all possible planning to minimize harm to the Section 4(f) property resulting from such use.”

(d) Record of Decision (ROD). This document is prepared by the district in draft form and accompanies the FEIS through the review and approval process. The ROD is only required on federally involved projects and includes the information required by Section 1505.2 of the CEQ Regulations.

The headquarters Project Development Office obtains the approved ROD from the federal agency and circulates it to the State Construction Engineer, the State Operations and Maintenance Engineer, and the district, and advises that the project may advance to the design stage.

The following format is used:

1. Decision. Identify the selected alternative. Reference to the FEIS may be used to avoid repetition.

2. Alternatives Considered. Briefly describe each alternative (with reference to the FEIS, as above), explain and discuss the balancing of values underlying the decision. Values for economic, environmental, safety, traffic service, community planning, and other decision factors may be different and be given different levels of relative importance. Identify each significant value and the reasons why some values were considered more important than others. The ROD should reflect the manner in which these values were considered in arriving at the decision. Identify the environmentally preferred alternative or alternatives. In addition, if Section 4(f) property is used, the Section 4(f) evaluation is summarized.

3. Measures to minimize harm. Describe all measures to minimize environmental harm that have been adopted for the proposed action. State whether all practicable measures to minimize environmental harm have been incorporated into the decision and, if not, why.

4. Monitoring or enforcement program. Describe any monitoring or enforcement program that has been adopted for the specific mitigation measures, as outlined in the FEIS.

5. Commitment List. Include an item-by-item list of commitments and mitigation measures from the commitment file. The list serves as a ready reference for the design, construction and maintenance of the project.

(e) WSDOT/FHWA Corridor. For corridor projects, the headquarters Project Development Office requests corridor approval from FHWA and the State Transportation Commission. FHWA corridor approval is required only for interstate projects.

220.05 CLASS II, CE

(1) Project Initiation

The district initiates the project by submitting a Work Order Authorization to the Program Development Engineer for review and approval. Upon approval of the Work Order Authorization, the project may proceed.

(2) Environmental Documentation

(a) NEPA. Federally funded projects are classified as Categorical Exclusions (CE) if they are included in one of the actions identified in 23 CFR 771.117.

Actions requiring no further federal environmental documentation because of blanket approval received from FHWA are identified in 23 CFR 771.117(c).
The remaining actions are approved as CE's when FHWA has approved the Environmental Classification Summary (ECS). These then require no further federal environmental documentation. If any CE project affects Section 4(f) properties a separate Section 4(f) evaluation document is required as outlined in 220.04(7). Supporting documentation must also be prepared for CE projects that may affect wetlands, farmlands, flood plains, or cultural resource properties. Supporting documentation is submitted with the ECS form.

The district identifies projects that have received prior CE concurrence when submitting the project design to the headquarters Project Development Office for approval. The design transmittal includes the date of FHWA concurrence.

Projects which are NEPA CE's having both federal and state funds, must still satisfy SEPA requirements. These projects may need environmental approval both as a NEPA CE and a SEPA Determination of Nonsignificance.

(b) SEPA. Projects funded by state funds only or by a combination of state and federal funds must satisfy one of the following SEPA requirements. In all cases the required SEPA action is identified on the ECS when it is approved by the State Project Development Engineer.

Projects are approved as Categorical Exemptions (CE) when the project meets the requirements of WAC 197-11-800 (SEPA Guidelines). The ECS identifying the project as a SEPA CE is the only environmental documentation necessary. SEPA actions requiring a checklist are identified in 220.06(6)(c).

220.06 CLASS III, EA/CHECKLIST

(1) Project Initiation

Environmental Assessment projects are initiated by the district submitting a Work Order Authorization to the Program Development Office for review and approval. The Program Development Office then notifies the district and the headquarters Project Development Office that the Work Order Authorization is approved. As required, the headquarters Project Development Office contacts the district to coordinate project environmental and public involvement requirements.

(2) Appointment of Disciplines and Project Manager

After approval of the Work Order Authorization, the district appoints various disciplines to conduct all studies necessary for EA preparation and a Project Manager (PM) to be responsible for development of the project. These projects do not require the appointment and use of a formal IDT but use various disciplines in an interdisciplinary approach for needed investigations.

(3) Coordination

As appropriate, the district coordinates with affected federal, state, and local agencies, Indian tribes, and the public in determining the scope of the action, alternatives to be considered, and significant issues to be addressed. The PM is responsible for conducting the coordination. During the early coordination process, FHWA in cooperation with WSDOT requests other agencies with involvement to become cooperating agencies. By law, federal agencies with jurisdiction must be requested to become cooperating agencies. The district makes these requests in writing and sends a copy to the headquarters Project Development Office.

(4) Data Collection, Inventory, and Evaluation

The various disciplines conduct studies to assess social, economic, and environmental impacts. The depth of study varies with the magnitude and setting of the proposal. Generally, discipline studies for an EA are developed using the same method outlined for EIS projects in this section. Studies are carried out to the point where a determination can be made as to the extent of environmental impact. If significant impacts are found, the district determines whether satisfactory mitigating measures can be incorporated into the project to reduce the impacts to insignificance or to begin the EIS process.

(5) Public Involvement

The district conducts public meetings, does mailings, and uses other methods appropriate to the magnitude and scope of the project to provide and obtain information to assist in developing the project. Public involvement methods are discussed in Chapter 210.

(6) Reports and Recommendations

(a) Discipline Reports. Refer to 220.04(8).

(b) Environmental Documents - NEPA. The district prepares a preliminary Environmental Assessment (EA) in accordance with the Environmental Procedures Manual M 31-11. Include an area map, vicinity map, site plan, photogrammetric maps (to depict the environmental setting), discipline reports, and any agency coordination letters such as endangered species listings, prime and unique farmland determinations, archaeological/historic reports, etc. If the project involves Section 4(f) lands, a separate evaluation is required as per 220.04(7) and 220.04(10) and is included as a separate section in the EA.

The preliminary EA and Section 4(f) evaluation are submitted to the headquarters Project Development Office which circulates the documents to appropriate WSDOT headquarters offices and the federal lead
agency for review and comment. If the reviewers determine that the proposal may have significant environmental impacts, the proposal is reevaluated to determine whether the significant impacts can be appropriately mitigated or eliminated. If the impacts cannot be eliminated an EIS is required. If no significant impacts are found, the headquarters Project Development Office returns the preliminary EA, with comments, to the district for revisions. The revised EA is resubmitted to the headquarters Project Development Office for approval.

The headquarters Project Development Office then requests federal concurrence to publish a notice announcing the public availability of the EA. The public review and comment period for an EA is 30 days. If a Section 4(f) evaluation is included, a 45 day public review and comment period is required. The headquarters Project Development Office also circulates the document to the federal lead agency, SHPO, and cooperating agencies. If Section 4(f) property is involved, the district circulates the document to the Department of the Interior and to the agency with jurisdiction over the Section 4(f) property.

At the conclusion of the public availability period, the district evaluates all comments received, including comments from public hearings, meetings, and open houses. The district responds to the comments and revises the document as necessary. If comments are minor, the district may issue an addendum referencing changes in the EA. The headquarters Project Development Office submits the final EA to the federal agency requesting a Finding of No Significant Impact (FONSI). After the federal agency issues the FONSI, the headquarters Project Development Office returns the signed FONSI to the district. The headquarters Project Development Office notifies the Department of Community Development (Clearing House) via letter that a FONSI is available from WSDOT or the federal lead agency.

c) Environmental Documents - SEPA.

1. If the project does not involve another agency with jurisdiction; demolition of any structure or facility not exempted by WAC 197-11-800(2)(f) or 197-11-880; issuance of clearing or grading permits not exempted in Part Nine of SEPA rules; but does require new easements; additional right of way; widening of more than a single lane; or any other action which is not SEPA exempt; the district will:

   a. Prepare the checklist and the DNS.
   b. Obtain the signature of the District Administrator or his designee.
   c. Send a copy to the headquarters Project Development Office.

d. Submit a copy to the DOE headquarters for listing in the SEPA register.

e. Process is complete.

2. If the project requires approvals from other agencies with jurisdiction; the district will:

   a. Prepare the checklist and the DNS or mitigated DNS.
   b. Obtain the signature of the District Administrator or his designee.
   c. Submit a copy to the headquarters Project Development Office for review and concurrence of mitigation measures before circulation.

d. Circulate for a 15-day review and comment period (in accordance with WAC 197-11-340(2)(b) or WAC 468-12-510(a)) to:

   - DOE headquarters.
   - DOE regional office.
   - Newspapers of general circulation in the project vicinity (indicate option to publish).
   - Agencies with jurisdiction.
   - Affected Indian tribes.

e. Evaluate review comments then proceed to:

   - Confirm the validity of the DNS; or
   - Prepare a mitigated DNS and revised checklist and recirculate in accordance with WAC 197-11-350 (see 2a above); or
   - Withdraw the DNS in accordance with WAC 197-11-340, prepare a Determination of Significance and proceed with an EIS.

If environmental documentation is needed to support the DNS, such as preservation of farmlands determination, archaeological/historical surveys, wetland reports, flood plain evaluations, or other expertise reports, the district requests the preparation of expertise reports and coordinates the processing of the reports to the appropriate agencies. Informational copies are also sent to the headquarters Project Development Office.

When either NEPA or SEPA proposals involve project commitments, these commitments will be recorded and completed as required for more major projects. See 220.08.

3. The NEPA-EA document can also be used to satisfy SEPA requirements. When the EA is approved, the district adopts the EA in accordance with part six of WAC 197-11 and WAC 197-11-340(1). The Adoption Notice, WAC 197-11-965, is filled out by the district and
circulated to DOE, to agencies with jurisdiction, to local agencies in which the proposal will be initiated, and to persons or organizations who have responded to the proposal in writing. An information copy is also sent to the headquarters Project Development Office.

When EAs or SEPA checklists contain commitments, commitment files will be established as per 220.08(3).

(7) Hearing and Notices

EA projects require a hearing when there is substantial controversy, when WSDOT wants a hearing, or when an agency with jurisdiction requests a hearing. For additional information refer to 220.04(9) and Chapter 210.

EAs normally have less potential for environmental impacts and public controversy and, consequently, less potential for public hearings. Prepare the EA in advance of any public hearing. The public hearing notice requirements follow the format and time schedule outlined in 220.04(9) and WAC 468-12-510. The notice of the public hearing published in local newspapers announces the availability of the EA and where it can be obtained or reviewed.

When a hearing is not required, the district publishes a notice in the local newspaper (similar to a public hearing notice) advising the public that the EA is available for review and comment and where the document may be obtained. Public availability and comment periods are identified in 220.06(6). The headquarters Project Development Office sends a notice of the availability to the Department of Community Development Clearing House.

After all environmental documents have been approved and finalized, they are returned to the district and the project may advance to the design stage.

220.07 PROJECT REEVALUATION

The district shall reevaluate a document any time it feels that single or cumulative conditions have changed which might cause new or more severe environmental impacts. Reevaluation is required when any one of the following conditions exist:

- An acceptable FEIS has not been submitted to FHWA within 3 years from the date of the DEIS circulation.
- Major steps to advance the project (such as approval to acquire a substantial portion of the right of way, or approval of PS&E) have not occurred within 3 years from FEIS approval.
- Any change is made to the proposed action and it is uncertain if a supplemental EIS is required. The district reevaluates the project by conducting appropriate environmental studies or, if necessary, by preparing an EA to assess the impacts of the changes.

When any of the conditions above exist, the reevaluation is submitted in written form to the headquarters Project Development Office. The headquarters Project Development Office reviews the reevaluation and forwards it for review and approval to the same federal office that approved the original EIS.

If the reevaluation identifies significant changes in the proposed action, the affected environment, the anticipated impacts, or the proposed mitigation measures, a new or supplemental document is prepared and circulated. For additional guidance on project reevaluations refer to 23 CFR 771.

220.08 PROJECT REVIEWS

(1) References

- NEPA Sections 1505.2 and 1505.3.
- 23 CFR 771.127.

(2) Procedures

- The district ensures that decisions made in environmental documents are accomplished in design and construction of projects, and maintained or improved during the life of the project.
- The district continues to maintain the project environmental commitment file which follows the project through design, right of way acquisition, PS&E, construction and maintenance. See No. (3) below.
- When requested by commenting agencies or the public, the district develops a progress report on the project mitigation implementation program and makes it available to those initiating the request.
- As requested, WSDOT makes available results of implemented mitigation measures established in the environmental document to the public upon request.
- During construction, the district implements the mitigation measures and monitors maintenance of environmental mitigation to ensure it is satisfactorily maintained or improved. The district must request concurrence from the headquarters Project Development Office for any significant alterations in mitigation measures agreed to during the environmental process, even when changes are made during construction or maintenance.
- When unique or unusual mitigation is required, the headquarters Project Development Office conducts periodic reviews during construction and/or operation to evaluate the effectiveness of mitigation measures that were incorporated into the contract.

(3) Commitment File

As an initial part of project development, the district establishes a project commitment file. Establishment of this file generally coincides with preparation of the environmental document or could be at later stages as required. The file consists of proposed mitigating
measures, commitments made to resource or other agencies with permitting authority, and other commitments made on the project. The file normally consists of design and environmental commitments. Other commitments may be added at the district’s discretion, such as right of way, access, maintenance, permits, and agreements.

The district continues to maintain the commitment file as a project progresses through its development process. Whenever commitments are made, they are incorporated into project documents and transferred from one phase of the project to the next. Commitments are normally included or identified in the following documents or actions:

- Environmental documents.
- Design reports.
- Right of way plans.
- Access plans.
- Findings and order.
- Contract plans.
- Pre-construction conference.
- Change orders.
- End of project report.
- Maintenance.

To organize and track commitments made during the development and implementation of a project, a “Record of Commitment,” DOT Form 220-021, is used which provides two functions:

(a) Establishes a permanent record of the commitment in paper form.

(b) Establishes the means of locating and summarizing commitments of a specific type through the use of a computer file.

When a commitment is made, record it on the Record of Commitment form. The form contains the detail necessary to document the commitment, including references to correspondence, agreement numbers, etc.

For easy retrieval, the information on each completed form is entered into the district computerized commitment file (and the form is then filed) according to state route, milepost, and date.

A commitment may be revised when all parties involved agree to the revision.

A computer system maintains a (statewide) summary of commitments. As each commitment is made, this Commitment Summary File receives data from the districts. Commitments can be identified according to route and milepost, district, date made, type, or responsibility.

When commitments are completed, the computer files and the forms are updated with the date the commitment was finished and appropriate comments. Records (forms) on completed commitments should be retained for at least a year after the completion date. Commitments requiring ongoing maintenance need to be retained in the files as long as the commitment is active.

When project documents reach headquarters, the headquarters Project Development Office reviews design reports and PS&E for inclusion of appropriate commitments. The headquarters Project Development Office also coordinates an annual review of selected commitments to evaluate the effectiveness of the commitment implementation process. Normally, two projects are reviewed in each district by environmental, design, construction, and maintenance personnel from headquarters and the district. The results of the evaluation, with appropriate recommendations, are furnished to the district.
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Permits and Approvals From Other Governmental Agencies

240.01 General
240.02 United States Department of the Army-Corps of Engineers
240.03 United States Coast Guard
240.04 United States Forest Service (USFS)
240.05 Federal Aviation Administration (FAA)
240.06 FHWA - Western Federal Lands Highway Division (WFLHD)
240.07 Federal Energy Regulatory Commission
240.08 Environmental Protection Agency
240.09 Washington State Departments of Fisheries and Wildlife
240.10 Washington State Department of Ecology (DOE)
240.11 Washington State Department of Natural Resources (DNR)
240.12 Washington State Department of Labor and Industries
240.13 Local Agencies
240.14 Utility Agreements

(2) Permits

Highway construction that infringes on waters or wetlands of the United States is required to have a Section 10 permit and/or a Section 404 permit. Either permit may be in the form of a nationwide or regional general permit or an individual permit. There are no regional permits applicable to WSDOT at this time.

(a) Section 10 Permit. A permit required for any construction, excavation, depositing of material, or any other work in navigable water affecting the course, location, condition or capacity of such waters. The purpose of the permit is to prevent obstructions to navigation.

Navigable waters are those waters of the United States that are subject to tidal action shoreward to mean high water or are used, have been used, or are susceptible to use in interstate or foreign commerce.

Waters of the United States include all navigable waters, interstate waters, intrastate waters of which the use, degradation or destruction could affect interstate or foreign commerce, tributaries to the above, and wetlands adjacent to the above.

(b) Section 404 Permit. A permit required for discharge of dredged or fill material into waters of the United States. The purpose of the permit is to prevent water quality degradation. A 404 permit is not required to maintain structures or drainage ditches, but may be required to construct temporary sedimentation basins.

(c) Nationwide Permits. These permits apply to both Section 10 and Section 404 permits and are fully detailed in 33 CFR 330. Some apply to certain waters and others to specific activities. Provided the conditions in (d) are followed, the permits authorize the following activities:

- Fills in nontidal waters where the mean annual flow is less than 5 cubic feet per second or not tributary to interstate or navigable waters.
- The repair, rehabilitation, or replacement of a previously authorized structure or fill to its original plan and uses. Dredging is not authorized by this permit.
- Outfall structures where the effluent is covered by a National Pollutant Discharge Elimination System (NPDES) permit, provided adverse impacts of the structure are minimal.
• Structures placed within anchorage areas to facilitate moorage if established by the Coast Guard.

• Bank stabilization measures necessary for erosion prevention, that are less than 500 feet long and average less than 1 cubic yard per lineal foot within waters of the United States. Also provided that no material is placed in any wetland, flow is not impaired to or from any wetland, only clean material is used, and the activity is a single complete project.

• Minor road crossing fills of less than 200 cubic yards below ordinary high water provided the opening will pass high flows and that discharges into wetlands do not extend beyond 100 feet on either side of ordinary high water. Also provided that the activity is a single complete project crossing a non-tidal water body.

• Fill placed incidental to construction of a bridge over navigable waters having a Coast Guard Section 9 permit. Approach fills are not included, nor are projects on non-navigable waters, where the Corps of Engineers has jurisdiction.

• Fills that do not exceed 10 cubic yards as part of a single complete project provided no fill is placed in wetlands.

• Dredging no more than 10 cubic yards as part of a single complete project.

• Activities authorized or funded by a federal agency if the project is categorically excluded from NEPA documentation. The Corps has concurred with the FHWA/UMTA list of categorical exclusions in Chapter 220.

(d) Conditions. The following special conditions are applicable for the nationwide permits in (c) to be valid.

• Discharge will not occur near a public water supply intake.

• Discharge will not occur in areas of concentrated shellfish production.

• The activity will not jeopardize a threatened or endangered species, or adversely modify critical habitat of such species.

• The activity will not significantly disrupt movement of indigenous aquatic life.

• Discharge will be free of toxic amounts of toxins.

• Structures and fills will be properly maintained to prevent erosion and other pollution.

• The activity will not occur in a National Wild and Scenic River System.

• The activity will not cause an unacceptable interference with navigation.

• The best management practices in (e) should be followed as much as practicable.

(e) Best Management Practices. Practices to follow, to the maximum extent practicable, when discharging dredged or fill material are:

• Avoid waters of the United States by using other practical alternatives.

• Avoid spawning areas during spawning season.

• Avoid restricting or impeding movement of indigenous aquatic species or the passage of water.

• Minimize adverse impacts on the aquatic system caused by the accelerated or restricted flow of water due to its impoundment.

• Avoid wetlands.

• In wetlands, place heavy equipment on mats.

• Avoid breeding areas for migratory waterfowl.

• Entirely remove temporary fills.

(3) Procedures

The WSDOT district coordinates proposed actions with the local Corps’ district to determine which permit is required, if the project is covered by the nationwide permit or if the project must comply with other conditions established by the Division Engineer. The Corps’ Division Engineers are authorized to modify nationwide permits by adding conditions or override nationwide permits by requiring individual permit applications on a case-by-case basis.

No application is required for projects authorized by the nationwide permit. For individual permits, the district makes application to the appropriate Corps of Engineers, District Engineer in Walla Walla, Seattle, or Portland. Appropriate Corps districts will hold a pre-application review with other agencies if the applicant desires. Applications for individual permits require specific details according to the instructions outlined in the pamphlet “U.S. Army Corps of Engineers Permit Program a Guide for Applicants,” prepared by the Corps of Engineers. When submitting an application, also submit a signed Certification of Consistency with the Coastal Zone Management Plan, if applicable. The Corps will forward the certification, along with the Corps’ public notice, to DOE for concurrence or objection.

The Corps is required to advertise by public notice for public interest whenever an acceptable application is received. The Department of Ecology (DOE), which functions as the state clearing house, circulates the public notice to and solicits comments from, all state agencies. When state agency concerns have been satisfied, the DOE responds to the Corps, indicating the state’s position on issuing the permit. If the state has no objection, the DOE will issue a water quality certification and a statement of consistency with the Coastal Zone Management Plan if required. The Corp issues the permit when all objections are resolved.
240.03 UNITED STATES COAST GUARD

(1) General

The Coast Guard issues permits for bridges, causeways, and drawbridges in navigable waters of the United States. When WSDOT develops a bridge project requiring a Coast Guard permit, the environmental coordination and documentation is developed in accordance with the Memorandum of Understanding between the U.S. Coast Guard (USCG) and the FHWA, signed May 1981.

This memorandum is intended to improve coordination, avoid unnecessary duplication of effort, and enhance problem resolution between the USCG, FHWA and WSDOT in the preparation of NEPA environmental documents. The Coast Guard and the FHWA agree that, when a highway section requires an action by both FHWA and Coast Guard, the FHWA will normally serve as the lead agency for the preparation and processing of environmental documents. Details of document preparation and processing are in Chapter 220.

(2) Procedures

The Bridge and Structures Office applies for all Coast Guard bridge permits and coordinates the permit review. The application must be documented by an analysis of the effect the project will have on the quality of the environment. The Coast Guard will issue a permit when other federal agencies have no objection and applicable state agencies notify DOE that there are no objections. When DOE notifies the Coast Guard of the state’s position, it will include a “Water Quality Certification” indicating the action complies with federal and state water quality standards detailed in 240.09.

Because the DOE certification depends on the finalization of the other water oriented permits, (such as Section 404 Permit, Shoreline Substantial Development Permit, etc.) the district and the Bridge and Structures Office should coordinate permit application times. This will enable all water permits to be acted upon concurrently and avoid possible delays.

(3) Coast Guard Bridge Construction Progress Report

A Coast Guard Bridge Construction Progress Report is required each month on all projects that have a Coast Guard permit. The report itemizes and identifies the location of known obstructions and their sequence of removal from the waterway. The district prepares the report and sends it to the headquarters Project Development Office, which submits the report to the Coast Guard. The Coast Guard permit also requires that they be notified when permitted portions of a project are complete. To ensure timely notification, the district will notify the headquarters Project Development Office which in turn notifies the Coast Guard that permitted construction is complete.

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240.04 UNITED STATES FOREST SERVICE (USFS)

(1) General

Under the Department of Agriculture, the USFS is responsible for the management of National Forests.

When the project will use lands managed by the USFS, each district is responsible for coordination and negotiation with the USFS on all matters related to highway use and occupancy in national forest lands. The district contacts the headquarters Land Management Office to coordinate and negotiate matters concerning acquisition of property rights with the USFS. If the project is on WSDOT fee title lands within USFS boundaries, the USFS has no jurisdiction and need not be contacted.

The Memorandum of Understanding “Highways Over National Forest Lands,” M 22-50, for highways in national forests is a general policy outlining responsibilities of WSDOT and the USFS.

(2) Procedures

The Memorandum of Understanding is used for coordinating location, design, construction, maintenance, signing, access control, and other matters related to state highway and forest highway use and occupancy. Generally, the following procedures apply:

(a) The district provides data to the Forest Supervisor, showing proposed routes of the improvement, and requests a Stage I Multiple Use Survey Report. A joint pre-survey field review is then made by the Forest Supervisor and the district.

The district forwards 2 copies of the Stage I Report to the headquarters Design Office for review. Any comments or recommendations made by Design are sent to the district for action.

(b) Following agreement between the WSDOT and the USFS on the contents of the Stage I Report, the district develops the design report and the USFS initiates a Stage II Multiple Use Survey Report. The development of these reports should be coordinated and concurrent, to resolve any difference of treatment or conflict of use between the district and the USFS.

The district furnishes copies of the proposed design report to the USFS and arranges for joint review. If mutual agreement cannot be reached on some aspects of the design report or Stage II Report, respective viewpoints will be defined and presented in the reports from each jurisdiction. Disagreements are negotiated through the headquarters Design Office, with district participation.

Copies of the Stage II Report are submitted by the USFS to the district for review; the Stage II Multiple Use Survey Report is processed and approved in the same manner as a design report.
The FHWA and USFS have developed the following guidance when federal projects involve USFS land. This guidance was issued as an FHWA Notice, May 1973, titled “Coordination of Environmental Impact Statements with the U.S. Forest Service.”

For these projects the district will request the USFS to make a determination statement that the land being proposed for highway use is or may be categorized as Section 4(f) land. The USFS will respond by one of three following ways, as noted below, prefaced by the following paragraph:

The proposed (Name) route (Location) (and the alternate routes) has been reviewed against the criteria of Section 4(f) of the USDOT Act of 1966, PL 89-670, as amended by the Federal Aid Highway Act of 1968, PL 90-495, Section 18.

Situation 1. Since this route crosses an area of Public Land under National Forest designation, as the Agency having jurisdiction of these Public Lands, we have determined that the route does not encroach on or use land from any of the types of specially designated areas in the above Public Laws.

Situation 2. Since this route crosses an area of Public Land under National Forest designation, as the Agency having jurisdiction of these Public Lands, we have determined that the route does in fact encroach on and uses land from a type of area as specified in the above public laws and we recommend a 4(f) determination procedure be initiated.

Situation 3. Since this route crosses an area of Public Land under National Forest designation, as the Agency having jurisdiction of these Public Lands, we have determined through detailed analysis that conditions of use exist of a nature which requires a designation of the type stated in the above act. It is our intent to now proceed with such a designation. Since the project will use land from the area proposed for designation, we recommend that a 4(f) determination procedure be followed.

The district must incorporate the USFS’s response into the environmental document identifying the Forest Service’s designation of the land and preparing a 4(f) evaluation if required.

240.05 FEDERAL AVIATION ADMINISTRATION (FAA)

(1) General

Proposed highway construction in the vicinity of public-use and military airports requires an FAA Notice. The district should make contact with airport authorities as early as possible to facilitate progress of location and design work within the required FAA regulations.

(2) References

- Federal Aviation Administration regulations Part 77. Objects Affecting Navigable Airspace.

(3) FAA Notice (Form 7460-1)

The requirements are shown on Figure 240-2. The WSDOT district will submit the following information to the FAA Regional Office:

(a) Map showing airport location with respect to existing highways. An 8-1/2 X 11 inch vicinity map with project and airport locations indicated is adequate.

(b) Map and diagram to show pertinent distances and elevations between runways and the proposed highway.

(c) Plans and profiles showing elevations of earthwork, pavement, structures, and intermediate obstructions, if any. Include the height of luminaires, bridge towers, or other tall appurtenances.

(d) One completed set of FAA Form 7460-1, “Notice of Proposed Construction or Alteration.”

Form 7460-1 must be submitted by the district at least 30 days before the date proposed construction or alteration is to begin. Form 7460-1 may require review and perhaps resubmittal if it is submitted more than 18 months in advance. The Assistant Secretary for Aeronautics should be contacted for clarification of aeronautical permits or FAA form 7460-1.

If Form 7460-1 results in studies by the FAA that may affect the proposal, the headquarters Project Development Office should be notified and included in any decisions. A record should be maintained of all contacts made with the FAA.

240.06 FHWA - WESTERN FEDERAL LANDS HIGHWAY DIVISION (WFLHD)

(1) General

WFLHD administers, advertises and awards projects which may include Indian Reservation Roads, National Park Roads, Forest Highways, Defense Installation Roads, etc. These projects may involve WSDOT by being on the state system or impacting the state system or local road systems.

Scheduling, planning, and programming of federal highway projects are considered in the development of other federal-aid highway programs. Representatives of WFLHD consult annually with the FHWA Division.
Office, WSDOT, and land management agencies concerning long-range planning and development of annual programs.

When WSDOT and WFLHD are co-participants in the development of a project, the function of each will be defined in a project agreement and a lead agency determined.

(2) References

The following should be reviewed when developing projects with WFLHD:

- Federal-aid Highway Program Manual (FHPM Volume 6, Chapter 9), Special Programs.

(3) Procedures

Prior to design phase or project development, the lead agency is determined between WSDOT and WFLHD.

When WSDOT is the lead agency, normal project development procedures are followed, including submittal of the design report to the FHWA Division Office by the headquarters Project Development Office.

WFLHD coordination for local agency projects will be through the State Aid Organization.

The following procedures generally apply when WFLHD has lead responsibility:

- WFLHD sends a request for a project review to the WSDOT district, specifying which items to review. A copy of the transmittal letter is sent to the headquarters Project Development Office. The request outlines the commitments required from the state. The items to review include such things as vertical and horizontal alignment, intersection design, bridge design, right of way plans, special provisions, sundry site plans, and utility plans.
- The district reviews the items and transmits the information to the headquarters Project Development Office for review. The district then coordinates all review actions and responds to WFLHD with all comments.
- The district will normally develop all access control activities; using procedures as outlined in Chapters 1420, 1430, and the Plans Preparation Manual.
- WFLHD forwards Environmental Document, Final Access Plan, Right of Way Plan, and PS&E, thru the district to the headquarters Project Development Office for final approval. They are then returned to the district with copies of pertinent correspondence.

WSDOT becomes involved with the FERC, through a license, when it proposes a project that may use lands within the boundaries of a hydroelectric project. The governing regulation of FERC, 18 CFR Parts 1-149, establish requirements that the licensee (hydroelectric project owner) must follow in approving uses for a third party action within the boundaries of a hydroelectric project.

(2) Procedures

To know what conditions will be required of the department, the district should initiate early coordination with the licensee. Approval to utilize lands within the hydroelectric project boundaries are granted when WSDOT resolves issues with the licensee and federal and state agencies having jurisdiction over fish, wildlife, shorelines and archaeological/historical concerns. The licensee does all necessary coordination with the FERC which can be a concurrent function with the department’s other permit coordination activities.

240.08 ENVIRONMENTAL PROTECTION AGENCY

(1) General

When a project with federal funds affects water quality of the Spokane Valley-Rathdrum Prairie Aquifer, the Whidbey Island Aquifer or the Camano Island Aquifer the department evaluates the project in accordance with a Memorandum of Understanding between FHWA, Region 10 and EPA, Region 10, signed November 1982. This memorandum outlines basic evaluation criteria and procedures to be followed by FHWA and EPA in conducting formal project reviews.

EPA and FHWA mutually agree that, generally, only projects requiring an environmental impact statement or environmental assessment need be submitted for review. Other projects which FHWA determines may have an adverse impact on an aquifer are also subject to review.

(2) Procedures

The department submits a summary of the project to FHWA. The summary includes a description of the project including termini, number of lanes or roadway width, type of construction, runoff control methods, and status of environmental document. Additional information may be requested by EPA if public controversy exists. EPA responds to project reviews within 30 calendar days unless they request an extension in writing or request additional information.

Information furnished to EPA is addressed to the Drinking Water Programs Branch in EPA’s Region 10 office. Project review comments or findings by EPA are addressed to the FHWA Division office processing the project.
240.09 WASHINGTON STATE DEPARTMENTS OF FISHERIES AND WILDLIFE

(1) General

The Washington State Departments of Fisheries and Game (WDF & WDW) are combined herein for simplicity. The Department of Fisheries deals with food fish and shellfish. The Department of Game has jurisdiction over wild animals, wild birds, and game fish. Both departments have similar permit and approval requirements within water areas.

WSDOT must obtain Hydraulic Project Approval (HPA) from WDF & WDW whenever WSDOT operations will take place within the ordinary high water marks of any waters of the state within the jurisdiction of the WDF & WDW. The Memorandum of Understanding between WSDOT and WDF & WDW clarifies responsibilities regarding compliance with the Hydraulic Code RCW 75.20.100.

(2) Procedures

The district determines which projects will affect waters under the authority of WDF & WDW and prepares an HPA application. Pre-application coordination may be desirable to adequately explain the project to the resource agency and ascertain their concerns. The application contains plans and a detailed narrative of proposed work, fish protection methods, anticipated date of proposed work, and name of WSDOT district representative.

The district submits an application to the headquarter's office of Fisheries and to the headquarter's office of Game. WDF & WDW will determine a need for the HPA. If an HPA is needed, WDF & WDW determine which of them will be the lead agency for the project and assign a field representative for field review.

The field representative contacts the district representative for coordination and review of project details. The respective agency representatives remain as project coordinators until completion of the project.

When the field review is complete and SEPA requirements have been met, the lead agency issues an HPA to WSDOT. WSDOT then incorporates provisions of the HPA into the project design. The district maintains coordination with WDF & WDW field representative to negotiate modifications to the project design documents and to the HPA if necessary.

The district also coordinates with the Bridge and Structures Office and the headquarters Project Development Office to maintain the exchange of information necessary for reviews and approvals.

The HPA issued for the project is also applicable to the construction project. Further details about an HPA application are covered in the Construction Manual M 41-01, Chapter 1 regarding "Relationship with FHWA and Other Federal, State and Local Agencies."

If an emergency condition exists and there is insufficient time to secure an HPA through normal channels, WSDOT contacts the WDF & WDW for oral approval. WDF & WDW should put the approval in writing within 30 days of oral approval.

240.10 WASHINGTON STATE DEPARTMENT OF ECOLOGY (DOE)

(1) General

The DOE has the legal authority to manage and develop Washington's air and water resources and to conduct a coordinated program of pollution control involving these and related land resources. The district obtains approval of water appropriation and pollution control measures and coordinates as needed with DOE.

(2) References

Refer to the Permits and Approvals listing at the end of this chapter (Figures 240-1a and 1b) and the specific legal references for the permit under consideration.

(3) Permits

(a) Water Quality Certification. Certification from DOE is required to obtain a federal permit or license for an action that may result in a discharge into navigable waters (240.02 and 240.03). The certification states that the discharge will comply with federal and state water quality standards. It may include a Short Term Modification of Water Quality Standards. (See (e) below.) An application for Water Quality Certification is not required.

(b) Flood Control Zone Permit. This permit indicates that a WSDOT project within a flood-control zone will be planned, constructed, operated, and maintained so it will not adversely influence the existing system of a stream or body of water, or adversely affect the security of life, health, and property against damage by flood water. The permit may be obtained from the DOE or from a local agency if the permit has been delegated by the DOE.

(c) Coast Zone Management Certification. This certification of compliance is an approval identifying the WSDOT project as consistent with the State and Federal Coastal Zone Management program. The approval may be issued in conjunction with Federal Permits (240.02 and 240.03).

(d) Waste Discharge Permit. This permit is required for operations involving sand and gravel washing, borrow pit dewatering or discharges from cement and asphalt batch plants into waters of the state. The state permit is the State Waste Disposal (Discharge) Permit. The federal equivalent is a National Pollution
Discharge Elimination System (NPDES) permit. DOE issues a combined permit satisfying both state and federal requirements. This permit may include a Short Term Modification.

(e) Short Term Modification. This permit is advised when the project activities may temporarily degrade water quality and a Waste Discharge Permit or Water Quality Certification is not necessary. This permit exempts WSDOT from being cited for violating water quality standards as long as the project complies with the prescribed terms and provisions.

(f) Appropriation of Water. A water right permit must be obtained from DOE before surface or ground water is appropriated for beneficial use. If the use is for construction purposes, such as dust control or batch plant operation, the permit is temporary and expires when the project is complete. The contractor usually applies for a temporary water permit but, if the usage is specifically required by WSDOT, the district acquires the permit before awarding the contract. If WSDOT needs to develop a permanent water supply, such as for a rest area or maintenance facility, the district applies to the DOE regional office for a permit to develop a water source. After the source is put to use, DOE issues a certificate establishing a water right in perpetuity.

(4) Procedures

The district determines which permits are applicable to the project, assembles the pertinent design information, and applies to the DOE regional office for a permit. If the information is inadequate, the DOE requests further information. If the application was appropriate, the DOE acts upon the request. If other DOE permits are required, the DOE will inform the district.

The headquarters Project Development Office may be requested to assist in resolving differences with the DOE. If the DOE has not responded to a permit request within 30 days, they should be contacted to determine the cause for delay and how to expedite a response. The district sends copies of correspondence and the permit to the headquarters Project Development Office.

(5) Water Pollution Control Plan (WPCP)

The WPCP contains design details of water pollution control measures for a project.

(a) Procedures. The district arranges a meeting with the appropriate DOE region and a headquarters Project Development Office representative at least annually to review upcoming projects that may have potential for water pollution. The district presents sufficient information to enable the DOE to determine whether a WPCP is necessary and what permits may be required. After the review, the district notifies the headquarters Project Development Office of projects requiring a WPCP. When the district prepares the actual plan they will coordinate with the DOE region and, as needed, get technical assistance from the headquarters Project Development Office. The completed plan is sent to the headquarters Project Development Office for review and approval. After approval, the district submits the WPCP to the DOE region for approval along with a copy of or reference to the approved SEPA document.

After DOE approves the WPCP, the district incorporates the relevant contents of the approved WPCP into the Contract Documents. As outlined in the Standard Specifications for Road, Bridge, and Municipal Construction (Section 1-07), the district also reviews, approves, and implements the contractor’s Temporary Water Pollution Control Plan. Temporary Water Pollution Control Plans should be carefully checked for compliance with the DOE approved WPCP in the contract documents. Any substantive deviations from the DOE approved WPCP should be discussed with DOE Regional representatives prior to approval of the contractor’s plan.

Construction activities should be monitored by the district to ensure that the DOE approved WPCP and the contractor’s Temporary Water Pollution Control Plan are followed and water quality is not adversely impacted. Additional measures to protect water quality may be needed as construction progresses and should be implemented when required.

For projects that involve rest area or maintenance site sewage disposal systems, the district shall submit plans and specifications to the DOE, DSHS, or local agency, depending on the volume of the system. See Figures 240-1a and 1b for the Permits and Approvals listing. After a mechanical or lagoon treatment facility is constructed, the district will submit an Operation and Maintenance Manual to DOE as per WAC 173-240.

(b) Contents of WPCP.

- Location and description of the project using a vicinity map and a detailed site map showing wells, streams and other water bodies, water and sewer lines, existing and proposed drainage, pollution control facilities, and access routes to these facilities.
- A list of wells, streams, and water bodies that might be impacted by the project, including their water quality classification and use.
- A list of permits or other documentation required for the project, such as Corps of Engineers, Shoreline, and Hydraulic Project Approval.
- Describe the construction and operation of stormwater systems including design storms and runoff quantities, drainage system sizes...
and capacities, and locations of discharges to receiving waters.

- Discuss construction and operation of erosion control methods, including maximum disturbed areas, contributing areas, and proposed maintenance.
- Discuss construction and operation of sediment control including methods, location, size, design criteria, and proposed maintenance.
- Oil and buoyant material control methods and proposed maintenance including hazardous spill control locations, methods, capacities, and clean-up procedures.
- Woodwaste fill and stockpile locations, construction procedures, drainage, and leachate control and prevention methods.
- Waste disposal methods and locations.
- Timing for installation of pollution control facilities.

240.11 Washington State Department of Natural Resources (DNR)

(1) General

The DNR administers the Forest Practice Act, the state’s natural resources, and certain state-owned lands. These lands include tidelands and shorelands, school trust lands, Forest Board lands, escheat lands, and certain Federal Land Grants provided by the Enabling Act.

When any DNR lands are needed for highway purposes, WSDOT negotiates for that use with the Commissioner of Public Lands. Except for obtaining rights of entry to do surveys and studies, all coordination and negotiations for DNR lands are made by the WSDOT Land Management Office.

(2) Lease Property

When WSDOT requires highway materials from DNR land, the district submits one copy of SF-4046, Application to Purchase Materials Upon State Lands, through the Land Management Office to DNR. The application includes estimates of quantities, time periods, and a map showing site details. DNR reviews the application and negotiates a royalty with WSDOT. Both agencies sign a nonexclusive contract (lease) for a specified time, allowing WSDOT to extract material from the site. Every six months for the life of the extraction lease, the district sends a “Removal Report” to DNR stating amount of material removed and includes payment for that material. The permit or lease normally allows WSDOT to stockpile materials at the site if room is available. Prior to using the site, WSDOT must also complete a reclamation plan as shown in Chapter 510 and the Plans Preparation Manual. When WSDOT uses their own land for surface mining, a DNR operating permit for surface mining is required.

Details for obtaining the permit are found in the Plans Preparation Manual.

(3) Right of Entry

When WSDOT determines that access to land is needed from the DNR, the district requests a Right of Entry from the local DNR office. A copy of the request is also sent to the Land Management Office. The district will not enter upon DNR land to survey or appraise until the Right of Entry is obtained.

(4) Transfer of Jurisdiction

When the district determines that DNR land is required for the project, the district will develop the appropriate right of way maps indicating DNR land involved. When the district is ready to appraise the property, they will contact a DNR appraiser to jointly inspect the parcel so appraisal issues can be immediately identified and discussed. The Land Management Office determines the need for timber cruises or other special studies. With the appraisal process complete, the Land Management Office submits maps, legal description, letter indicating intent to acquire, and WSDOT offer to DNR. The DNR should respond in 60 days. If accepted, WSDOT receives a Transfer of Jurisdiction. If rejected, the Land Management Office continues negotiations.

If lands are needed for a marine facility the WSDOT must only file a map of required area with DNR in accordance with RCW 47.12.026.

If any of the above actions involve leased DNR land, the WSDOT must get a release or waiver from the lessee before the DNR will act.

(5) Washington Forest Practice

(a) General. The DNR administers and enforces the Washington Forest Practices Rules and Regulations, except as otherwise provided in the Forest Practice Act. WAC 222, “Washington Forest Practices Rules and Regulations,” is available in booklet form through the DNR. Lands may be private or publicly owned lands on which activities are planned that are subject to the authority of the Forest Practices Regulations.

All Forest Practices Regulations are promulgated to achieve compliance with the water quality laws. Forest Land is land that is capable of supporting a merchantable stand of timber and is not being actively used for a purpose incompatible with timber growing. Forest Practice is any activity conducted on or directly pertaining to forest land and relating to growing, harvesting, or processing timber such as road and trail construction, harvesting (final and intermediate), precommercial thinning, reforestation, fertilization, prevention and suppression of
diseases and insects, salvage of trees, and brush control.

When any land that can be defined as Forest Land is altered or becomes the site of construction, the district may be required to fill out a Forest Practices Application/Notification form and submit it to the DNR area office. If the contractor fills out the application, it must still be signed by the District Administrator. Permit application forms are available from DNR. Locations and addresses are shown on Figure 240-3.

(b) Permit Procedures. The types of Forest Practices for the determination of permit application and notification requirements are divided into four classes:

- Class I Forest Practice operations are those with no direct potential for damaging a public resource. Class I requires no application or notification but does require compliance with all other Forest Practice Regulations.

- Class II Forest Practice operations are those that are determined to have a less than ordinary potential to damage a public resource. Class II requires a notification to DNR. Operations may begin five calendar days after the notification is sent.

- Class III Forest Practice operations are those that are not listed under Classes I, II or IV. Class III requires an application that must be approved or disapproved within fourteen calendar days of receipt by DNR.

- Class IV Forest Practice operations are those that are determined to have potential for a substantial impact on the environment. Class IV Forest Practices are divided into two groups; Class IV Special and Class IV General. Each requires an application to DNR that is approved or disapproved within thirty calendar days. Class IV Special requires an additional evaluation by DNR to determine whether a detailed environmental impact statement is necessary. Additional time is generally required when a detailed environmental impact statement is necessary.

240.12 WASHINGTON STATE DEPARTMENT OF LABOR AND INDUSTRIES

(1) General

When WSDOT has need to store explosives, the district obtains a storage license from the State Department of Labor and Industries (L&I).

(2) License

The district files an "Application for License to Operate a Storage Magazine for Explosives." The application is available through any office of L&I and must be submitted with detailed plans of the storage facility showing its distance from inhabited buildings, public highways, and other facilities. The approximate quantity, in pounds, of stored material or storage capacity should also be identified.

(3) Procedures

The district completes the application and sends it to the Olympia Office of L&I. The district also takes the lead in coordinating with any other agency that may be involved to secure approval of the storage facilities.

If the stored material involves projectiles or military explosives, the facility plan must be coordinated with and reviewed by the U.S. Department of Defense.

Concurrence to store explosives must also be obtained from the property owner where the facility is on lands that WSDOT does not own, such as U.S. Forest Service Land, DNR land, etc.

240.13 LOCAL AGENCIES

(1) General

Many local agencies have miscellaneous use permits and regulations that they have instituted to maintain orderly growth and development. WSDOT complies with permits, approvals, or licenses delegated to the local agency by the state, such as building, air pollution, and shorelines permits.

The Department of Transportation, as a state agency, is not legally obligated and will not obtain permits and approvals enacted at local discretion. However, in maintaining a working relationship with local agencies, the district coordinates project development activities with the local agencies, seeking to obtain their views, comments, and input.

(2) Change of Grade Permit

Whenever WSDOT construction entails a change in street grades in an incorporated city or town, the state is obligated by law to present the plans of new grades to the city or town for adoption by ordinance. To eliminate project delays, the district should send plans to the local agency for approval during the design report stage.

On limited access facilities, no grade approval is usually required for the highway itself. However, plans must be submitted to any incorporated city or town for grade approval for connecting streets, frontage roads, streets outside the limited access, and streets or connections within interchange areas, including any roadway passing over or under the facility but having no connection to it.

(3) Shoreline Substantial Development Permit

(a) General. Local governments, delegated the authority by DOE, issue a Shorelines Permit for projects that involve substantial development on waters of the state or shorelines of the state. Shorelines of the state
include the water areas of the state and their associated wetlands, including lands within 200 feet of the high-water mark and associated marshes, bogs, swamps, floodways, river deltas, and flood plains. Streams with a mean annual flow of less than 20 cfs or lakes smaller than 20 acres (including the adjacent wetlands) are exempt. Substantial development means any development of which the total cost, or fair market value, exceeds $2,500; or, any development that materially interferes with normal public use of the water or shorelines of the state. DOE has maps showing areas affected by the Shoreline Development Permit.

A Conditional Use Permit or Variance (RCW 36.70, “Planning Enabling Act”) is required when the project or an element of the project does not conform to the Shoreline Master Plan. For this permit, DOE makes the decision whether to approve or deny the permit based on the local agency’s recommendation.

(b) Process. The district applies for a Shoreline Substantial Development permit from the local agency when sufficient design information is available. The local agency will schedule a hearing on the application to solicit any comments. When responses to comments are satisfied and the local agency receives WSDOT’s final environmental document, the local agency then takes action on the shorelines permit. If the permit is denied, WSDOT may appeal to the Shorelines Hearings Board. Construction in the shoreline area cannot begin until 30 days after the permit has been approved.

240.14 UTILITY AGREEMENTS

To complete projects to the contract stage, it is frequently necessary to enter into agreements with numerous other entities. Most frequently used are Utility Agreements, Detour and Haul Road Agreements, and Railroad Agreements. The initiation of these agreements is done by the district Utilities Section. Further information is available in the Utilities Manual, M 22-87.
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<td>After/during preparation of environmental document</td>
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<td>State-Flood Control Zone Act of 1935 Federal-EO 11958 (Flood plain Mgmt.)</td>
</tr>
</tbody>
</table>

**Figure 240-1a**

Design Manual
September 1990
<table>
<thead>
<tr>
<th>Permit Approval</th>
<th>Grantor</th>
<th>Conditions Requiring</th>
<th>When To Initiate</th>
<th>Who Applies</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>CZMA</td>
<td>DOE</td>
<td>Applicants for federal permit/license are required to certify that the activity will comply with the state’s Coastal Zone Management program (Shoreline Management Act)</td>
<td>When applying for permit</td>
<td>District</td>
<td>CZMA Sec. 307, 16 USC 145, RCW 90.59</td>
</tr>
<tr>
<td>NPDES</td>
<td>DOE</td>
<td>Discharge of pollutants into state surface waters</td>
<td>During design</td>
<td>District</td>
<td>WAC 173-220, 402, 33 USC 1344, RCW 90.48.160, WAC 173-220</td>
</tr>
<tr>
<td>State Waste Disposal (Discharge)</td>
<td>DOE</td>
<td>Discharge of waste material from sand and gravel washing, pit dewatering, or cement/asphalt plant discharge into state waters</td>
<td>During design</td>
<td>District</td>
<td>RCW 90.48.160, WAC 173-220</td>
</tr>
<tr>
<td>Short-Term Modification (Regional)</td>
<td>DOE</td>
<td>Short-term activities which may result in temporary reduction of water quality standards and activities not subject to a waste discharge permit or water quality certification</td>
<td>During design</td>
<td>District</td>
<td>WAC 173-201-035(8)(e), WAC 173-201-035(5)(a), WAC 173-102-100(2)</td>
</tr>
<tr>
<td>Water Rights Appropriation</td>
<td>DOE</td>
<td>Appropriation of ground water or surface water</td>
<td>Prior to putting water to use</td>
<td>District or Contractor</td>
<td>RCW 90.44, RCW 90.03.250</td>
</tr>
<tr>
<td>Forest Practices Approval (Area Offices)</td>
<td>DNR</td>
<td>Public/private land capable of supporting merchantable timber — some activities — road construction, pits, pesticide use, hydraulic permits, shoreline permits, reforestation, etc.</td>
<td>Environmental document phase/prior to commencing</td>
<td>Contractor</td>
<td>WAC 222</td>
</tr>
<tr>
<td>Operating Permit for Surface Mining</td>
<td>DNR</td>
<td>Surface mining (pit and quarry sites) — more than 3 acres disturbed at one time or pit walls are more than 30 feet high and steeper than 1:1</td>
<td>After approval of the ultimate reclamation plan</td>
<td>HQ</td>
<td>RCW 78.44</td>
</tr>
<tr>
<td>Shoreline Management Counties/Cities</td>
<td>DOE</td>
<td>Shoreline development or construction valued at $2,500 or more, or materially interfering with normal public use of water. Development within 200 feet of water must be consistent with the local Shoreline Master Plan.</td>
<td>During preparation of environmental document</td>
<td>District</td>
<td>RCW 90.58, RCW 36.70</td>
</tr>
<tr>
<td>Temporary Air Pollution Control Authority/DOE</td>
<td>Local Air Pollution Control Authority/DOE</td>
<td>Pollutants above allowed levels for temporary periods</td>
<td>Prior to work commencing</td>
<td>Contractor</td>
<td>RCW 90.94</td>
</tr>
<tr>
<td>New Source Construction</td>
<td>DOE</td>
<td>Air pollution from point source (asphalt plants, rock crushers, etc.)</td>
<td>Prior to work commencing</td>
<td>Contractor</td>
<td>RCW 70.94,152</td>
</tr>
<tr>
<td>Building</td>
<td>County/City</td>
<td>Construction of any building — value of materials over $500</td>
<td>Prior to work commencing</td>
<td>Contractor</td>
<td>RCW 36.21,060</td>
</tr>
<tr>
<td>Sewage Facilities</td>
<td>DOE/DSHS/County</td>
<td>Construction/modification of domestic/industrial wastewater facilities (sewer relocation, rest area construction...) DOE: greater than 14,500 gpd, surface water discharge, or a mechanical treatment process involvement. DSHS: 3,500 gpd to 14,500 gpd. County: less than 3,500 gpd.</td>
<td>Prior to work commencing</td>
<td>District/Contractor</td>
<td>RCW 90.48.110, WAC 173-240</td>
</tr>
</tbody>
</table>

CFR — Code of Federal Regulations  
CZMA — Coastal Zone Management Act  
DNR — Department of Natural Resources  
DOE — Department of Ecology  
EO — Executive Order  
EPA — Environmental Protection Agency  
FERC — Federal Energy Regulatory Commission  
FHWA — Federal Highway Administration  
FWCA — Fish and Wildlife Coordination Act  
FWPCA — Federal Water Pollution Control Act  

NMFS — National Marine Fisheries Service (Dept. of Commerce)  
NPDES — National Pollutant Discharge Elimination System  
OAH — Office of Archaeology and Historic Preservation  
RCW — Revised Code of Washington  
SDWA — Safe Drinking Water Act  
USFWS — U. S. Fish & Wildlife Service (Dept. of Interior)  
WAC — Washington Administration Code

Figure 240-1a

240-12  
Design Manual  
September 1990
NOTICE REQUIREMENTS RELATED TO HIGHWAYS

NOTICE REQUIREMENTS RELATED TO HELIPORTS

NOTES:
The following FAA Notice requirements are excerpts from: Federal Aviation Regulations Part 77, Objects Affecting Navigable Airspace, Published January 1975.

Each airport must be available for public use and listed in the Airport Directory of the current Airman's Information Manual, or in either the Alaska of Pacific Airman's Guide and Chart Supplement; under construction and the subject of a notice or proposal on file with FAA, and except for Military airports, it is clearly indicated that that airport will be available for public use, or operated by an armed force of the United States. (Heliports and seaplane bases without specified boundaries are excluded.)

SUBPART B - NOTICE OF CONSTRUCTION OR ALTERATION

§77.13(a)(2) - A notice is required for any proposed construction or alteration that would be of greater height than an imaginary surface extending outward and upward at one of the following slopes -

(i) 100 to 1 for a horizontal distance of 20,000 feet from the nearest point of the nearest runway more than 3,200 feet in actual length.

(ii) 50 to 1 for a horizontal distance of 10,000 feet from the nearest point of the nearest runway of each airport with its longest runway no more than 3,200 feet in actual length.

(iii) 25 to 1 for a horizontal distance of 5,000 feet from the nearest landing and takeoff area of each heliport, available for public use and listed in the Airport Directory of the current Airman's Information Manual or in either the Alaska or Pacific Airman's Guide and Chart Supplement; is under construction and is the subject of a notice or proposal on file with FAA and except for military heliports, it is clearly indicated that that heliport will be available for public use, or operated by a Federal Military agency.

§77.13(a)(3) - Notice is required for any proposed construction or alteration of any highway, railroad, or other traverse way for mobile objects if a greater height than the standards of §77.13(a)(1) or (2) after their height has been adjusted upward by one of the following:

17 feet for an Interstate highway that is part of the National System of Military and Interstate Highways,

15 feet for any other public roadway, 10 feet or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road,

23 feet for a railroad

For a waterway or any other traverse way, an amount equal to the height of the highest mobile object that would normally use it.
DNR AREA MANAGEMENT UNITS

Figure 240-3
310
Preliminary Studies

310.01 General
310.02 Legislative Studies
310.03 Route/Design Studies

310.01 GENERAL

Preliminary project studies are prepared to identify the feasible route alternatives or design options before advancing the project.

Preliminary studies are undertaken at the discretion of the district, or at the request of the legislature, Transportation Committee, or WSDOT management. Preliminary studies should not be used when the required environmental and design report process would more appropriately render a decision.

310.02 LEGISLATIVE STUDIES

Mandate for a study comes from the legislature in the form of a law or a resolution. Responsibility for execution of the study may be assigned to the Legislative Transportation Committee, the State Transportation Commission, or a consulting firm. The study may encompass any subject within the scope of the Commission’s jurisdiction. The Assistant Secretary for Planning, Research and Public Transportation has primary staff responsibility for implementing legislative studies assigned to WSDOT. Initially, the legislative intent and scope of the study need to be clarified. If the session law does not make the intent clear, then the sponsoring legislators are contacted by department management to determine intent and precisely what information is being sought. If WSDOT is assigned the project, a Study Plan is developed which includes a statement of the legislative intent, a scope of work, a time table for the completion of the study, and an estimate of cost to complete the study. The study cost estimate is shown in Figure 310-1.

The scope of work spells out the areas of study and detail with which they will be investigated. It specifies the organization that will be responsible for gathering data for, or preparing, the various sections of the study. The format of the report is another item that is determined at this time.

A timetable is needed, since frequently the department is working against a fixed deadline for submittal to the legislature. When several organizations are contributing to the total study, it will establish when each portion must be completed.

When a study plan has been prepared, a fund request is made for conducting the study. The fund request will be made by the Assistant Secretary for Planning, Research and Public Transportation.

(1) Content of Study Report

(a) Areas of Investigation. The following are some areas of investigation which may be applicable to individual studies, or as a guide to possible areas of investigation and to suggest other topics which might be included:
   - Origin and destination surveys.
   - Traffic analysis and evaluation.
   - Benefit/Cost analysis.
   - Functional classification evaluation.
   - Accident analysis and summary.
   - Bridge condition survey evaluation and analysis.
   - Maintenance evaluation.
   - Photogrammetric services.
   - Soils and geological surveys and analysis.
   - Land use study and analysis.
   - Environmental impact analysis.
   - State interest evaluation.
   - Economic impact evaluation.
   - Social impact evaluation.
   - Public involvement evaluation.
   - Engineering evaluation.
   - Cost estimates.
   - Toll feasibility analysis.

Only items bearing on the issues being investigated should be included in the report.

(b) Allied Procedures. Environmental procedures are not necessarily applicable to legislative studies. A formal Environmental Impact Statement (EIS) is not prepared unless one is specifically required. However, every attempt should be made to identify anticipated environmental impacts and the probable extent of those impacts so that the study report may be used to make decisions on the basis of material it contains.

Public involvement procedures such as workshops, public meetings, community surveys, and newsletters may be utilized, if desirable or necessary, to develop data to complete the study. All publicity procedures should be checked with the legislative sponsor prior to taking any action since extensive publicity may be undesirable.

Hearings are not held by the department unless specifically required by the legislation. The appropriate legislative committee schedules and makes all arrangements for any hearings which are held.
(c) Written Text. Most who read the report and act upon it do not have a technical background. To be effective the report should be written in easily understood language. If detailed technical data is needed or used in the report, it should be summarized in nontechnical language. The technical details may be included in an appendix or retained as back-up data.

Estimates of cost should contain the major items, and should be rounded off commensurate with the accuracy of the methods used in developing quantities. It may be desirable to give a cost range for the estimate rather than a single figure. Estimate worksheets should be retained as back-up data. The date of the price index used in the estimate and the methods used in developing the estimate should be recorded.

If several people write different sections of the report, it should be edited and finalized by one person so that there is continuity and a similar style of writing throughout.

The report should be thorough, but concise, with the inclusion of supporting data, maps, photographs, and charts. Use and documentation of the best available resources should be made.

The report should present only the facts developed in the study. It should not make a recommendation. The department's recommendation is made in the letter of transmittal which is signed by the Secretary. A copy of the letter is bound in each copy of the report.

(d) Maps, Photographs, and Charts. Maps, photographs, charts, etc., are an important part of any report and frequently can be a deciding factor in whether the findings are understood and consequently accepted or rejected. The following are points to keep in mind when preparing these materials for a report:

- Maps, photos, charts, etc., should have a title, a scale and north arrow, if appropriate.
- The scale of maps or aerial mosaics should be dictated by the needs and characteristics of the particular study. Generally, the smallest practical scale should be used (consistent with illustrating the necessary details).
- Vertical alignment profiles may be necessary depending upon the requirements of the particular study. If they are not pertinent to the study, they should be omitted. If profiles are used, they should be to the same scale and on the same sheet as the plan.
- Maps, and particularly plan-profile sheets, should be limited to 11 by 17 inch maximum size (8 1/2 by 11 inch size is preferred). Sometimes it is feasible to utilize facing pages which allow an 11 by 17 inch size without a fold-out. Avoid long fold-outs.

- Photographs, charts and graphs should be clearly labeled, easily interpreted, and relevant to the study. Lettering size and contrast should maximize readability.

(2) Format of Study Report

Reports are standardized in the interest of maintaining continuity.

The report should be put together in the following sequence:

(a) Front Cover
(b) Letter of Transmittal
(c) Title Page
(d) Table of Contents
(e) Summary
(f) Body of Report
(g) Appendices

For continuity of legislative reports and consistency in identification of departmental publications, it is necessary to use the same color and design for all report covers prepared during a particular legislative session. An 8 1/2 by 11 inch size is used unless there is some reason to do otherwise. Preparation of covers should be coordinated with the Public Affairs Office. Information to be included on the report cover is shown in Figure 310-2.

The letter of transmittal contains the departmental recommendation and is signed by the Secretary. A draft is prepared by the District Administrator or Assistant Secretary responsible for the study and submitted to the Assistant Secretary for Planning, Research and Public Transportation with the draft report. The final letter is prepared and submitted to the Secretary for signature.

A sample of a typical title page is shown in Figure 310-3. As a minimum, it should contain the information shown. Transportation Commissioners are listed in the order of seniority.

The table of contents, introduction, and summary are generally self-explanatory. The introduction and summary should be brief, clear, and understandable. The summary should not contain a recommendation or material that has not been discussed in the body of the report.

The body of the report may be styled and formatted to fit the needs and content of the particular study, in a manner which makes the most effective presentation of the study material.

The appendices should contain any back-up data, technical material, or other information which is determined to be desirable or necessary to include in the report but which are too cumbersome or awkward to include in the body of the report.
(3) Publication and Distribution

The headquarters Reproduction Section has the capability and expertise to turn out quality reports. When it is necessary or expedient to use the Department of Printing or commercial sources, coordinate arrangements through the headquarters Reproduction Section.

Distribution of the report is made by the Assistant Secretary for Planning, Research and Public Transportation (PR&PT) on the following basis:

- 55 copies to Legislative Transportation Committee
- 1 copy to State Transportation Commission
- 1 copy to Secretary of Transportation
- 1 copy to Deputy Secretary of Transportation
- 1 copy to Assistant Secretary for Aeronautics Division
- 1 copy to Assistant Secretary for Highways Division
- 1 copy to Assistant Secretary for Management Services Division
- 1 copy to Assistant Secretary for Marine Transportation Division
- 1 copy to Assistant Secretary for Planning, Research and Public Transportation Division
- 1 copy to Legislative Liaison
- 1 copy to Public Affairs Administrator
- 3 copies to WSDOT Library (Additional copies may be requested for State Library)
- 1 copy to State Project Development Engineer
- 1 copy to Program Development Engineer

For reports that may have wide public interest, extra copies should be available to the Legislative Transportation Committee for public distribution.

RCW 47.01.145 requires that whenever a study is prepared for the Legislative Transportation Committee, it should be available to each legislator. Individual legislators are furnished copies upon their request. This should not be done until the study is transmitted to the Legislative Transportation Committee.

The study is considered the property of the Legislative Transportation Committee and it is their decision as to when and to whom the report is distributed. Results of the report and department recommendations are not made public until the report has been furnished to the Legislative Transportation Committee. All requests for copies of the report will be referred to the Legislative Transportation Committee through the Assistant Secretary for PR&PT.

310.03 ROUTE/DESIGN STUDIES

A preliminary study can be developed by the district when there is a need for selecting new routes, for evaluating design alternatives, to better define affordable solutions, or to more accurately define a project or related group of projects and their associated budget needs.

The study of a project begins by determining need and controlling factors within the project area (e.g., terrain and existing or potential facilities). Maps, photographs, environmental findings, and engineering data needed for investigation of each alternative are assembled. When presenting alternative comparisons, the same basic criteria and methods of investigation and evaluation are used for each alternative.

Assign a number or letter to each alternative involved in the study and identify each alternative by that designation throughout the study and in all reports and estimates.

To facilitate comparison, designate the beginning and end of all alternates from common termini.

(1) Preliminary Data

All support data, maps, and graphics must provide a sound basis for route planning and design alternates. The following types of information are used:

- Land use, population and density.
- Geological structure.
- Potential of the area for future industrial, residential, farm, or recreational development.
- Existing roads and highways serving the area.
- Existing, planned and potential utilities and facilities.
- Photogrammetric maps and aerial photographs of the area.
- Environmental conditions.

(2) Information Resources

Recent 7 1/2 minute or 15 minute quadrangles or aerial surveys provide adequate information for the initial investigation. These and other maps, photographs, and data can usually be obtained from the following sources:

- Previous surveys and reports.
- Maps by federal, state, county, and municipal agencies.
- Stereographs from private sources and governmental agencies, particularly the USGS and U.S. Department of Agriculture.
- Geological reports and bulletins.
- Railway maps and profiles.
- Maps made by the Cartographic Section of the PR&PT Division.

(Also refer to Chapter 1440.)
(3) Mapping Requirements

The type and scale of mapping required are dictated by the terrain and land use intensity of the study area. Mosaic reproductions or photographic prints may be used to show alternates.

Mapping for urban and suburban areas should be to a scale of 1 inch equals 100 or 200 feet with 5 or 10-foot contour intervals. In areas of little or no land use and in mountainous or heavily timbered areas, mapping may be done to a scale of 1 inch equals 400 feet with 10-foot contour intervals. This mapping may be done photogrammetrically.

Headquarters Geographical Services Branch is available to assist in the preparation of route maps. Geographical Services will make available upon request planimetric and topographic maps, halftone photography and strip maps, regular photography at any scale desired, and all types of photogrammetric mapping and related products.

(4) Traffic Analysis

The district or division will prepare a sketch map showing the traffic data needed for evaluation and forward the map and survey request to PR&PT. The request should note any possibility of a proposed environmental document, which would require additional traffic data and analysis.

Traffic analyses for interchanges, ramps, structures, or intersections, for proposed or existing facilities, or other special traffic needs will be furnished upon request.

(5) Route/Design Considerations

The following principles should be used in determining route location and design alternatives for the area under study.

(a) Satisfactory vertical and horizontal alignment is easily attained in river valleys and large mountain canyons. However, numerous stream crossings, expensive drainage and protective structures that may be needed to avert floods and washouts and environmental impacts could be a disadvantage.

(b) Locations on ridges and divides require steeper grades and more horizontal curvature than valley routes, but require fewer drainage and protective structures.

(c) Locations along mountainsides or hillsides offer numerous advantages. The gradient may be chosen to fit the topography as well as the distance requirements and elevation differences between fixed controls. On upper sidehills, snow and earth slide hazard will be low, and few bridges, drainage, and protective structures will be needed. A southern exposure will minimize pavement icing and reduce snow removal.

(d) Locations in level to moderately rolling terrain usually permit the highest standards of location and design; land use and right-of-way cost, rather than topography, will influence route selection.

(e) In highly developed regions, all but the major topographical obstacles will usually have to be disregarded; land use, right-of-way cost, and other route corridors will be the major considerations in route/design selection.

(6) Elimination of Alternatives

Elimination may proceed by successive reduction of the study area, refinement of the alternative requirements, and selection of the more representative alternatives.

Alternatives can be reduced to manageable proportions by first eliminating unreasonable ones that fall into any one of three areas:

(a) Alternatives that fall outside of the study area are eliminated on the basis of the study requirements. Support elimination of these alternatives with a map or statement describing the study area, and a statement of the study requirements including the project termini, travel desires, type and level of service, transportation function, type and importance of location controls, and any other pertinent considerations.

(b) Alternatives which are so alike that the cost of individual study would exceed the benefit to be derived from individual considerations. Present one alternative from each such group and document that similar alternatives have been considered and eliminated.

(c) Alternatives so environmentally sensitive that further study is not recommended.

(7) Environmental Screening

Environmental screening is used to provide environmental impact information as a basis for eliminating alternatives from further study or to provide environmental information for public involvement. Environmental screening can be an informal process performed by various environmental disciplines. (See Chapter 220.)

The information is intended to help the district or division obtain timely environmental information without an unnecessary amount of wasted effort. The district or division needs to inform the appropriate environmental expertise that they are requesting environmental screening information. If the project requires a discipline report this will be requested at a later date during preparation of the appropriate environmental document.

Examples of the conditions that would make environmental screening desirable:

- When environmental impact information is needed for a legislative study or preliminary study that is required prior to the start of the environmental process.
• When environmental impact information is needed for public involvement prior to selecting the alternatives for further study.

(8) Cost and Quantity Determinations

(a) Cost Estimates. Quantity determinations form the basis for comparison of cost estimates made for each route being considered in the study. Cost estimates may be based on the format identified in the Plans Preparation Manual.

Base estimates on information from maps, quantities determined for recent similar roadways, field surveys, previous estimates, and reports from other departments.

(b) Road User Benefit Analysis. A road user benefit analysis may be made to compare the annual road user costs and the annual costs of improvement, maintenance, and operation of each alternative over a given period of time. It may be prepared following procedures in A Manual on User Benefit Analysis of Highways and Bus-Transit Improvements (AASHTO).

(9) Preliminary Route/Design Study Report

The Study Report is prepared from information developed above for the evaluation of the design and economic feasibility of the route or routes studied.

The support material for the report substantiates and explains the route planning and design decisions.

The reports are prepared in 8 1/2 by 11 inch format and six copies will be submitted to the headquarters Project Development Office for review. Submit seven copies if FHWA approval is required.

Content should include the following as appropriate:

• Vicinity Map.

• Table of Contents.

• Summary. A general description of the project area and a general assessment of the feasibility of alternatives studied.

• Topographic Map. A map showing topographic data pertinent to the project and alternatives under study. See 310.03(3).

• Description of Alternates Studied. Describe the general location and terrain for each alternative. See 310.03(5) and (6).

• Existing Roads, Railroads, Bridges etc. Show existing facilities, as appropriate.

• Traffic Data. See 310.03(4).

• Right of Way. Describe the property affected, the nature of impacts, and any other right of way problems.

• Construction. Identify unique problems created by excessive borrow or waste.

• Environmental Consequences. See 310.03(7).

• Cost Estimates. See 310.03(8).
LEGISLATIVE STUDY COST ESTIMATE

<table>
<thead>
<tr>
<th>SR No.</th>
<th>Title</th>
<th>$</th>
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<tbody>
<tr>
<td>1.</td>
<td>Origin and Destination Study</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Traffic Analysis and Evaluation</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Benefit/Cost Analysis</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Functional Classification and Evaluation</td>
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<tr>
<td>5.</td>
<td>Accident Analysis and Summary</td>
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<tr>
<td>6.</td>
<td>Bridge Condition Survey Evaluation and Analysis</td>
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<tr>
<td>7.</td>
<td>Maintenance Evaluation</td>
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</tr>
<tr>
<td>8.</td>
<td>Photogrammetric Services</td>
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<td>9.</td>
<td>Soils and Geological Surveys and Analyses</td>
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<td>10.</td>
<td>Environmental Impact Evaluation</td>
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<td>11.</td>
<td>State Interest and Economic Evaluation</td>
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<td>12.</td>
<td>Social Impact Evaluation</td>
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<td>13.</td>
<td>Priority and Funding Evaluation</td>
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<tr>
<td>14.</td>
<td>Consultant Services</td>
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</tr>
<tr>
<td>15.</td>
<td>Engineering Data and Cost Estimates</td>
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<tr>
<td>16.</td>
<td>District Evaluation and Narrative</td>
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</tr>
<tr>
<td>17.</td>
<td>Field Review</td>
<td></td>
</tr>
<tr>
<td>18.a.</td>
<td>Other Costs (Specify)</td>
<td></td>
</tr>
<tr>
<td>18.b.</td>
<td>Other Costs</td>
<td></td>
</tr>
<tr>
<td>18.c.</td>
<td>Other Costs</td>
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<td>Local Participation</td>
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<td>Total State Cost</td>
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</table>

LEGISLATIVE STUDY COST ESTIMATE

Figure 310-1
LEGISLATIVE STUDY
ANATONE TRANSPORTATION STUDY
ASOTIN COUNTY
(Date of Report)

PREPARED FOR
the
LEGISLATIVE TRANSPORTATION COMMITTEE
at the direction of the
19____ LEGISLATURE

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION

(Information shown must be included on all covers; style and format may be altered)

LEGISLATIVE STUDY REPORT COVER
Figure 310-2
LEGISLATIVE STUDY
ANATONE TRANSPORTATION STUDY
ASOTIN COUNTY
(Date of Report)

WASHINGTON STATE TRANSPORTATION COMMISSION

Pat Wanamaker
Chairman

Bernice Stern
Vaughn Hubbard
Richard Odabashian

Albert D. Rosellini
Jerry Overton
Leo B. Sweeney

Commissioners

DEPARTMENT OF TRANSPORTATION

Duane Berentson
Secretary

(All information shown must be included; style and format may be altered)

LEGISLATIVE STUDY REPORT TITLE PAGE
Figure 310-3

310-8
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 multidisciplined 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 multidisciplined 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 is 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 $2 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 the Olympia Service Center (OSC) 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 OSC 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 at 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 regional 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 (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, OSC, 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, OSC, 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, analysis, and rationale for recommendations) is included in the Workbook as part of the Final Report. 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 prepare 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 following documents are to be preserved in the project file.

- Value Engineering Study Final Report and Workbook
- VE Decision Document

P:DM3
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td><strong>1. Selection Phase</strong> 315.04(1)</td>
<td>Select the right projects, timing, team, and project processes and elements.</td>
</tr>
<tr>
<td><strong>2. Investigation Phase</strong></td>
<td>Investigate the background information, technical input reports, field data, function analysis, and team focus and objectives.</td>
</tr>
<tr>
<td><strong>3. Speculation Phase</strong></td>
<td>Be creative and brainstorm alternative proposals and solutions.</td>
</tr>
<tr>
<td><strong>4. Evaluation Phase</strong></td>
<td>Analyze design alternatives, technical processes, life cycle costs, documentation of logic, and rationale.</td>
</tr>
<tr>
<td><strong>5. Development Phase</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>6. Presentation Phase</strong></td>
<td>Present the recommendations of the VE team in an oral presentation, and in a written report and workbook</td>
</tr>
<tr>
<td><strong>7. Implementation Phase</strong> 315.04(2)</td>
<td>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.</td>
</tr>
<tr>
<td><strong>8. Audit Phase</strong></td>
<td>Maintain a records system to track the results and accomplishments of the VE program on a statewide basis. Compile appropriate statistical analyses as requested.</td>
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Steps 2-6 are performed during the study, see *Introduction To Value Engineering Principles and Practices* for procedure’s during these steps.
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<td></td>
<td>WIN</td>
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**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**

**Date's requested for VE study**

---

**Request for Value Engineering Study**

*Figure 315-2*
<table>
<thead>
<tr>
<th>Project Related Input* (Study Package)</th>
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<td>Estimates</td>
<td>Photo/Video log access/SRView</td>
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<td>R/W Plans</td>
<td>Van for Field Trip **</td>
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<td>Soils Reports</td>
<td>Easel(s)</td>
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<td>Plan Sheets</td>
<td>Large Tablet Paper (2x2 squares)</td>
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<td>Environmental Documents</td>
<td>Colored Marking Pens</td>
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<tr>
<td>X-sections and Profiles</td>
<td>Masking and Clear Adhesive Tape</td>
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<tr>
<td>Land Use Maps</td>
<td>Workbook(s)</td>
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<td>Contour Maps</td>
<td>Polaroid Camera</td>
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<tr>
<td>Quadrant Maps</td>
<td>Design Manual</td>
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<tr>
<td>Accident Data</td>
<td>“Green Book”</td>
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<tr>
<td>Traffic Data</td>
<td>Standard Plans</td>
</tr>
<tr>
<td>Up to Date Large Scale Aerial Photographs</td>
<td>Standard Specifications</td>
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<td>Vicinity Map</td>
<td>M.P. Log</td>
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<td>Hydraulics Report</td>
<td>Bridge List</td>
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<td>Aerial Photos</td>
<td>WSDOT Phone Book</td>
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<td>Existing As-Built Plans</td>
<td>Scales and Straight Edge</td>
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<td></td>
<td>Red Book - Field Tables</td>
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<td>Unit Bid Prices</td>
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<tr>
<td></td>
<td>Calculators</td>
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<tr>
<td></td>
<td>Scissors</td>
</tr>
</tbody>
</table>

* 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.
325 Design Matrix Procedures

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

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

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

The Preventive Maintenance mentioned under project type on Interstate Design Matrices 1 and 2 includes roadway work such as pavement patching; restoration of drainage system; panel replacement; joint and shoulder repair; and bridge work such as crack sealing, joint repair, seismic retrofit, scour countermeasures and painting.

Preventive maintenance projects must not degrade any existing safety or geometric aspects of the facility.

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

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

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

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

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

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

(1) Project Types

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

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

Nonstructural Overlay is an asphalt concrete pavement overlay that is placed to minimize the aging effects and minor surface irregularities of the existing asphalt concrete pavement structure. The existing pavement structure is not showing extensive signs of fatigue (longitudinal or alligator cracking in the wheel paths). Nonstructural overlays are typically less than 0.13 ft thick.

AC Structural Overlay is an asphalt concrete pavement overlay that is placed to increase the load carrying ability of the pavement structure. Structural overlay thickness is greater than or equal to 0.13 ft.

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

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

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

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

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

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

(2) Design Elements

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

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

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

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

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

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

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

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

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

On/Off Connection is the widened portion of the main line beyond the ramp terminal. (See Chapter 940.)
Fill/Ditch Slope is downward slope from edge of shoulder to bottom of ditch or catch. (See Chapter 640.)

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

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

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

Basic Safety is the safety items listed in Chapter 410.

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

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

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

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

Intersections Turning Radii See Chapter 910 for definition.

Intersections Angle See Chapter 910 for definition.

Intersections Sight Distance See Chapter 910 for definition.

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

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

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

325.03 Design Matrix Procedures

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

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

325.04 Selecting a Design Matrix

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

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

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

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

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

325.06 Using a Design Matrix

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

Full design level applies to all design elements except as noted in design matrices and in Design Manual chapters as applicable.

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

(1) Design Levels

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

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

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

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

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

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

(2) Design Variances

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

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

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

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

- Accident history or potential
- Benefit/cost analysis
- Engineering judgment
- Environmental issues
- Route continuity
<table>
<thead>
<tr>
<th>State Route</th>
<th>NHS Route Designation</th>
<th>Beginning SR MP</th>
<th>Begin ARM</th>
<th>Ending SR MP</th>
<th>End ARM</th>
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<tr>
<td>US 2</td>
<td>I-5 to Idaho State Line</td>
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This list provided by the OSC Planning Office

NHS Highways in Washington
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This list provided by the OSC Planning Office

NHS Highways in Washington (continued)

*Figure 325-2b*
P  **Preservation** — Preserve the highway infrastructure cost effectively to protect the public investment.

**P1 Roadway**
1. Repave highways at regular intervals to minimize long-term costs.
2. Restore existing safety features.

**P2 Structures**
1. Rehabilitate or replace existing bridges and other structures to preserve operational and structural integrity.
2. Reduce the risk of naturally caused catastrophic bridge failures.

**P3 Other Facilities**
1. Refurbish rest areas to extend service life and improve safety.
2. Construct weigh facilities to ensure enforcement across the entire highway system.
3. Refurbish electrical systems, electronics, and mechanical systems to extend service life and improve safety. Rehabilitate or replace existing major drainage features to preserve operational and structural integrity.
4. Stabilize known unstable slopes.
5. The program support subcategory consists of critical construction support items that are required to maintain efficiency and ensure continued progress of the construction programs.

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

I1 Mobility — Improve mobility within congested highway corridors.

1. Mitigate congestion on urban highways in cooperation with local and regional jurisdictions when the peak period level of service falls below Level of Service D.

2. Provide uncongested condition (Level of Service C) on rural highways.

3. Provide bicycle connections along or across state highways within urban growth areas to complete local bicycle networks.

4. Complete the Freeway Core HOV Lane System in the Puget Sound region.

5. Provide uncongested conditions (Level of Service C) on high occupying vehicle (HOV) lanes.

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

1. Improve highway sections that have a high accident history.

2. Improve geometrics of the Interstate system per the Federal Highway Administration (FHWA)/WSDOT Stewardship Agreement.

Paraphrased excerpt from the State Highway System Plan, State Highway System Plan Service Objectives and Action Strategies.
Improve roadways where geometrics, traffic volumes, and speed limits indicate a high accident potential.

1. Eliminate major at-grade intersections on multilane highways with speed limits of 45 mph or higher.
2. Construct intersection channelization, signals, or both when traffic volume warrants (thresholds) are met.

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

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

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

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

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

Improvement Program (continued)
## Design Matrix 1
Interstate Routes (Main Line)
Figure 325-4

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<td>(6) Applies only to bridge end terminals and transition sections.</td>
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<td>(9) Continuous shoulder rumble strips required in rural areas. See Chapter 700.</td>
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<td>(12) Impact attenuators are considered as terminals.</td>
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<td>(13) See Chapter 440 and 640.</td>
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<td>(14) Includes crossroad bridge rail.</td>
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### Design Matrix 2

**Interstate Interchange Areas**  
**Figure 325-5**

![Design Matrix 2 Diagram](image_url)

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<td>English Version</td>
<td>Page 325-12</td>
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#### Not Applicable
- (6) Applies only to bridge end terminals and transition sections.
- (10) See Chapter 820.
- (11) See Chapter 1120.
- (12) Impact attenuators are considered as terminals.
- (15) EU for signing and illumination.

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---|---
June 1999 | Design Matrix Procedures
### Design Matrix Procedures

#### NHS Routes (Main Line)

**Figure 325-6**

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### Design Matrix 4

**Non-Interstate Interchange Areas**

**Figure 325-7**

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

(1) Collision Reduction (HAL, HAC, PAL), or Collision Prevention (Risk, Signalization & Channelization). Specific deficiencies that created the project must be upgraded to design level as stated in matrix.

(2) Modified design level may apply based on a corridor or project analysis. See 325.02.

(3) If designated in limited access master plan apply limited access standards, if not access management standards apply. See Chapter 920.

(4) Full design level may apply based on a corridor or project analysis. See 325.02.

(5) For bike/pedestrian design see Chapter 1020.

(6) Applies only to bridge end terminals and transition sections.

(7) 4 ft minimum shoulders.

(12) Impact attenuators are considered as terminals.
## Design Matrix 5

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<td>(5-15) Bridge Restrictions</td>
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<td>(5-17) Bridges</td>
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</table>

### Design Manual

**Design Matrix Procedures**

- **December 1999**
- **Design Manual English Version**
- **Design Matrix Procedures**
- **December 1999**
- **Page 325-15**

---

**Design Matrix Procedures**

- **Figure 325-8**
- **Non-NHS Routes**
- **Design Matrix Procedures**
- **December 1999**
- **Page 325-15**
330.03 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 project definition phase are included. Changes that occur throughout the project development process are documented. Justification and approvals, if required, are also included.

The design documentation identifies:

- The condition or problem that generated the purpose and need for the project (as noted in the Project Summary)
- The design alternatives considered
- The project design selected
- The work required to satisfy the commitments made in the environmental documents
- The conformity of the selected design to departmental policies and standard practices
- The supporting information for any design variances
- The internal and external coordination

The design documentation is used to:

- Examine estimates of cost
- Prepare access and right-of-way plans
- Assure that all commitments are provided for in the recommended design
- Plan for maintenance responsibilities as a result of the project
- Provide supporting information for design variances
- Explain design decisions
- Document the project development process and design decisions
- Preserve a record of the project’s development for future reference
- Prepare plans, specifications, and estimate (PS&E)
330.04 Project Development

The region initiates the project by preparing the Project Summary package. The project coordination with other disciplines (such as Real Estate Services, Utilities, and Surveying) is started in the project definition 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, and manuals as listed in D 00-00; the Master Plan for Limited Access Highways; State Highway System Plan; Level of Development Plan; Route Development Plan; FHWA Washington Stewardship Plan; and the Project Summary.

The region develops and maintains documentation for each project. This file includes documentation of all work on the project from before the project definition phase through public involvement, environmental action, design decisions, right of way acquisition, and PS&E development. 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 Figure 330-2.

Upon receipt of the ECS approval, 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 Engineer works with the regions on project development and conducts process reviews on projects as described in 330.08.

330.05 Project Definition Phase

Project definition is the initial phase of project development. The project definition effort is prompted by the State Highway System Plan. The project definition phase consists of determining a preliminary project description, schedule, and estimate. The intent is to make design decisions early in the project development process. During the project definition effort, the Project Summary documents are produced.

**Project Summary** provides information on the results of the project definition phase; links the project to the Highway System Plan; and documents the design decisions, the environmental classification, and agency coordination. The Project Summary is developed before the project is funded for construction. The Project Summary consists of the Environmental Review Summary, Design Decisions Summary, and Project Definition.

**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 project definition, the information in the ERS must be reviewed and changed to match the new project definition. The ERS is prepared during the project definition effort. The ERS is approved by the region.

**Design Decisions Summary (DDS)** states the roadway geometrics, design deviations, evaluate upgrades (EUs), other roadway features, and any design decisions made during the project definition phase 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. To sign the Design Decision Summary the region must be comfortable that there will be no significant change in the project definition or estimated cost. Design decisions may be revised throughout the project development process based on continuing evaluations.

The DDS is approved by the Assistant State Design Engineer for new construction and reconstruction projects on the Interstate system. The regional design authority approves the DDS for all other types of projects. (See Figure 330-1)

**Project Definition (PD)** identifies the various disciplines and design elements that will be encountered in project development. The Project
Definition states the needs, the purpose of the project, program categories, and the design matrices that were used to develop the Project Definition. This information determines the level of documentation and evaluation that is needed for approval of the design. The Project Summary is completed in the project definition phase.

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

### 330.06 Design Documentation

**(1) FHWA Requirements**

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

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

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

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

- The report requesting new or revised access points

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

#### (2) Design Documents

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

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

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

The **Design Variance Inventory** form lists all design exceptions, evaluate upgrades not upgraded to the applicable design level, and deviations. See Figure 330-6 for sample evaluate upgrade and Figures 330-7a and b and 8a and b for sample deviations.

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

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

*Address rock scour within the project limits whenever feasible.

### 330.07 Design Approval

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

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

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

### 330.08 Process Review

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

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

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

The OSC Project Development Branch schedules
the process review and coordinates it with the
region. Notification of the scheduled process
review is sent to FHWA for their information and
for use in coordinating a joint process review.

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 that have
arisen.

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.
<table>
<thead>
<tr>
<th>Project Design</th>
<th>FHWA Oversight Level</th>
<th>Deviation and Corridor/Project Approval</th>
<th>EU Approval</th>
<th>Design Approval</th>
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<td>• Local agency funds</td>
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<td>Region</td>
</tr>
</tbody>
</table>

FHWA = Federal Highway Administration  
OSC = Olympia Service Center

(a) Requires FHWA review and approval (full oversight) of design and PS&E submitted by OSC Design.

(b) To determine the appropriate oversight level, FHWA reviews the Project Summary (or other programming document) submitted by OSC Design or by TransAid through OSC Design.

(c) FHWA oversight is accomplished by process review. (See 330.08.)

(d) Reduction of through lane or shoulder widths (regardless of funding) requires FHWA review and approval of the proposal.

(e) See Chapter 325 for definition.
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*If on the preapproved list.

**Notes:**
X Normal procedure
[1] Federal aid projects only
[3] Applies to new/reconstruction projects on Interstate routes
[13] Assistant Secretary for Environmental and Engineering Service Center approval
[14] State Design Engineer approval
[15] Refer to Chapter 210 for approval requirements

**Reviews and Approvals**
*Figure 330-2*
<table>
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Reviews and Approvals, Design

*Figure 330-3a*
Notes:
X  Normal procedure
[2] Refer to Figure 330-1 for design approval level
[3] Applies to new/reconstruction projects on Interstate routes
[4] OSC Program Management
[5] Submit to OSC Materials Branch for review and approval
[6] Approved by Regional Administrator
[9] Applies only to regions with a Landscape Architect
[10] Applies only to regions without a Landscape Architect
[12] Include channelization details
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<td>OSC(a)</td>
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<td>Right of way certification for federal aid projects</td>
<td>OSC(b)</td>
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<td>Railroad agreements</td>
<td>OSC(c)</td>
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<td>OSC<a href="c">2</a>(d)</td>
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<td>FHWA</td>
<td>OSC(c)</td>
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<td>Region[3]</td>
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<td>Nonstandard bid item use</td>
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<td>Incentive provisions</td>
<td>FHWA</td>
<td>OSC(e)</td>
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<td>Nonstandard liquidated damages</td>
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<td>OSC<a href="e">5</a></td>
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</tbody>
</table>

**Notes:**

[1] This work requires a written agreement. See Plans Preparation Manual.
[2] Use of state forces is subject to $30,000 limitation as stipulated in RCWs 47.28.030 and 47.28.035.
[3] Applies only to federal aid projects. However, document for all projects.
[6] Region approval subject to $250,000 limitation.

**Regional or Olympia Service Center approval authority:**

(a) Office of Equal Opportunity
(b) Real Estate Services
(c) Design Office
(d) Program Management Office
(e) Construction Office

**PS&E Process Approvals**

*Figure 330-4*
Project Analysis

L-0000     SR A
Yodelin Hill Climbing Lane     SR A MP B to MP C

Overview

High truck volumes and steep grades are adversely impacting traffic flows and safety on this section of highway. The purpose of this project is to increase traffic flows and safety by adding a climbing lane.

For this NHS rural mobility project, the Design Matrix calls for full design level with an option to use modified design level based on a corridor or project analysis. In Design Manual Chapter 440, the ADT of 6300, DHV of 730, and truck percentage of 18% in design year 2016 indicates design class P-2 multilane. Considering the following justification, the region proposes to design this project to the modified design level MDL-14 with a truck climbing lane.

A climbing lane warrant has been met.

Route Description

This section of SR A parallels a mountain stream and is located in steep mountainous terrain. Adjacent roadway sections consist of two 11.3 ft lanes with 4 ft shoulders. Fill slopes generally range between 3H:1V and 4H:1V as do ditch inslopes. The posted speed is 60 mph in both directions.

Comparison

<table>
<thead>
<tr>
<th></th>
<th>Existing Conditions</th>
<th>Modified Design Level (MDL-14)</th>
<th>Full Design Level (P-2)</th>
<th>Proposed Level (MDL-14)</th>
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</thead>
<tbody>
<tr>
<td>Fill slopes</td>
<td>3H:1V to 4H:1V</td>
<td>4H:1V</td>
<td>6H:1V</td>
<td>4H:1V</td>
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<tr>
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<td>10 ft</td>
<td>4 ft</td>
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<td>none</td>
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</table>

The use of full design level would require a wider roadway which would in turn require significant impacts to the stream, very high and lengthy rock cut, additional right of way including acquisition of numerous cabins, and utility impacts. The cost to construct this section to full design level is approximately $6 million more than to construct to modified design level with an additional climbing lane.

Adding a fourth lane throughout this narrow corridor would have minimal benefits to the traveling public. There is no proposed improvement in the 20 year System Plan to make either this section, or adjacent sections of highway, four lanes.
Accidents

The accident history from April 1993 through March 1996 indicates 28 accidents resulting in 1 fatality, 16 injuries, and $392,100 in property damage.

14 of the 28 accidents, including the fatality, occurred while passing uphill traffic. Seven other accidents occurred during turning maneuvers at four different locations throughout the project.

Addition of the truck climbing lane should reduce the number and severity of accidents on this section of roadway. The additional fourth lane throughout would probably not significantly reduce the number or severity of accidents.

Summary

Considering route continuity, environmental constrains, additional cost, and minimal benefit, the region feels constructing to full design level is not justified. Therefore, the region proposes to construct this project to modified design level.

---

Sample Project Analysis

*Figure 330-5b*
Evaluate Upgrade

Subject Project: L-0000, Region Wide Channelization
Intersections of Concern: SR 1 at V Street
SR 15 at SR 13

Project Description
The purpose of this project is to make safety improvements to five intersections in the region. This evaluation is for the intersection angles at the intersections of SR 1 at V Street and SR 15 at SR 13.

Design Matrix
The Design Matrix requires an evaluation of upgrading intersection angles outside the range of 75-105 degrees. This applies to both Non-NHS and NHS routes.

Existing Intersection Angles
The existing intersection angles are as follows:

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 1 at V Street</td>
<td>107-41-53</td>
</tr>
<tr>
<td>SR 15 at SR 13</td>
<td>126-52-57</td>
</tr>
</tbody>
</table>

The accident history listings show no accidents related to the existing intersection angle.

Impacts
Upgrading these intersection angles on this project would result in the following impacts:

SR 1 at V Street: A USBR irrigation siphon crosses SR 1 at this intersection. To correct the intersection angle would require realignment of the irrigation canal and construction of a new siphon. This canal is operational year-round. In addition to the irrigation impacts upgrading the angle would require purchase of right of way.

SR 15 at SR 13: This intersection was constructed to its present configuration under a developer agreement. This intersection is surrounded by retail developments. Correction of the intersection angle would require reconstruction of the existing signal system and extensive right of way purchase. The impacted parcels would result in negative economic impacts to a newly developed area and the relocation of multiple businesses.

Funding
Reconstructing these intersections to meet design standards would cost approximately $500,000 for the intersection of SR 1 at V Street and approximately $2,000,000 for the intersection of SR 15 at SR 13.

Recommendation
After considering the accident history, impacts to USBR canal, impacts to multiple businesses, and the limited right of way, reconstructing these intersections to meet the intersection angle standards does not represent good economic or engineering judgment. The realignment would provide minimal benefits for the excessive costs. Therefore it is proposed to not upgrade the existing intersection angles.

Sample Evaluate Upgrade (EU)
Figure 330-6
Overview

The purpose of this I-2 project is to reduce accidents in the intersection of Apple Tree Lane and State Route A by adding left turn channelization. This intersection is a high accident location (HAL).

Existing Conditions

State Route A is an NHS route. This section of SR A is semi-urban and follows the rolling terrain as it approaches the city. The posted speed is 45 mph and the ADT is 4500 with a truck percentage of 9%.

The adjacent roadway consists of two 12 ft lanes, 7.3 to 8 ft shoulders, and 3H:1V to 4H:1V fill and ditch inslopes.

A wetland is present at the toe of the existing 3H:1V slope near the intersection. The water in the wetland is less than 2 ft deep and thus is not a hazard. There are no hazards within the Design Clear Zone in this vicinity.

Proposed Project

It is proposed to construct two 12 ft lanes, 8 ft shoulders, one 12 ft left turn lane (each direction) and 4H:1V fill and ditch inslopes except for the 3H:1V fill slope noted below. All turning movements will meet standards for the WB-40 design vehicle.

MDL-11 standards are proposed.

Deviation Description

Modified design level calls for 4H:1V fill slopes for fill height less than 20 ft. In order to avoid impacts to a wetland, the region proposes to leave an existing 3H:1V fill slope ranging in height from 7 to 13 ft for a length to 130 ft (MP 101.22 to MP 101.24) on the right. There will not be any hazards on the 3H:1V fill slope or within in the Design Clear Zone in this vicinity.

Other Options Considered

Several options were considered.

Option 1 - Realign the highway to the north to avoid the wetland. The left turn lane is designed asymmetrically. All of the widening is proposed to be on the opposite side of the highway from the wetland to avoid impacts. Shifting the highway further would create a potentially hazardous alignment in an otherwise straight section of highway. This would be especially dangerous at night and during snowy and icy conditions.

This option would also require minor right of way acquisition and would adversely impact access to a pumping island at a gas station.
Option 2 - Install guardrail or barrier. Guardrail is not required as per Chapter 700 and the installation of guardrail to protect a 3H:1V slope would place a fixed object (guardrail) closer to the traveling public than the slope.

Option 3 - Fill the Wetland. Using a 4H:1V fill slope would impact 6 acres of wetland. This would require mitigation consisting of creating more wetlands elsewhere. It would also require long term maintenance and monitoring of the wetland. The estimated cost for this including permits (if possible), design, construction, and maintenance is $90,000.

Accident Summary
From April 1993 to March 1996 there were 41 accidents including 35 injuries and two fatalities at this intersection. 16 accidents were rear-enders. 22 accidents occurred during turning movements (including both fatalities).

14 of the 41 accidents occurred at night. Illumination is proposed.

Only two accidents were single vehicle run off the road accidents. Neither included an injury.

The proposed left turn lane for both eastbound and westbound traffic should reduce the number and severity of accidents at this intersection. Drive off the road accidents are not prevalent at this intersection.

Recommendation
The proposed project addresses the primary causes of this intersection being a HAL by providing a left turn lane with illumination.

The 3H:1V slope is not a significant hazard. There are no better alternatives to the 3H:1V slope.

Therefore, the region requests a deviation to leave the existing 3H:1V slope as noted above.

Regional Concurrence Date OSC Design Approval Date
3. Modified Design

This project proposes to add an auxiliary (add/drop) lane to northbound SR 52 through a portion of downtown Suak between the Universal Street On Ramp and the Morgan Street Off Ramp. This auxiliary lane will be added to the northbound main line by reconstructing the existing shoulders and repaving the roadway. There is no roadway bridge widening proposed for this project. Items of work associated with this project include: shoulder reconstruction, replacement of bridge rail and guardrail, drainage work, striping, minor electrical, and signing.

The intent of this project is to provide an economically feasible solution to a congestion problem occurring at the Morgan Street Off Ramp. This congestion problem has resulted in a “High Accident Location” as is documented in the WSDOT 1992 HAL Review and again summarized in the 1996 High Accident Location Review. (See Appendix A - 1996 High Accident Review)

Though this work will provide a capacity increase for SR 5, the main benefit from this project will be accident reduction. There will be reduced rear end accidents along the inside lane by providing an exit only lane to the Morgan Street Off Ramp. This auxiliary lane will provide safer storage on the main line when the ramp queues up onto SR 5. (See Appendix B - Photographs)

SR 5 is a NHS route. This section of SR 5 is in a highly urban area, with a design speed of 60 mph, and the current ADT is 213,000. The average daily traffic truck percentage is 45%. The design classification is I-1 documented per “Design Guidelines - for Interstate Routes - PCC Pavements - Geometric Elements”, Reconstruction, Capacity Improvements and HOV Lanes.

Deviation #1 — Reduced Shoulder Widths

Existing Condition:

Currently, the Universal Street On Ramp merges into the inside lane of northbound SR 5 at approximately MP 165.94. The Morgan Street Off Ramp then diverges from the inside lane at approximately MP 166.44. The northbound main line of SR 5 in this section consists of 14 ft through lanes. The existing outside shoulder is standard with a width of 11 ft. The existing inside shoulder is nonstandard for approximately half of the project from the beginning of the project (station 67+84) to the end of Bridge 5/545E (station 82+06). The nonstandard shoulder in this section varies in width from 5 ft to 10 ft. The existing inside shoulder becomes standard for the second half of the project with a width of 10 ft. (See Appendix C - Existing Channelization.)

Alternatives:

1. No Build - By not constructing this project, the right shoulder would remain standard and the left shoulder would remain standard for the second half of the project. The left shoulder on the first half of the project would remain nonstandard. This option would not solve the SR 5 capacity, Morgan Street storage, and the high accident problems associated with the current configuration. A benefit/cost evaluation for this alternative would be undefined as both the benefit and cost would be nothing.

2. Build to Full Standards - Widening the bridge and roadway to provide a full standard 10 ft shoulder on both sides would benefit safety, emergency use, disabled use, maintenance, and refuge. However, this option of the alternative would be in the hundreds of millions of dollars. The bridge and roadway could either be widened to the right, left, or both. Widening in either direction would require additional right-of-way in downtown Suak. Widening to the right would require realigning the Apple off and on ramps, and relocating an 27 by 2,600 ft retaining wall supporting Capital Hill. Undercrossings, city streets, parking, retail business, and apartment complexes would be impacted and possibly have to be relocated. Widening on the left would require realigning southbound SR 5 farther to the west. Again, this would impact undercrossings, existing ramp alignments, city streets, businesses, and large buildings including the Washington State Convention Center. The cost of providing 10 ft shoulders could easily exceed hundreds of millions of dollars.

5. Modified Design - (See Appendix D - Channelization Plans) Construct project with standard shoulder widths. This configuration would consist of full standard lane widths including 4.12 ft through lanes and 1.12 ft auxiliary (add/drop) lane. The left shoulder adjacent to the auxiliary (add/drop) lane would be a 2 ft. width. The right shoulder would reduce from a full standard 10 ft width down to a 6 ft width. This would be maintained for a short segment of 260 ft. The right shoulder would then increase to 8 ft. This width would be maintained past the Owhi Way Undercrossing. The shoulder would then taper back to a full 10 ft width. This configuration would maximize the right shoulder width allowing most of the right shoulder throughout the limits of the project to be used for emergency use. This configuration allows enough room to have the Universal On Ramp become an add lane that would drop at the Morgan Street Off Ramp.

This alternative would provide the benefit of increasing capacity for the short segment and overall corridor, provide safer additional storage for the Morgan off ramp on the main line, and thereby reduce accidents. All of these benefits would come at a reasonable cost.

Recommendation #1

We recommend alternative #3 and request a design deviation for the following reasons:

1. This is the only economically feasible alternative that increases storage for the Morgan Off Ramp and solves the current congestion problem.

2. All of the barrier within the project limits will be upgrading to current AASHTO standards, thus helping mitigate the reduced shoulder widths.

3. The smaller standard left shoulder with a minimum width of 2 ft is only adjacent to the auxiliary (add/drop) lane and not the main line through lanes.

4. If, at a later date, the reduced shoulder widths prove to be a safety problem, the roadway could simply be restriped back to the original configuration and this section of the corridor would have full depth PCCP shoulders and upgraded barriers to current AASHTO standards.

5. By providing this additional lane, we estimate we will reduce rear end accidents by one third. We also anticipate a reduction in the number of side swipe accidents.

6. As the photographs show (Appendix B), motorists are already using the shoulder for storage. By making this improvement, we eliminate the conflicts that the current shoulder usage is creating.

Deviation #2 — Undercrossings - Barriers

Existing Condition:

There are four undercrossings that fall within the project limits. (See Appendix D - Channelization Plans) They are:

- Spruce Street Undercrossing
- Spruce Street / Balen Ave. Undercrossing
- Apple Way Undercrossing
- Owhi Way Undercrossing

With the exception of a single Northbound off ramp to Apple and a single Northbound on ramp from Apple, there is no other access to northbound SR 5. All four undercrossings have the original barriers (bridge rails) which consist of a 7 in high curb with a width of either 2 ft, 10 ft, or 12 ft. On top of the curb is a 10 in wide by 1.5 ft high parapet supporting a Type 3-A Bridge Rail. (See Appendix B - Bridge Rail Photographs).

Standard:

The standard barrier (bridge rail) for an undercrossing is required to withstand a 5kip load. (Section 710.08 Bridge Rails, WSDOT Design Manual, June, 1995) The Bridge and Structures office was asked to assess these bridge rails for strength and found that they do not meet current AASHTO specifications for strength. (See Appendix E - Bridge Correspondence)

Alternative:

1. No Build - This alternative would leave the existing bridge rails on all the undercrossings. A benefit/cost evaluation for this alternative would be undefined as the cost would be nothing.

2. Build to Full Standards (Concrete Safety Shape - Preferred Treatment) - Under this alternative, all of the existing bridge rails would be removed and replaced with a concrete safety shape barrier. This alternative has been estimated to cost approximately $500,000. The benefit of this alternative has been estimated to be very small for the reasons listed under “Recommendation” of this deviation.

3. Build to Full Standards (Attach Thrie Beam to Parapet) - Under this alternative, their beam would be attached directly to the parapets. Although the cost for this alternative is significantly less the Alt. #2 (approximately $150,000), once again the benefit has been estimated to be very small.

4. Modified “Full Standard” Add a safety shaped barrier between the traveled lanes and the sidewalks. This alternative initially seems to be make the most sense because it additionally provides a barrier between the vehicles and the pedestrians and saves the cost of removing the old rail. However, this is an extremely high pedestrian area that would require many pedestrian access points (breaks in the barrier). These breaks would be required at the ends of the bridges and all four corners of Spruce and Balen.
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English Version
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All of these new barriers would be inside the clear zone and therefore make it a more dangerous situation for the motorist than is currently existing.

Recommendation #2
We recommend alternative #1 and request a design deviation to leave the existing bridge rails on all four undercrossings for the following reasons:
1. All of the existing bridge rails are outside of the clear zone (1.6 ft behind the face of curb for 35 mph or less).
2. All of the undercrossings are tangent sections with low speeds (posted 25 mph).
3. There is no evidence or record of repair work indicating that any of the existing bridge rails have ever been damaged by any sort of impact. Certainly, no vehicle has ever broken through these barriers.
4. Although the DOT does not maintain traffic data (traffic counts and accident history) for these undercrossings that are City of Suak streets with no access to the interstate, evidence and conversations suggest that the majority of accidents that have occurred on these undercrossings are rear-end types. Replacing the barriers would do nothing to reduce rear-end accidents.
5. All barriers except the north side of Oswi and the north side of Spruce have a 10 ft or 12 ft wide sidewalk in front of them. It would be difficult for a vehicle to even reach these barriers. The north side of Sprar has a 12 ft sidewalk with large concrete planter boxes between the traveled lane and the sidewalk. (See Appendix B - Bridge Rail Photographs - 1st Picture).
6. The cost of this work and traffic and pedestrian impacts may jeopardize the likelihood of the project ever being funded.
7. There are literally miles and miles of substandard bridge rail along the SR5 corridor through the downtown Suak area where vehicle speeds exceed 60 mph and impacts to these rails occur on a regular basis. These barriers should be brought to standard before money is spent on these undercrossings. If bridge rail replacement projects were prioritized, these undercrossings would be at the bottom of the list.

Deviations #3 - Reduced Lane Widths
Existing Condition:
1. Currently, the Universal Street On-Ramp merges into the inside lane of northbound SR5 at approximately MP 165.94. The Morgan Street Off-Ramp then diverges from the inside lane at approximately MP 166.44. The northbound main line of SR5 in this section consists of four 12 ft throughlanes. The existing outside shoulder is standard with a width of 1.6 ft. The existing inside shoulder is nonstandard for approximately half of the project from the beginning of the project (station 67+64) to the end of Bridge 5-9543E (station 82+08). The nonstandard shoulder in this section varies in width from 5 ft to 10 ft. The existing inside shoulder becomes standard for the second half of the project with a width of 10 ft. (See Figure 440-1a, Geometric Design Data, Interstate, WSDOT Design Manual, March, 1994)

Alternatives:
1. No Build - By not constructing this project, all four existing lanes would remain at the full standard width of 12 ft and no auxiliary lane would be constructed. The right shoulder would remain standard and the left shoulder would remain standard for the second half of the project. The left shoulder on the first half of the project would remain substandard (see deviation request #1). This option would not solve the SR5 capacity, Morgan Street storage, and the high accident problems associated with the current configuration. A benefit/cost evaluation for this alternative would be undefined as both the benefit and cost would be nothing.
2. Build to Full Standards - Widening the bridge and roadway to provide a full standard 12 ft lanes and 10 ft shoulders would benefit safety, emergency use, disabled use, maintenance use, and refuge. However, the cost of this alternative would be in the hundreds of millions of dollars. The bridge and roadway could either be widened to the right, left or both. Widening in either direction would require additional right-of-way in downtown Suak. Widening to the right would require realigning the Apple off and on ramps, and relocating an 27 by 2,600 ft retaining wall supporting Capital Hill. Undercrossings, city streets, parking, retail businesses, and apartment complexes would be impacted and possibly need to be relocated. Widening to the left would require realigning southbound SR 5 further to the west. Again, this would impact undercrossings, existing ramp alignments, city streets, businesses, and large buildings including the Washington State Convention Center. The cost of providing 10 ft shoulders could easily exceed hundreds of millions of dollars.

3. Modified Design - (See Appendix D - Channelization Plans) Construct project with substandard lane widths. This configuration would consist of utilizing reduced lane widths of 11 ft for all but lane 4. The left shoulder adjacent to the auxiliary (add/drop) lane would vary from a 2 ft width to 4 ft width. This design would provide a right shoulder that would remain at full standards, 10 ft width. This configuration would maximize the right shoulder width allowing full use of the right shoulder throughout the limits of the project to be used for emergency use. This configuration allows enough room to have the Universal On Ramp become an exit lane that would drop at the Morgan Street Off Ramp. This alternative would provide the benefit of increasing capacity for the short segment and overall corridor, provide safer additional storage for the Morgan off ramp on the main line, and thereby reduce accidents. All of these benefits would come at a reasonable cost.

Recommendation #3
We recommend alternative #3 and request a design deviation to construct this project under a modified design for the following reasons (The text below has been extracted from our Memorandum dated May, 5 1997):

The intent of this project is to provide an economically feasible solution to the congestion problem occurring at the Morgan Street Off Ramp. This problem has resulted in a "High Accident Location". The main benefits from this project will be accident reduction and capacity improvement.

Early discussions during the initial scoping of this project directed us to maintain 12 ft lanes throughout the project and accommodate the additional add/drop lane by reducing the width of the shoulders. Our initial channelization plans were developed with 12 ft lanes, a 2 ft inside shoulder, and a 6-ft outside shoulder.

During the NW Regions Traffic review of the channelization plans, they commented that the reduced shoulder width is not desirable through this location. They believe that it is crucial to have a least one usable shoulder for disabled use, maintenance, enforcement, and incident response. There are no/minimum shoulders immediately south of this project and when accidents occur under the convention center, disabled vehicles are pushed north to this location. The effect of losing this shoulder for disabled vehicles can be devastating to the corridor’s capacity. This is one of the few full shoulder remaining in this section of SR 5 where disabled vehicles can be cleared from the traveled lane. History shows that for every minute an incident blocks 1 lane, there is a resultant 5 minutes of delay to the affected motorist. This adds up quickly and we know how vital this section of SR-Z is for moving people and goods. Effective incident management (including clearance/removal) is critical through this stretch.

Accident statistics for a 3-year period between October 1993 and October 1996, reveal a total of 672 accident occurred along this section of SR-Z. Of these, 408 occurred south of the Universal Street vicinity. It is estimated that up to 100 of these 408 may be attributed to the conflict area where Universal traffic merges onto the mainline. 482 of the 672 accidents were rear-end type. This equates to 72%, vs. a statewide average of 35% and a NW Region average of 45%. The highest number of these rear end accidents (not surprisingly) occurred in lane 4 (the inside lane), see photos - Appendix B.

The only way to provide a full usable 10 ft outside shoulder and maintain a desirable SSD (SSD only meets minimum, not desirable, with a two foot inside shoulder) along this section of SR 5 is to reduce some or all of the lane widths from 12 ft to 11 ft. Many alternatives were considered and through sound engineering principles and practices it was determined that alternative E was the best design.

[A portion of the original’s text was omitted here to save space.] For these reasons, we recommend the implementation of alternative E shown in Appendix E of this document and more specifically on the proposed channelization sheets shown in Appendix D.

Appendices
(Sample list follows)
A. Accident History
B. Photographs
C. Existing Channelization
D. Channelization Plans
E. Bridge Correspondence
F. Benefit/Cost Analysis
G. Traffic Study

Sample Deviation, Urban
Figure 330-8b
410 Basic Design Level

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 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 paving 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
- Striping changes that will provide additional or improved channelization for intersections where sufficient pavement width and structural adequacy exist
- 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

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.

P:DM4
430 Modified Design Level

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

Design elements that do not have modified design level guidance include:
- Access control, see Chapter 1420
- Access management, see Chapter 920
- Basic safety, see Chapter 410
- Clear zone, see Chapter 700
- Traffic barriers, see Chapter 710
- Gore area lighting, see Chapter 840
- Interchange areas, see Chapter 940

Design elements that have both modified and full design level components include:
- Horizontal alignment, see Chapter 620
- Superelevation and shoulder cross slope, see Chapter 640
- Vertical alignment, see Chapter 630

430.02 Design Speed
When applying modified design level to a project, select a design speed for use in the design process that reflects the character of the terrain and the type of highway. Select a speed that is not less than the posted speed, the proposed posted speed, or the operating speed, whichever is higher.

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

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

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

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

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

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

(2) Median Width
See Figure 430-3.

430.04 Ramp Lane Widths
Ramp lane widths are shown in Figure 430-1 and in Figure 430-10. For ramps with radii less than 300 ft apply full design level see Chapter 640.

<table>
<thead>
<tr>
<th>Curve Radius</th>
<th>Lane Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangent - 4,000</td>
<td>13</td>
</tr>
<tr>
<td>3,000 - 2,000</td>
<td>14</td>
</tr>
<tr>
<td>1,000 - 300</td>
<td>15</td>
</tr>
</tbody>
</table>

Turning Ramp Lane Widths
Modified Design Level
Figure 430-1
430.05 Stopping Sight Distance

(1) Existing Stopping Sight Distance for Vertical Curves

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

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

(2) Stopping Sight Distance for Horizontal Curves

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

For Figure 430-8, an obstruction is any object with a height of 2 ft or more above the roadway surface on the inside of a curve. Examples of possible obstructions are median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings.

430.06 Profile Grades

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

430.07 Cross Slope

On all tangent sections, the normal cross slopes of the traveled way are 2 percent. Cross slopes up to 2 percent have a barely perceptible effect on vehicle steering, but cross slopes steeper than 2 percent can be noticeable. The algebraic difference in cross slopes is an operational factor during a passing maneuver on a two-lane road. Its influence increases when increased traffic volumes decrease the number and size of available passing opportunities.

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

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

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

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

If the existing pavement does not meet the conditions above, correct the cross slope(s) to be within the range of 1.5 to 2.5 percent. For a two-way, two-lane road, provide an algebraic difference to meet the appropriate conditions stated above except when facilitating drainage in areas of intense rainfall. When applying modified design level to a road with bituminous surface treatment (BST), cross slope correction is not required on the basis of algebraic differences alone.
To maintain or restore curb height, consider lowering the existing pavement level and correcting cross slope by grinding before an asphalt overlay. On urban highways, the cross slope of the outside shoulder may be steepened to minimize curb height and other related impacts. The shoulder may be up to 6 percent with a rollover between the traveled way and the shoulder of no more than 8 percent.

430.08 Fill Slopes and Ditch Inslopes

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

When a crossroad or road approach has steep foreslopes, there is the possibility that an errant vehicle might become airborne. Therefore, flatten crossroad and road approach foreslopes to 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.

430.09 Intersections

(1) General

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

(2) Design Vehicle

The following is provided as a guide for determining the design vehicle.

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Design Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction of Major Truck Routes</td>
<td>WB-67</td>
</tr>
<tr>
<td>Junction of State Routes</td>
<td>WB-40</td>
</tr>
<tr>
<td>Ramp Terminals</td>
<td>WB-40</td>
</tr>
<tr>
<td>Other Rural</td>
<td>SU¹</td>
</tr>
<tr>
<td>Urban Industrial</td>
<td>SU¹</td>
</tr>
<tr>
<td>Urban Commercial</td>
<td>P¹</td>
</tr>
<tr>
<td>Residential</td>
<td>P¹</td>
</tr>
</tbody>
</table>

¹When the intersection is on a transit 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

(3) Angle

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

430.10 Structures

The minimum widths for bridges are shown in Figure 430-4. Consider joint use with other modes of transportation in lane and shoulder design. See Chapter 1020, Facilities for Nonmotorized Transportation, Chapter 1050, High Occupancy Vehicle Facilities, and Chapter 1060, Transit Benefit Facilities.
<table>
<thead>
<tr>
<th>Design Class</th>
<th>MDL-1</th>
<th>MDL-2</th>
<th>MDL-3</th>
<th>MDL-4</th>
<th>MDL-5</th>
<th>MDL-6</th>
<th>MDL-7</th>
<th>MDL-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current ADT</td>
<td>Under 4000</td>
<td>Over 4000</td>
<td>Under 4000</td>
<td>Over 4000</td>
<td>Under 4000</td>
<td>Over 4000</td>
<td>Under 4000</td>
<td>Over 4000</td>
</tr>
<tr>
<td>Design Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
</tr>
<tr>
<td>Traffic Lanes Number</td>
<td>4 or more 11 ft</td>
<td>4 or more 11 ft</td>
<td>4 or more 11 ft</td>
<td>4 or more 12 ft</td>
<td>4 or more 11 ft</td>
<td>4 or more 11 ft</td>
<td>4 or more 11 ft</td>
<td>4 or more 12 ft</td>
</tr>
<tr>
<td>Width</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking Lanes Urban</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>8 ft</td>
<td>8 ft(a)</td>
<td>8 ft</td>
<td>8 ft(a)</td>
</tr>
<tr>
<td>Median Width Rural</td>
<td>Existing</td>
<td>Existing</td>
<td>Existing</td>
<td>Existing</td>
<td>2 ft</td>
<td>4 ft</td>
<td>4 ft</td>
<td>4 ft</td>
</tr>
<tr>
<td>Urban</td>
<td>Existing</td>
<td>Existing</td>
<td>Existing</td>
<td>Existing</td>
<td>2 ft</td>
<td>2 ft</td>
<td>2 ft</td>
<td>2 ft</td>
</tr>
<tr>
<td>Shoulder Width Right(k)</td>
<td>4 ft</td>
<td>2 ft</td>
<td>4 ft</td>
<td>6 ft</td>
<td>4 ft</td>
<td>6 ft(b)</td>
<td>4 ft</td>
<td>6 ft(b)</td>
</tr>
<tr>
<td>Left(p)</td>
<td>2 ft</td>
<td>2 ft</td>
<td>6 ft</td>
<td>2 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Width for Bridges to Remain in Place(c)(d)(m)</td>
<td>24 ft(g)</td>
<td>26 ft(g)</td>
<td>24 ft(g)</td>
<td>26 ft(h)</td>
<td>48 ft(g)</td>
<td>50 ft(g)(l)</td>
<td>50 ft(g)(l)</td>
<td>54 ft(h)(l)</td>
</tr>
<tr>
<td>Minimum Width for Rehabilitation of Bridges to Remain in Place(c)(e)(n)</td>
<td>28 ft(g)</td>
<td>30 ft(g)</td>
<td>28 ft(g)</td>
<td>32 ft(h)</td>
<td>54 ft(g)</td>
<td>60 ft(g)(l)(f)</td>
<td>56 ft(g)(l)</td>
<td>64 ft(h)(l)(f)</td>
</tr>
<tr>
<td>Minimum width for Replacement</td>
<td>Full Design Level Applies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Access Control: See Chapter 1420, Access Control Master Plan, or WAC 468-52 designated classification

General: If current ADT is approaching a borderline condition, consider designing for the higher classification.

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

(b) May be reduced by 2 ft under urban conditions.

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

(d) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only, exclusive of deck replacement. Should bridge rail replacement, deck replacement, or widening be necessary, use “Minimum for Rehabilitation of Bridges to Remain in Place” values.

(e) Use these widths when a structure within the project limits requires any work over and above the treatment of the deck such as bridge rail replacement or widening.

(f) Includes 6 ft shoulders — may be reduced by 2 ft on each side under urban conditions.

(g) Add 11 ft for each additional lane.

(h) Add 12 ft for each additional lane.

(i) Includes a 4 ft median — may be reduced to 2 ft under urban conditions.

(k) For lanes 11 ft or more in width, the minimum shy distance to the face of the curb is 2 ft on the right. However, for noncontinuous curbs or where bicycles are anticipated, the minimum shy distance to the face of the curb is 3 ft on the right.

(n) For median widths 25 ft or less, see Chapter 1120.

(p) For lanes 11 ft or more in width, the minimum shy distance to the face of the curb is 1 ft on the left.

Modified Design Level for Multilane Highways and Bridges

*Figure 430-3*
Two-Lane Highways

<table>
<thead>
<tr>
<th>Design Class</th>
<th>MDL-9</th>
<th>MDL-10</th>
<th>MDL-11</th>
<th>MDL-12</th>
<th>MDL-13</th>
<th>MDL-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current ADT</td>
<td>Under 1000</td>
<td>1000-4000</td>
<td>Over 4000</td>
<td>Under 1000</td>
<td>1000-4000</td>
<td>Over 4000</td>
</tr>
<tr>
<td>Minimum Design Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
<td>Posted Speed</td>
</tr>
<tr>
<td>Traffic Lane (a)</td>
<td>11 ft</td>
<td>11 ft</td>
<td>11 ft</td>
<td>11 ft</td>
<td>12 ft</td>
<td>12 ft</td>
</tr>
<tr>
<td>Parking Lanes Urban</td>
<td>8 ft</td>
<td>8 ft</td>
<td>8 ft(b)</td>
<td>8 ft</td>
<td>8 ft</td>
<td>8 ft(b)</td>
</tr>
<tr>
<td>Shoulder Width (d)</td>
<td>2 ft</td>
<td>3 ft(c)</td>
<td>4 ft</td>
<td>2 ft</td>
<td>3 ft(c)</td>
<td>4 ft</td>
</tr>
<tr>
<td>Access Control</td>
<td>See Chapter 1420 and Access Control Master Plan, or WAC 468-52 designated classification.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) See Figures 430-5 and 430-6 for turning roadways.
(b) Parking restriction recommended when ADT exceeds 7,500.
(c) For design speeds of 50mph or less, width 1 ft narrower may be used on roads of 2,000 ADT or less, with justification.
(d) For lanes 11 ft or more in width, the minimum shy distance to the face of the curb is 2 ft. However, for noncontinuous curbs or where bicycles are anticipated, the minimum shy distance to the face of the curb is 3 ft.

<table>
<thead>
<tr>
<th>Current ADT</th>
<th>Minimum Width* for Bridges to Remain in Place(a)</th>
<th>Minimum Width* for Rehabilitation of Bridges to Remain in Place(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 250</td>
<td>20 ft</td>
<td>26 ft</td>
</tr>
<tr>
<td>251 to 1000</td>
<td>22 ft</td>
<td>28 ft</td>
</tr>
<tr>
<td>1001 to 4000</td>
<td>24 ft</td>
<td>32 ft</td>
</tr>
<tr>
<td>Over 4000</td>
<td>28 ft</td>
<td>32 ft</td>
</tr>
</tbody>
</table>

General: If current ADT is approaching a borderline condition, consider designing for the higher classification.
*Width is the clear distance between curbs or rails, whichever is less.
(a) Use this column when a bridge within the project limits requires deck treatment only, exclusive of deck replacement. Should bridge rail replacement, deck replacement, or widening be necessary, use “Minimum Width for Rehabilitation of Bridges to Remain in Place” values.
(b) Use this column when a structure within the project limits requires any work over and above the treatment of the deck such as bridge rail replacement or widening.
<table>
<thead>
<tr>
<th>Radius of Center Line R (ft)</th>
<th>Minimum Total Roadway Width W (ft)</th>
<th>Minimum Lane Width L (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangent</td>
<td>26</td>
<td>11</td>
</tr>
<tr>
<td>900</td>
<td>26</td>
<td>11</td>
</tr>
<tr>
<td>800</td>
<td>27</td>
<td>12</td>
</tr>
<tr>
<td>700</td>
<td>27</td>
<td>12</td>
</tr>
<tr>
<td>600</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>500</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>400</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>350</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>300</td>
<td>31</td>
<td>12</td>
</tr>
<tr>
<td>250</td>
<td>33</td>
<td>13</td>
</tr>
<tr>
<td>200</td>
<td>35</td>
<td>13</td>
</tr>
<tr>
<td>150</td>
<td>39</td>
<td>13</td>
</tr>
</tbody>
</table>

Notes: Also see minimums from Figure 430-4.

If the minimum total roadway width is greater than the sum of the shoulders and lane widths, apply the extra width to the inside of the curve.
Minimum Total Roadway Widths for Two-Lane Highway Curves, D<90°
Modified Design Level
Figure 430-6

Delta Angle of Curve (Degrees)

If result is less than the total roadway width from Figure 430-4, use the greater.
When the intersection of the algebraic difference of grade with the length of vertical curve is above the selected design speed line, corrective action must be considered.

Kc see Chapter 650

Evaluation for Stopping Sight Distance for Crest Vertical Curves
Modified Design Level
Figure 430-7
When the intersection of the lateral clearance (M) with the curve radius (R) falls below the curve for the selected design speed, corrective action must be considered.

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 ft or more above the inside lane.
Main Line Roadway Sections
Modified Design Level

Figure 430-9

Notes:

(a) See Figures 430-3 and 4 for minimum roadway widths and Figures 430-5 and 6 for turning roadway widths.

(b) Widen and round embankments steeper than 4H:1V

(c) See Chapter 640 for shoulder slope requirements.

(d) Or as recommended by the soils or geotechnical report. Refer to Chapter 700 and 710 for clear zone and barrier requirements.

(e) Consider flatter slopes for the greater fill heights and ditch depths where practical.

(f) 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 and 710 for clear zone and barrier requirements.

(g) Minimum ditch depth is 2 ft for design speeds over 40 mph or 1.5 ft for design speeds 40 mph or less.

<table>
<thead>
<tr>
<th>Height of Cut (ft)</th>
<th>Slope not Steeper than</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>4H:1V</td>
</tr>
<tr>
<td>5 - 20</td>
<td>3H:1V</td>
</tr>
<tr>
<td>over 20</td>
<td>2H:1V</td>
</tr>
</tbody>
</table>

Cut Slope Selection

<table>
<thead>
<tr>
<th>Height of Fill/Depth of Ditch (ft)</th>
<th>Slope not Steeper than</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20</td>
<td>4H:1V</td>
</tr>
<tr>
<td>20 - 30</td>
<td>3H:1V</td>
</tr>
<tr>
<td>over 30</td>
<td>2H:1V</td>
</tr>
</tbody>
</table>

Fill and Ditch Slope Selection
(a) See Chapter 640 for shoulder slope requirements.

(b) See text 430.04 for minimum ramp width.

(c) 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.

(d) Widen and round embankments steeper than 4H : 1V.

(e) Minimum ditch depth is 2 ft for design speeds over 40 mph and 1.5 ft for design speeds at and under 40 mph.
440.01 General
Full design level is the highest level of design standards and is used on new and reconstructed highways. These projects are designed to provide optimum mobility, safety, and efficiency of traffic movement. The overall objective is to move the greatest number of vehicles, at the highest allowable speed, and at optimum safety. Major design controls are functional classification, terrain classification, urban or rural surroundings, traffic volume, traffic character and composition, design speed, and access control.

440.02 References
Revised Code of Washington (RCW) 47.05.021, Functional classification of highways.
Revised Code of Washington (RCW) 47.24, City Streets as Part of State Highways
Washington Administrative Code (WAC 468-18-040), “Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings”
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.

440.03 Definitions

auxiliary lane The portion of the roadway adjoining the through lanes for parking, speed change, turning, storage for turning, weaving, truck climbing, and other purposes supplementary to through-traffic movement.

bikeway Any trail, path, part of a highway or shoulder, sidewalk, or any other traveled way specifically signed and/or marked for bicycle travel.

collector system Routes that primarily serve the more important intercounty, intracounty, and intraurban travel corridors, collect traffic from the system of local access roads and convey it to the arterial system, and on which, regardless of traffic volume, the predominant travel distances are shorter than on arterial routes (RCW 47.05.021).

functional classification The grouping of streets and highways according to the character of the service they are intended to provide.

high pavement type Portland cement concrete pavement or asphalt cement concrete pavement on treated base.

intermediate pavement type Asphalt cement concrete pavement on an untreated base.

Interstate System A network of routes selected by the state and the FHWA under terms of the federal aid acts as being the most important to the development of a national system. The Interstate System is part of the principal arterial system.

lane A strip of roadway used for a single line of vehicles.
lane width  The lateral design width for a single lane, striped as shown in the Standard Plans and Standard Specifications. The width of an existing lane is measured from the edge of traveled way to the center of the lane line or between the centers of successive lane lines.

low pavement type  Bituminous surface treatment.

median  The portion of a divided highway separating the traveled ways for traffic in opposite directions.

minor arterial system  A rural network of arterial routes linking cities and other activity centers that generate long distance travel and, with appropriate extensions into and through urban areas, form an integrated network providing interstate and interregional service (RCW 47.05.021).

National Highway System (NHS)  An interconnected system of principal arterial routes that serves interstate and interregional travel; meets national defense requirements; and serves major population centers, international border crossings, ports, airports, public transportation facilities, other intermodal transportation facilities, and other major travel destinations. The Interstate System is a part of the NHS.

outer separation  The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road.

principal arterial system  A connected network of rural arterial routes with appropriate extensions into and through urban areas, including all routes designated as part of the Interstate System, that serve corridor movements having travel characteristics indicative of substantial statewide and interstate travel (RCW 47.05.021).

roadway  The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

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.

shoulder width  The lateral width of the shoulder, measured from the outside edge of the outside lane to the edge of the roadway.

traveled way  The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

usable shoulder  The width of the shoulder that can be used by a vehicle for stopping.

### 440.04 Functional Classification

As provided in RCW 47.05.021, the state highway system is divided and classified according to the character and volume of traffic carried by the routes and distinguished by specific geometric design standards. The functional classifications used on highways, from highest to lowest classification, are Interstate, principal arterial, minor arterial, and collector. The higher functional classes give more priority to through traffic and less to local access.

The criteria used in making the functional classification consider the following:

- Urban population centers within and without the state stratified and ranked according to size
- Important traffic generating economic activities, including but not limited to recreation, agriculture, government, business, and industry
- Feasibility of the route, including availability of alternate routes within and without the state
- Directness of travel and distance between points of economic importance
- Length of trips
- Character and volume of traffic
- Preferential consideration for multiple service which shall include public transportation
- Reasonable spacing depending upon population density
- System continuity
440.05 Terrain Classification

To provide a general basis of reference between terrain and geometric design, three classifications of terrain have been established.

**Level.** Level to moderately rolling. This terrain offers few or no obstacles to the construction of a highway having continuously unrestricted horizontal and vertical alignment.

**Rolling.** Hills and foothills. Slopes rise and fall gently but occasional steep slopes might offer some restriction to horizontal and vertical alignment.

**Mountainous.** Rugged foothills, high steep drainage divides, and mountain ranges.

Terrain classification pertains to the general character of the specific route corridor. Roads in valleys or passes of mountainous areas might have all the characteristics of roads traversing level or rolling terrain and are usually classified as level or rolling rather than mountainous.

440.06 Geometric Design Data

(1) **State Highway System**

For all projects designed to full design level, use the geometric design data in Figures 440-3 through 6b.

(2) **State Highways as City Streets**

When a state highway within an urban area is coincident with and is a portion of a local agency roadway, develop the design features in cooperation with the local agency. For facilities on the NHS, use the design criteria in this manual for the functional class of the route as the minimum standards. For facilities not on the NHS, the Local Agency Guidelines may be used as minimum design criteria; however, the use of WSDOT standards is encouraged where feasible.

(3) **City Streets and County Roads**

Plan and design facilities that cities or counties will be requested to accept as city streets or county roads according to the applicable standards shown in:

- WAC 468-18-040.
- Local Agency Guidelines.
- The standards of the local agency that will be requested to accept the facility.

440.07 Design Speed

Design speed is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern the maximum safe speed.

Vertical and horizontal alignment, sight distance, and superelevation will vary appreciably with design speed. Such features as traveled way width, shoulder width, and lateral clearances are usually not affected. See Chapters 620, 630, 640, and 650 for the relationships between design speed, geometric plan elements, geometric profile elements, superelevation, and sight distance.

The choice of a design speed is influenced principally by functional classification, posted speed, terrain classification, traffic volumes, accident history, access control, and economic factors. However, a geometric design that adequately allows for future improvement is the major criterion, rather than strictly economics. Categorizing a highway by a terrain classification often results in arbitrary reductions of the design speed when, in fact, the terrain would allow a higher design speed without materially affecting the cost of construction. Savings in vehicle operation and other costs alone might be sufficient to offset the increased cost of right of way and construction.

It is important to consider the geometric conditions of adjacent sections. Maintain a uniform design speed for a significant segment of highway.

Select a design speed that is as high as practical within the range given in Figures 3, 4a, 5a, and 6a. The desirable design speed is dependent on the posted speed. Figure 440-1 provides guidance for selecting the desirable design speed.
Select a design speed for urban arterial streets and highways with some access control and fairly long distances between intersections as discussed above. However, highway arterials that have obvious “street-like” characteristics, operationally and physically, do not require a design speed determination. In such instances, closely spaced intersections and other operational constraints usually limit vehicular speeds, negating the design speed factor.

### 440.08 Traffic Lanes

Lane width and condition has a great influence on safety and comfort. The added cost for wider lanes is offset, to some extent, by the reduction in shoulder maintenance cost due to the lessening of wheel load concentrations at the edge of the lane.

Lanes 12 ft wide provide desirable clearance between large vehicles where traffic volumes are high and a high number of large vehicles are expected.

Highway capacity is also affected by the width of the lanes. With narrow lanes, drivers must operate their vehicles closer (laterally) to each other than they normally desire. To compensate for this, drivers reduce their speed and increase the headway, resulting in reduced capacity.

Figures 440-3 through 440-6b give the minimum lane width for the various design classes. See Chapter 640 for guidance on width requirements on turning roadways.

### 440.09 Shoulders

The shoulder width is controlled by the functional classification of the roadway, the traffic volume, and the function the shoulder is to serve.

The more important shoulder functions are to:

1. Provide space for:
   - Stopping out of the traffic lanes
   - Escaping potential accidents or to reduce their severity
   - Lateral clearance to roadside objects, such as guardrail (see Chapters 700 and 710)
   - Pedestrian and bicycle use (see Chapter 640)
   - Large vehicle off tracking on curves (see Chapter 640)
   - Maintenance operations
   - Law enforcement
   - Bus stops (see Chapter 1060)
   - Slow vehicles turnouts and shoulder driving (see Chapter 1010)
   - Ferry holding lanes
   - A sense of openness contributing to driver ease and freedom from strain
   - For use as a lane during reconstruction of the through lanes

2. Provide structural support for the traveled way

3. Improve sight distance in cut sections (see Chapter 650)

4. Improve capacity

5. Reduce seepage adjacent to the traveled way by discharging storm water farther away

For minimum overall shoulder widths based on functional classification and traffic volume, see Figures 440-3 through 6b.

Guidance and width requirements for the shoulder functions with chapter references is in those chapters. Figure 440-2 gives minimum...
overall and usable shoulder widths for other functions. For the remaining functions listed, the benefits vary with the width of the shoulder.

The width of shoulder required for maintenance operations depends on the operation performed and the equipment needed. To be able to park a maintenance truck out of the through lane, 10 ft usable width is needed. For equipment with outriggers, such as used to service luminaires and repair guardrail, a width of 12 ft is required or a lane will need to be closed while the equipment is working. Contact the region maintenance office to determine the shoulder width for maintenance operations. When shoulder widths wider than called for in Figures 440-3 through 6b are requested, compare the added cost of the wider shoulders to the added benefits to maintenance operations and other benefits that may be derived. When the maintenance office requests a shoulder width different than for the design class, justify the width selected.

<table>
<thead>
<tr>
<th>Shoulder Function</th>
<th>Minimum Shoulder Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum lateral clearance and structural support</td>
<td>2 ft</td>
</tr>
<tr>
<td>Pedestrian or bicycle use</td>
<td>4 ft(1)</td>
</tr>
<tr>
<td>Stopping out of the traffic lanes</td>
<td>6 ft(2)</td>
</tr>
<tr>
<td>Law enforcement and Ferry holding</td>
<td>6 ft(3)</td>
</tr>
</tbody>
</table>

(1) Minimum when pedestrians or bicycles are considered, see Chapter 1020 for additional information
(2) Minimum usable shoulder width.
(3) Minimum usable shoulder width, 10 ft preferred. See Chapters 1040 and 1050 for additional information on enforcement areas.

When vertical features (such as traffic barrier, walls, or curbs) are at the edge of the shoulder, add shy distance to the usable shoulder to obtain the overall shoulder width for the shoulder function. A distance of 2 ft is normally used for the shy distance. See Chapter 710 for the required widening at traffic barrier, see Chapter 910 for shy distances at curbs.

Provide a minimum clearance to roadside objects so that the shoulders do not require narrowing. At existing bridge piers and abutments, shoulders less than full width to a minimum of 2 ft shy may be used with design exception documentation. See Chapter 700 for design clear zone and safety treatment requirements.

Shoulder widths greater than 10 ft may encourage use as a travel lane. Therefore, use shoulders wider than this only where required to meet one of the listed functions. See Chapter 1010 when shoulder driving is to be allowed.

### 440.10 Medians

The primary functions of a median are to:

- Separate opposing traffic
- Provide for recovery of out-of-control vehicles
- Reduce head-on accidents
- Provide an area for emergency parking
- Allow space for left turn lanes
- Minimize headlight glare
- Allow for future widening

For maximum efficiency, make medians highly visible both night and day. Medians may be depressed, raised, or flush with the through lanes.

The width of a median is measured from edge of traveled way to edge of traveled way and includes the shoulders. The minimum median width for each design class is given in Figures 440-3 through 440-6b. When selecting a median width, consider future needs such as wider left shoulders when widening from four to six lanes.

See Chapter 700 for barrier requirements and Chapter 910 for left-turn lane design.
440.11 Parking
In urban areas and rural communities, land use might require parking along the highway. In general, on-street parking decreases capacity, increases accidents, and impedes traffic flow. Therefore, it is desirable to prohibit parking.

Although design data for parking lanes are included on Figures 440-4a through 6b, consider them only in cooperation with the municipality involved. The lane widths given are the minimum for parking.

440.12 Pavement Type
The pavement types given in Figures 440-3 through 6a are the recommended for each design class. Submit Form 223-528, Pavement Type Determination to the OSC Materials Laboratory for a final determination of the pavement type to use. When a roadway is to be widened and the existing pavement will remain, the new pavement type may be the same as the existing without a pavement type determination.

440.13 Structure Width
Provide a clear width between curbs on a bridge equal to the approach roadway width (lanes plus shoulders). The structure widths given in Figures 440-3 through 6a are the minimum bridge width for each design class.

Shy distance is not normally added to the roadway width for the bridge width. When a bridge is in a run of roadside barrier, consider adding the shy distance on shorter bridges to prevent narrowing the roadway.

440.14 Grades
Grades can have a pronounced effect on the operating characteristics of the vehicles negotiating them. Generally, passenger cars can readily negotiate grades as steep as 5% without appreciable loss of speed from that maintained on level highways. Trucks, however, travel at the average speed of passenger cars on the level but display up to a 5% increase in speed on downgrades and a 7% or more decrease in speed on upgrades (depending on length and steepness of the grade as well as weight to horsepower ratio).

The maximum grades for the various functional classes and terrain conditions are shown in Figures 440-3 through 6a. For the effects of these grades on the design of a roadway see Chapters 630 and 1010.
### Geometric Design Data, Interstate

**Figure 440-3**

<table>
<thead>
<tr>
<th>Design Class</th>
<th>Divided Multilane</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Year</th>
<th>(1)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Access Control</th>
<th>Full</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Separate Cross Traffic</th>
<th>Highways</th>
<th>Railroads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Rural</th>
<th>Urban</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80(^{(3)})</td>
<td>70(^{(4)})</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traffic Lanes</th>
<th>Number</th>
<th>Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 or more divided</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Median Width (ft)</th>
<th>4 lane</th>
<th>6 lanes or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural —Minimum(^{(5)})</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Urban —Minimum</td>
<td>16</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shoulder Width (ft)</th>
<th>Right of Traffic</th>
<th>Left of Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>10(^{(6)})</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10(^{(6)})</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pavement Type(^{(7)})</th>
<th>High</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Right of Way(^{(8)})</th>
<th>Rural —Minimum Width (ft)</th>
<th>63 from edge of traveled way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban —Minimum Width (ft)</td>
<td>As required(^{(9)})</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structures Width(^{(10)}) (ft)</th>
<th>Full roadway width each direction(^{(11)})</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Grades (%)(^{(12)})</th>
<th>Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Level</td>
<td>4</td>
</tr>
<tr>
<td>Rolling</td>
<td>5</td>
</tr>
<tr>
<td>Mountainous</td>
<td>6</td>
</tr>
</tbody>
</table>

**Interstate Notes:**

1. The design year is 20 years after the year the construction is scheduled to begin.
2. See Chapter 1420 for access control requirements.
3. 80 mph is the desirable design speed, with justification the design speed may be reduced to 60 mph in mountainous terrain and 70 mph in rolling terrain.
4. 70 mph is the desirable design speed, with justification, the design speed may be lowered to 50 mph.
5. Independent alignment and grade is desirable in all rural areas and where terrain and development permits in urban areas.
6. For existing 6-lane roadways, existing 6 ft left shoulders may remain when no other widening is required.
7. Submit Form 223-528, Pavement Type Determination.
8. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
9. In urban areas, make right of way widths not less than those required for necessary cross section elements.
10. See Chapter 1120 for minimum vertical clearance.
11. For median widths 26 ft or less, address bridge(s) in accordance with Chapter 1120.
12. Grades 1% steeper may be used in urban areas where development precludes the use of flatter grades and for one-way down grades except in mountainous terrain.
<table>
<thead>
<tr>
<th>Design Class</th>
<th>P-1</th>
<th>P-2</th>
<th>P-3</th>
<th>P-4</th>
<th>P-5</th>
<th>P-6(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHV in Design Year(2)</td>
<td>NHS</td>
<td>NHS</td>
<td>NHS</td>
<td>NHS</td>
<td>NHS</td>
<td>NHS</td>
</tr>
<tr>
<td>Access Control(5)</td>
<td>Full</td>
<td>Partial</td>
<td>Partial</td>
<td>Partial</td>
<td>Partial</td>
<td>Partial</td>
</tr>
<tr>
<td>Separate Cross Traffic Railroads</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>Design Speed Range (mph)(8)</td>
<td>70</td>
<td>50</td>
<td>40</td>
<td>60</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Traffic Lanes Number</td>
<td>4 or more divided</td>
<td>4 or 6 divided</td>
<td>4 or 6 divided</td>
<td>4 or 6 divided</td>
<td>4 or 6 divided</td>
<td>4 or 6 divided</td>
</tr>
<tr>
<td>Shoulder Width (ft)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Median Width (ft)</td>
<td>40(12)</td>
<td>40(12)</td>
<td>40(12)</td>
<td>40(12)</td>
<td>40(12)</td>
<td>40(12)</td>
</tr>
<tr>
<td>Parking Lanes Width (ft) — Minimum</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Pavement Type(15)</td>
<td>High</td>
<td>High or Intermediate</td>
<td>High or Intermediate</td>
<td>High or Intermediate</td>
<td>High or Intermediate</td>
<td>High or Intermediate</td>
</tr>
<tr>
<td>Grades (%) (22)</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Other Design Considerations</td>
<td>Urban</td>
<td>Urban</td>
<td>Urban</td>
<td>Urban</td>
<td>Urban</td>
<td>Urban</td>
</tr>
</tbody>
</table>

**Figures:**
- Figure 440-4a: Geometric Design Data, Principal Arterials

**Table Notes:**
1. Design Class P-6 is considered for special cases.
2. DHV in Design Year:
   - NHS: Non Highway System
   - NHS: Non Highway System
3. Access Control:
   - Full
   - Partial
4. Separate Cross Traffic Railroads:
   - All
   - Partial
5. Design Speed Range (mph):
   - 70: 70-90 mph
   - 50: 50-70 mph
   - 40: 40-50 mph
   - 60: 60-80 mph
6. Traffic Lanes Number:
   - 4 or more divided
   - 4 or 6 divided
7. Shoulder Width (ft):
   - 10
8. Median Width (ft):
   - 40(12)
9. Parking Lanes Width (ft) — Minimum:
   - None
10. Pavement Type:
    - High
    - High or Intermediate
11. Grades (%):
    - 40
12. Other Design Considerations:
    - Urban
**Principal Arterial Notes:**

1. Justify the selection of a P-6 standard.
2. The design year is 20 years after the year the construction is scheduled to begin.
3. Where DHV exceeds 700, provide four lanes. For lower volumes, when the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes on a P-3 design class highway, perform an investigation to determine if a P-2 design class highway is justified.
4. When considering a multilane highway, perform an investigation to determine if a truck climbing lane will satisfy the need.
5. See Chapter 1420 for access control requirements.
6. All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
7. Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
8. The preferred design speed is within the range. Design speeds above the range may be selected, with justification. The lower end of the range is the minimum design speed for the design class.
9. 12-ft lanes are required when the truck DHV is 6% or greater.
10. Minimum left shoulder width is to be as follows: four lanes — 4 ft; six or more lanes — 10 ft. For 6-lane roadways, existing 6 ft left shoulders may remain when no other widening is required.
11. When curb section is used, a 6 ft shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs.
12. On freeways or expressways requiring less than eight lanes within the 20-year design period, provide sufficient median or lateral clearance and right of way to permit addition of a lane in each direction if required by traffic increase after the 20-year period.
13. When signing is required in the median of a six-lane section, the minimum width is 6 ft. If barrier is to be installed at a future date, a 8 ft minimum median is required.
14. Parking restricted when ADT is over 15,000.
15. Submit Form 223-528, Pavement Type Determination.
16. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
17. 63 ft from edge of traveled way.
18. Make right of way widths not less than those required for necessary cross section elements.
19. See Chapter 1120 for the minimum vertical clearance.
20. For median widths 26 ft or less, address bridges in accordance with Chapter 1120.
21. For pedestrian, bicycle, and sidewalk requirements see Chapter 1020. Curb requirements are in Chapter 910. Lateral clearances from the face of curb to obstruction are in Chapter 700.
22. Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

**Geometric Design Data, Principal Arterial**

*Figure 440-4b*
<table>
<thead>
<tr>
<th>Design Class</th>
<th>Divided Multilane</th>
<th>Two-Lane</th>
<th>Undivided Multilane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M-1</td>
<td>M-2</td>
<td>M-3</td>
</tr>
<tr>
<td>DHV in Design Year(2)</td>
<td>NHS</td>
<td>Non NHS</td>
<td>Over 701</td>
</tr>
<tr>
<td>Access Control(5)</td>
<td>Partial</td>
<td>Partial</td>
<td>Partial or None</td>
</tr>
<tr>
<td>Separate Cross Traffic Highways</td>
<td>Where Warranted</td>
<td>All</td>
<td>Where Warranted</td>
</tr>
<tr>
<td>Design Speed Range (mph)(8)</td>
<td>70</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Traffic Lanes Number</td>
<td>4 or 6 divided</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Width (ft)</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Shoulder Width (ft) Right of Traffic</td>
<td>10</td>
<td>Variable(10)</td>
<td>8</td>
</tr>
<tr>
<td>Left of Traffic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median Width (ft) 4 lane</td>
<td>60</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>6 lane</td>
<td></td>
<td>60</td>
<td>22</td>
</tr>
<tr>
<td>Parking Lanes Width (ft) — Minimum</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Pavement Type(14)</td>
<td>High</td>
<td>As required</td>
<td>High or Intermediate</td>
</tr>
<tr>
<td>Right of Way(15) — Min Width (ft)</td>
<td>(16)</td>
<td>(17)</td>
<td>120</td>
</tr>
<tr>
<td>Structures (ft)(18)</td>
<td>Full Roadway Width(19)</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>Other Design Considerations-Urban</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Grades (%)(21)

<table>
<thead>
<tr>
<th>Type of Terrain</th>
<th>Rural — Design Speed (mph)</th>
<th>Urban — Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Level</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Rolling</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Mountainous</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

Geometric Design Data, Minor Arterial

Figure 440-5a
Minor Arterial Notes:

1. Justify the selection of an M-5 standard.
2. The design year is 20 years after the year the construction is scheduled to begin.
3. Where DHV exceeds 700, provide four lanes. For lower volumes, when the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future four-lane facility. When considering truck climbing lanes an M-2 design class highway, perform an investigation to determine if an M-1 design class highway is justified.
4. When considering a multilane highway, perform an investigation to determine if a truck climbing lane will satisfy the need.
5. See Chapter 1420 for access control requirements.
6. All main line and major-spur railroad tracks will be separated. Consider allowing at-grade crossings at minor-spur railroad tracks.
7. Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
8. The preferred design speed is within the range. Design speeds above the range may be selected, with justification. The lower end of the range is the minimum design speed for the design class.
9. When the truck DHV is 6% or greater, consider 12 ft lanes.
10. The minimum left shoulder width is 4 ft for four lanes and 10 ft for six or more lanes. For 6-lane roadways, existing 6 ft left shoulders may remain when no other widening is required.
11. When curb section is used, a 6 ft shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs.
12. When signing is required in the median of a six-lane section, the minimum width is 6 ft. If barrier is to be installed at a future date, a 8 ft minimum median is required.
13. Parking restricted when ADT is over 15,000.
14. Submit Form 223-528, Pavement Type Determination.
15. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
16. 63 ft from edge of traveled way
17. Make right of way widths not less than those required for necessary cross section elements.
18. See Chapter 1120 for the minimum vertical clearance.
19. For median widths 26 ft or less, address bridges in accordance with Chapter 1120.
20. For pedestrian, bicycle, and sidewalk requirements see Chapter 1020. Curb requirements are in Chapter 910. Lateral clearance from the face of curb to obstruction are in Chapter 700.
21. Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.
### Geometric Design Data, Collector

**Figure 440-6a**

<table>
<thead>
<tr>
<th>Design Class</th>
<th>Undivided Multilane</th>
<th>Two-Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C-1</td>
<td>C-2</td>
</tr>
<tr>
<td>Rural</td>
<td>Urban</td>
<td>Rural</td>
</tr>
<tr>
<td>DHV in Design Year&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>NHS</td>
<td>Non NHS</td>
</tr>
<tr>
<td>Access Control</td>
<td>(4)</td>
<td>Where Warranted</td>
</tr>
<tr>
<td>Separate Cross Traffic</td>
<td>Highways</td>
<td>Railroads</td>
</tr>
<tr>
<td>Design Speed Range (mph)&lt;sup&gt;(6)&lt;/sup&gt;</td>
<td>70</td>
<td>40</td>
</tr>
<tr>
<td>Traffic Lanes</td>
<td>Number</td>
<td>4</td>
</tr>
<tr>
<td>Width (ft)</td>
<td>12</td>
<td>11&lt;sup&gt;(7)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Shoulder Width (ft)</td>
<td>8</td>
<td>8&lt;sup&gt;(8)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Median Width — Minimum (ft)</td>
<td>4</td>
<td>2&lt;sup&gt;(9)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Parking Lanes Width (ft) — Minimum</td>
<td>None</td>
<td>10</td>
</tr>
<tr>
<td>Pavement Type&lt;sup&gt;(10)&lt;/sup&gt;</td>
<td>High or Intermediate</td>
<td>As required</td>
</tr>
<tr>
<td>Right of Way (ft)</td>
<td>150</td>
<td>80</td>
</tr>
<tr>
<td>Structures Width (ft)&lt;sup&gt;(12)&lt;/sup&gt;</td>
<td>Full Roadway Width</td>
<td>40</td>
</tr>
<tr>
<td>Other Design Considerations-Urban</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Graded (%)<sup>(14)</sup>

<table>
<thead>
<tr>
<th>Type of Terrain</th>
<th>Rural — Design Speed (mph)</th>
<th>Urban — Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Level</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Rolling</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Mountainous</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
**Collector Notes:**

1. The design year is 20 years after the year the construction is scheduled to begin.
2. Where DHV exceeds 900, provide four lanes. For lower volumes, when the volume/capacity ratio is equal to or exceeds 0.85, consider the needs for a future four-lane facility. When considering truck climbing lanes on a C-2 design class highway, perform an investigation to determine if a C-1 design class highway is justified.
3. When considering a multilane highway, perform an investigation to determine if a truck climbing lane will satisfy the need.
4. See Chapter 1420 for access control requirements.
5. Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the hazard potential. Provide justification for railroad grade separations.
6. The preferred design speed is within the range. Design speeds above the range may be selected, with justification. The lower end of the range is the minimum design speed for the design class.
7. Consider 12 ft lanes when the truck DHV is 6% or greater.
8. When curb section is used, a 6 ft shoulder outside the face of curb is acceptable. See Chapter 910 for shy distances at curbs.
9. When signing is required in the median of a six-lane section, the minimum width is 6 ft median. If barrier is to be installed at a future date, a 8 ft minimum median is required.
10. Submit Form 223-528, Pavement Type Determination.
11. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut. See Chapter 640 and the Standard Plans for slope treatment information.
12. See Chapter 1120 for the minimum vertical clearance.
13. For pedestrian, bicycle, and sidewalk requirements, see Chapter 1020. Curb requirements are in Chapter 910. Lateral clearances from the face of curb to obstruction are in with Chapter 700.
14. Except in mountainous terrain, grades 1% steeper may be used in urban areas where development precludes the use of flatter grades or for one-way downgrades.

**Figure 440-6b**

**Geometric Design Data, Collector**
Investigation of Soils, Rock, and Surfacing Materials

510

510.01 General

It is the responsibility of the Washington State Department of Transportation (WSDOT) to understand the characteristics of the soil and rock materials that support or are adjacent to the transportation facility to ensure that the facility, when designed, will be adequate to safely carry the estimated traffic. It is also the responsibility of WSDOT to ensure the quality and quantity of all borrow materials used in the construction of transportation facilities.

The following information serves as guidance in the above areas. Where a project consists of a surface overlay of an existing highway, requirements as set forth in WSDOT Pavement Guide for Design, Evaluation and Rehabilitation are used.

To identify the extent and estimated cost for a project, it is necessary to obtain and use an adequate base data. In recognition of this need, preliminary soils investigation work begins during project definition. This allows early investigative work and provides necessary data in a timely manner for use in project definition and design. More detailed subsurface investigation follows during the project design and plan, specification, and estimate (PS&E) phases.

It is essential to get the region’s Materials Engineer (RME) and the Olympia Service Center (OSC) Geotechnical Branch involved in the project design as soon as possible once the need for geotechnical work is identified. See 510.04(3) for time-estimate information. Furthermore, if major changes occur as the project is developed, inform the RME and OSC Geotechnical Branch as soon as possible so that the geotechnical design can be adapted to the changes without significant delay to the project.

510.02 References

Construction Manual, M 41-01, WSDOT

Hydraulics Manual, M 23-03, WSDOT

Plans Preparation Manual, M 22-31, 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

WSDOT Pavement Guide for Design, Evaluation and Rehabilitation

510.03 Materials Sources

(1) General

The region’s Project Development Engineer (RPDE) determines when a materials source is needed. The region’s Materials Engineer (RME) determines the best materials source for the project. (See Figure 510-1.) It is preferred that existing approved materials source sites be used when there are suitable sites available. When there are no approved sites available, the RME conducts a site investigation. The Olympia Service Center (OSC) Geotechnical Branch provides assistance upon request.

The RME selects sources for gravel base, borrow excavation and gravel borrow, crushed surfacing materials, mineral and concrete aggregates, riprap, and filler only after careful investigation of:

- The site. (Consider the adequacy of the work area.)
- The quality of the material.

510.04 Geotechnical Investigation, Design, and Reporting

510.05 Use of Geotechnical Consultants

510.06 Geotechnical Work by Others

510.07 Surfacing Report

510.08 Documentation
• The quantity of the material. (Consider the needs of the immediate project and the needs to support future maintenance and construction work in the area.)
• Reclamation requirements.
• Aesthetic considerations.
• Economic factors.
• Ability to preserve or enhance the visual quality of the highway and local surroundings.

Once the materials source investigation and laboratory testing have been completed the RME prepares a materials source report. The materials source report summarizes the site geology, site investigation (including boring and test pit logs), source description, quality and quantity of material available, and other aspects of the materials sources that are relevant.

(2) Materials Source Approval
The RME submits the materials source report to the OSC Geotechnical Branch for review and approval.

The OSC Materials Office and the OSC Design Office must approve each pit or quarry site before it is purchased, leased, or acquired on a royalty basis. Until the approval process is complete, the project cannot be advertised for bids. Local and state permits are required for materials sources. To avoid delay in advertising the project, begin the site investigations and permitting process in the early stages of project definition.

510.04 Geotechnical Investigation, Design, and Reporting
(1) General
A geotechnical investigation is conducted on all projects that involve significant grading quantities, unstable ground, or foundations for structures in a manner that preserves the safety of the public who use the facility, as well as preserving the economic investment by the state of Washington. Geotechnical engineering must be conducted by engineers or engineering geologists who possess adequate geotechnical training and experience, and must be conducted in accordance with regionally or nationally accepted geotechnical practice. Where required by law, geotechnical engineering must be performed by, or under the direct supervision of, a person licensed to perform such work in the state of Washington.

(2) Key Contacts for Initiating Geotechnical Work
In general, the RME functions as the clearing house for all geotechnical work, with the exception of structural projects and Washington State Ferries (WSF) projects. The RME takes the lead in conducting the geotechnical work if the geotechnical work required is such that the ground is stable and relatively firm, bedrock is not involved, and the design of the project geotechnical elements does not require specialized geotechnical design expertise. If this is not the case, the RME asks for the involvement and services of the OSC Geotechnical Branch. They respond to and provide recommendations directly to the region’s project design office (or the OSC Equipment and Facilities Office in the case of Facilities projects), but always keeping the RME “in the loop.”

For structural projects (bridges and tunnels, for example), the Bridge and Structures Office works directly with the OSC Geotechnical Branch.

For WSF projects, the Terminal Engineering Office works directly with the RME or the OSC Geotechnical Branch, depending on the nature of the project.

For walls and noise walls, see Chapters 1130 and 1140, respectively. For geosynthetic design, see Chapter 530.

(3) Scheduling Considerations for Geotechnical Work
The region’s Design Office, Bridge and Structures Office, WSF, and the Equipment and Facilities Office are responsible for identifying the potential need for geotechnical work, and requesting time and budget estimates from the RME or the OSC Geotechnical Branch, as early as practical to prevent delays to the project.
Once the geotechnical design request and the site data are received by the RME or the OSC Geotechnical Branch, it can take anywhere from two to six months, or more, to complete the geotechnical design, depending on the complexity of the project, whether or not test holes are needed, current workload, the need to give the work to consultants, and how long it takes to obtain environmental permits and rights of entry (ROE).

If a consultant must be used, the minimum time required to complete a design (for even a simple project) is typically 2.5 months.

In true emergency situations (a highway blocked by a landslide or a collapsed bridge, for example), it is possible to get geotechnical design work completed (in house or by consultants) more rapidly to at least provide a design for temporary mitigation.

Consider all of these factors when deciding how soon to initiate the geotechnical work for a project but, in general, the sooner, the better.

(4) Site Data and Permits Needed to Initiate Geotechnical Work

To initiate geotechnical work on a project during the design and PS&E phases, provide the following information:

(a) Project description.

(b) Plan sheets showing the following:
   • Station and location of cuts, fills, walls, bridges, retention/detention ponds, or other geotechnical features to be designed.
   • Existing utilities (as-built plans are acceptable).
   • Right of way limits.
   • Wetlands.
   • Drainage features.
   • Existing structures.
   • Other features or constraints that could affect the geotechnical design or investigation.

(c) Electronic files, or cross sections every 50 ft to 65 ft or as appropriate, to define existing and new ground line above and below the wall, cut, fill, and other pertinent information.
   • Show stationing.
   • Show locations of existing utilities, right of way lines, wetlands, and other constraints.
   • Show locations of existing structures that might contribute load to the cut or fill.

(d) Right of entry agreements and permits required for geotechnical investigation.

(e) Due date and work order number.

(f) Contact person.

When the alignment and any constraints as noted above are staked, the stationing on the plans and in the field must be in the same units. Physical surveys are preferred to photogrammetric surveys to ensure adequate accuracy of the site data.

Permits and agreements to be supplied by the region might include:
   • HPA
   • Shoreline permits
   • Tribal lands and waters
   • Railroad easement and right of way
   • City, county or local agency use permits
   • Sensitive area ordinance permits

The region’s project office is also responsible for providing the stations, offsets, and elevations of test holes to the nearest 1 ft once the test holes have been drilled. Provide test hole locations using state plane coordinates as well, if available.

(5) Overview of Geotechnical Design Objectives for the Various Project Stages

(a) Project Definition. The project design office uses the geotechnical investigation results obtained during the project definition phase to develop the project delivery cost and schedule. Geotechnical recommendations provided for this phase will be at the conceptual/feasibility level. The investigation for this phase usually consists of a visual project walk-through and a review of the existing records, geologic maps, and so forth.
For projects of significant geotechnical scope and complexity, and if soil borings are not available at critical locations within the project, some soil borings might be drilled at this time. Potential geotechnical hazards (earthquake faults, liquefaction, landslides, rockfall, soft ground, for example) are identified during project definition, and conceptual hazard avoidance or mitigation plans are developed. Future geotechnical design services needed in terms of time and cost, including the need for special permits to perform the geotechnical exploration (critical areas ordinances), are determined at this time.

(b) **Project Design.** Once the roadway geometry is established, detailed design of cut and fill slopes, adequate to establish the right-of-way needs, is accomplished. Once approximate wall locations and heights are known, preliminary design of walls is performed to establish feasibility, primarily to establish right-of-way needs (as is true for slopes) and likely wall types. A similar level of design is applied to hydraulic structures, and to determine overall construction staging and constructibility requirements to address the geotechnical issues at the site. Conceptual and/or more detailed preliminary bridge foundation design is conducted during this phase if it was not conducted during project definition. Before the end of this phase, the geotechnical data necessary to allow future completion of the PS&E level design work is gathered (final geometric data, test hole data, and so forth.).

(c) **PS&E Development.** Final design of all geotechnical project features is accomplished. Recommendations for these designs, as well as special provisions and plan details to incorporate the geotechnical design recommendations in the PS&E, are provided in the geotechnical report. Minor geotechnical features such as signal/sign foundations and small detention/retention ponds are likely to be addressed at this stage, as the project details become clearer. Detailed recommendations for the constructibility of the project geotechnical features are also provided.

(6) **Earthwork**

(a) **Project Definition.** The project designer contacts and meets with the RME, and the OSC Geotechnical Branch as needed, at the project site to conduct a field review to help identify the geotechnical issues for the project.

In general, if soil/rock conditions are poor and/or large cuts or fills are anticipated, the RME requests that the OSC Geotechnical Branch participate in the field review and reporting efforts.

The designer provides a description and location of the proposed earthwork to the RME.

- For widening of existing facilities, the anticipated width, length, and location of the widening, relative to the current facility, are provided.
- For realignments, the approximate new location proposed for the facility is provided.
- Locations in terms of length can be by mile post or stations.

A brief conceptual level report is provided to the designer that summarizes the results of the investigation.

(b) **Project Design.** Geotechnical data necessary to allow completion of the PS&E level design is compiled during the design phase. This includes soils borings, testing, and final geometric data. Detailed design of cut and fill slopes can be done once the roadway geometry is established and geotechnical data is available. The purpose of this design effort is to determine the maximum stable cut or fill slope and, for fills, potential for short and long term settlement. Also, the usability of the cut materials and the type of borrow needed for the project, if any, is evaluated. Evaluate the use of soil bioengineering as an option for building steeper slopes or to prevent surface erosion. See the Chapter 1350 - Soil Bioengineering for more information.

The designer requests a geotechnical report from the RME. The site data indicated in 510.04(4), as applicable, is provided. It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. The time required to obtain permits and rights of entry
must be considered when establishing schedule requirements.

The RME, in conjunction with the OSC Geotechnical Branch, provides the following information as part of the geotechnical report (as applicable):

1. General description of the regional and site geology
2. Summary of the investigation
3. Boring logs
4. Laboratory tests and results
5. Soil/rock unit descriptions
6. Ground water conditions
7. Embankment design recommendations
   - The slope required for stability
   - Estimated amount and rate of settlement
   - Stability and settlement mitigation requirements
   - Construction staging requirements
   - Effects of site constraints
   - Monitoring needs
   - Material and compaction requirements
   - Subgrade preparation
8. Cut design recommendations
   - The slope required for stability
   - Stability mitigation requirements (deep seated stability and erosion)
   - Identification of seepage areas and how to mitigate them
   - Effects of site constraints
   - Monitoring requirements
   - Usability of excavated cut material, including gradation, moisture conditions and need for aeration, and shrink/swell characteristics

The recommendations include the background regarding analysis approach and any agreements with the region or other customers regarding the definition of acceptable level of risk.

The project office uses the report to finalize design decisions for the project. To meet slope stability requirements, additional right of way might be required or a wall might be needed. Wall design is covered in Chapter 1130. Construction timing might require importing material rather than using cut materials. The report is used to address this and other constructibility issues. The report is also used to proceed with completion of the project PS&E design.

(c) **PS&E Development.** Adequate geotechnical design information to complete the PS&E is typically received during project design. Additional geotechnical work might be needed when right of way cannot be acquired, restrictions are included in permits, or other requirements are added that result in changes in the design.

Special provisions and plan details, if not received as part of the report provided during project design, are developed with the assistance of the RME or the OSC Geotechnical Branch. The project designer uses this information, as well as the design phase report, to complete the PS&E documents. Both the region’s Materials Section and the OSC Geotechnical Branch can review the contract plans before the PS&E review process begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(7) **Hydraulic Structures and Environmental Mitigation**

(a) **Project Definition.** The designer provides a description and location of the proposed hydraulic/environmental improvements and other pertinent site information, and discusses the extent of the hydraulics and environmental improvements, with both the RME and the Hydraulics Sections, to identify the geotechnical issues to be investigated. At this stage, only the identification and feasibility of the proposed hydraulic structures or environmental mitigation are investigated. The cost and schedule require-
ments for the geotechnical investigation are also determined at this time.

Examples of hydraulic structures include, but are not limited to, large culverts, pipe arches, underground detention vaults, and fish passage structures. Examples of environmental mitigation include, but are not limited to, detention/retention ponds and wetland creation.

(b) **Project Design.** The designer requests a geotechnical report from the RME. The site data indicated in 510.04(4), as applicable, is provided along with the following information:

- Pertinent field observations (such as unstable slopes, existing soft soils or boulders, or erosion around and damage to existing culverts or other drainage structures).
- Jurisdictional requirements for geotechnical design of berms/dams.

It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

The RME, with support from the OSC Geotechnical Branch as needed, provides the following information, when requested and where applicable, as part of the project geotechnical report:

- Soil boring logs.
- Soil pH and resistivity.
- Water table elevation.
- Soil infiltration rates (highest rate for assessing spill containment/aquifer protection and long-term rate for determining pond capacity).
- Bearing capacity and settlement for hydraulic structure foundations.
- Slope stability for ponds.
- Retention berm/dam design.
- Potential for and amount of differential settlement along culverts and pipe arches and the estimated time required for settlement to occur.
- Soil pressures and properties (primarily for underground detention vaults).
- Erosion potential.
- Geosynthetic design per Chapter 530.
- Recommendations for mitigation of the effect of soft or unstable soil on the hydraulic structures.
- Recommendations for construction.

Note that retaining walls that are part of a pond, fish passage, and the like, are designed per Chapter 1130.

The project designer uses the geotechnical information to:

- Finalize design decisions.
- Evaluate and mitigate environmental issues.
- Proceed with completion of the PS&E design (includes determining the most cost effective hydraulic structure/pond to meet the desired objectives, locating and sizing ponds and foundations for hydraulic structures, structural design, mitigating the effects of settlement, satisfying local jurisdictional requirements for design, and so forth).

(c) **PS&E Development.** During PS&E development, the designer uses the information provided in the geotechnical report as follows:

- Select pipe materials in accordance with corrosion, resistivity, and abrasion guidelines in the *Hydraulics Manual*.
- Consider and include construction recommendations.

Additional design and specification guidance and support from the RME or the OSC Geotechnical Branch are sought as needed. Both sections provide careful review of the contract plans before the PS&E review process begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.
(8) Signals, Sign Bridges, Cantilever Signs, and Luminaire Foundations

(a) Project Definition and Design.
Geotechnical information is usually not required for signals, sign bridges, cantilever signs, and luminaires during project definition.

The region’s Traffic Office contacts the RME for conceptual foundation recommendations. The conceptual recommendations are based on existing information in the area, and identify if Standard Plan foundations are feasible or if special design foundations are required. If good soils are anticipated or the foundations will be placed in fill, Standard Plan foundations can be assumed. If special design foundations are required, additional time and money can be included in the project to accommodate increased field exploration for foundation design, OSC Geotechnical Branch involvement, and structural design by the Bridge and Structures Office.

(b) PS&E Development. Foundation recommendations are made by either the RME or the OSC Geotechnical Branch. The recommendations provide all necessary geotechnical information to complete the PS&E.

The region’s Traffic Office (or region’s Project Engineer in some cases) is responsible for delivering the following project information to the region’s Materials Engineer:

- Plan sheet showing the location of the structures (station and offset) and the planned structure type.
- Applicable values for: XYZ, strain pole class, sign bridge span length, luminaire height, variable message sign weight, wind load, CCTV pole height, and known utility information in the area.

The RME provides the following information to the requester if Standard Plan foundation types can be used:

- Allowable lateral bearing capacity of the soil.
- Results of all field explorations.
- Groundwater elevation.
- Foundation constructibility.

The region uses this information to complete the plan sheets and prepare any special provisions. If utilities are identified during the field investigation that could conflict with the foundations, the region’s project office pursues moving or accommodating the utility. Accommodation could require special foundation designs.

If special designs are required, the RME notifies the requester that special designs are required and forwards the information received from the region to the Geotechnical Branch. The Geotechnical Branch provides the Bridge and Structures Office with the necessary geotechnical recommendations to complete the foundation designs. The region coordinates with the Bridge and Structures Office to ensure that they have all the information necessary to complete the design. Depending on the structure type and complexity, the Bridge and Structures Office might produce the plan sheets and special provisions for the foundations, or they might provide the region with information so that the region can complete the plan sheets and special provisions.

(9) Buildings, Park and Ride Lots, Rest Areas, and Communication Towers

In general, the RME functions as the clearing house for the geotechnical work to be conducted in each of the phases for technical review of the work if the work is performed by consultants, or for getting the work done in-house. For sites and designs that are more geotechnically complex, the RME contacts the OSC Geotechnical Branch for assistance.

Detailed geotechnical investigation guidance is provided in Facilities Operating Procedure 9-18, “Site Development.” In summary, this guidance addresses the following phases of design:

(a) Site Selection. Conceptual geotechnical investigation (based on historical data and minimal subsurface investigation) of several alternative sites is performed in which the geotechnical feasibility of each site for the intended use is evaluated, allowing the sites to be ranked. In this phase, geological hazards (landslides, rockfall, compressible soils, liquefaction,
and so forth) are identified, and geotechnical data adequate to determine a preliminary cost to develop and build on the site is gathered.

(b) **Schematic Design.** For the selected site, the best locations for structures, utilities, and other elements of the project are determined based on site constraints and ground conditions. In this phase, the site is characterized more thoroughly than in the site selection phase, but subsurface exploration is not structure specific.

(c) **Design Development.** The final locations of each of the project structures, utilities, and other project elements determined from the schematic design phase are identified. Once these final locations are available, a geotechnical investigation adequate to complete the final design of each of the project elements (structure foundations, detention/retention facilities, utilities, parking lots, roadways, site grading, and so forth) is conducted. From this investigation and design, the final PS&E is developed.

**(10) Retaining Walls, Reinforced Slopes, and Noise Walls**

(a) **Project Definition.** The designer provides a description and location of the proposed walls or reinforced slopes, including the potential size of the proposed structures and other pertinent site information, to the RME. At this stage, only the identification and feasibility of the proposed walls or reinforced slopes are investigated. A field review may also be conducted at this time as part of the investigation effort. In general, if soil/rock conditions are poor and/or large walls or reinforced slopes are anticipated, the RME requests that the OSC Geotechnical Branch participate in the field review and reporting efforts. The cost and schedule requirements for the geotechnical investigation are also determined at this time.

A brief conceptual level report that summarizes the results of the investigation may be provided to the designer at this time, depending on the complexity of the geotechnical issues.

(b) **Project Design and PS&E Development.** Geotechnical data necessary to allow completion of the PS&E level design for walls and reinforced slopes are compiled during the design and PS&E development phases. This includes soils borings, testing, and final geometric data. Detailed design of walls and reinforced slopes can be done once the roadway geometry is established and geotechnical data are available. The purpose of this design effort is to determine the wall and slope geometry needed for stability, noise wall and retaining wall foundation requirements, and the potential for short- and long-term settlement.

The designer requests a geotechnical report from the RME for retaining walls, noise walls, and reinforced slopes that are not part of the bridge preliminary plan. For walls that are part of the bridge preliminary plan, the Bridge and Structures Office requests the geotechnical report for the walls from the OSC Geotechnical Branch. For both cases, see Chapter 1130 for the detailed design process for retaining walls and reinforced slopes and Chapter 1140 for the detailed design process for noise walls. It is important that requests for a geotechnical report be made as early in the design phase as practical. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

For retaining walls and reinforced slopes, the site data to be provided with the request for a geotechnical report are as indicated in Chapter 1130. Also supply right of entry agreements and permits required for the geotechnical investigation. The site data indicated in 510.04(4), as applicable, are provided for noise walls.

The RME or the OSC Geotechnical Branch (see Chapter 1130 or 1140 for specific responsibilities for design), provides the following information as part of the geotechnical report (as applicable):

1. General description of the regional and site geology
2. Summary of the investigation
3. Boring logs
4. Laboratory tests and results
5. Soil/rock unit descriptions
6. Ground water conditions
7. Retaining wall/reinforced slope and noise wall recommendations

- Recommended geometry for stability
- Stability and settlement mitigation requirements, if needed
- Foundation type and capacity
- Estimated amount and rate of settlement
- Design soil parameters
- Construction staging requirements
- Effects of site constraints
- Monitoring needs
- Material and compaction requirements
- Subgrade preparation

The recommendations may also include the background regarding analysis approach and any agreements with the region or other customers regarding the definition of acceptable level of risk. Additional details and design issues to be considered in the geotechnical report are as provided in Chapter 1130 for retaining walls and reinforced slopes and in Chapter 1140 for noise walls. The project designer uses this information for final wall/reinforced slope selection and to complete the PS&E.

For final PS&E preparation, special provisions and plan details (if not received as part of the report provided during project design) are developed with the assistance of the region Materials Section or the OSC Geotechnical Branch. Both the region Materials Section and the OSC Geotechnical Branch can review the contract plans before the PS&E review process begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(11) Unstable Slopes

Unstable slope mitigation includes the stabilization of known landslides and rockfall that occur on slopes adjacent to the WSDOT transportation system, and that have been programmed under the P3 unstable slope program.

(a) Project Definition. The region’s project office provides a description and location of the proposed unstable slope mitigation work to the RME. Location of the proposed work can be mile post limits or stationing. The region’s project designer meets at the project site with the RME and the OSC Geotechnical Branch to conduct a field review, discuss project requirements, and to identify geotechnical issues associated with the unstable slope project. The RME requests that the OSC Geotechnical Branch participate in the field review and project definition reporting.

The level of work in the project definition phase for unstable slopes is conceptual in nature, not final design. The geotechnical investigation generally consists of a field review, a more detailed assessment of the unstable slope, review of the conceptual mitigation developed during the programming phase of the project, and proposed modification (if any) to the original conceptual level unstable slope mitigation. The design phase geotechnical services cost and schedule, including any required permits, are determined at this time. A brief conceptual level report is provided to the project designer that summarizes the results of the project definition investigation.

(b) Project Design. Geotechnical information and field data necessary to complete the unstable slope mitigation design is compiled during this design phase. This work includes, depending on the nature of the unstable slope problem, test borings, rock structure mapping, geotechnical field instrumentation, laboratory testing, and slope stability analysis. The purpose of this design effort is to determine the most appropriate method (s) to stabilize the known unstable slope.

The designer requests a geotechnical report from the OSC Geotechnical Branch through the RME. The site data indicated in 510.04(4), as applicable, is provided along with the following information:

- Plan sheet showing the station and location of the proposed unstable slope mitigation project.
- If requested, Digital Terrain Model (DTM) files necessary to define the on-ground
topography of the project site. The limits of the DTM will have been defined during the project definition phase.

It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. Unstable slope design investigations might require geotechnical monitoring of ground movement and ground water over an extended period of time to develop the required field information for the unstable slope mitigation design. The time required to obtain rights of entry and other permits, as well as the long-term monitoring data, must be considered when establishing schedule requirements for the geotechnical report.

The OSC Geotechnical Branch provides the following information as part of the project geotechnical report (as applicable):

- General site description and summary of site geology.
- Summary of the field investigation.
- Boring logs.
- Laboratory tests and results.
- Geotechnical field instrumentation results.
- Summary of the engineering geology of the site including geologic units encountered.
- Unstable slope design analysis and mitigation recommendations.
- Constructibility issues associated with the unstable slope mitigation.
- Appropriate special provisions for inclusion in the contact plans.

The region’s project design office uses the geotechnical report to finalize the design decisions for the project and the completion of the PS&E design.

(c) PS&E Development. Adequate geotechnical design information to complete the PS&E is typically obtained during the project design phase. Additional geotechnical work might be needed when right of way cannot be acquired, restrictions are included in permits, or other requirements are added that result in changes to the design.

Special provisions, special project elements, and design details (if not received as part of the design phase geotechnical report) are developed with the assistance of the RME and the OSC Geotechnical Branch. The region’s project designer uses this information in conjunction with the design phase geotechnical report to complete the PS&E document. The RME and the OSC Geotechnical Branch can review the contract plans before the PS&E review begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(12) Rockslope Design

(a) Project Definition. The region’s project office provides a description and location of the proposed rock excavation work to the RME. For widening of existing rock cuts, the anticipated width and length of the proposed cut in relationship to the existing cut are provided. For new alignments, the approximate location and depth of the cut are provided. Location of the proposed cut(s) can be mile post limits or stationing. The project designer meets at the project site with the RME and the OSC Geotechnical Branch to conduct a field review, discusses project requirements, and identify any geotechnical issues associated with the proposed rock cuts. The RME requests that the OSC Geotechnical Branch participate in the field review and project definition reporting.

The level of rock slope design work for the project definition phase is conceptual in nature. The geotechnical investigation generally consists of the field review, review of existing records, an assessment of existing rockslope stability, and preliminary geologic structure mapping. The focus of this investigation is to assess the feasibility of the rock cuts for the proposed widening or realignment, not final design. A brief conceptual level report that summarizes the result of the
(b) **Project Design.** Detailed rockslope design is done once the roadway geometrics have been established. The rockslope design cannot be finalized until the roadway geometrics have been finalized. Geotechnical information and field data necessary to complete the rockslope design are compiled during this design phase. This work includes rock structure mapping, test borings, laboratory testing, and slope stability analysis. The purpose of this design effort is to determine the maximum stable cut slope angle, and any additional rockslope stabilization measures that could be required.

The designer requests a geotechnical report from the OSC Geotechnical Branch through the RME. The site data indicated in 510.04(4), as applicable, is provided.

It is important that the request for the geotechnical report be made as early in the design phase as practical. Cost and schedule requirements to generate the report are project specific and can vary widely. The time required to obtain permits and rights of entry must be considered when establishing schedule requirements.

The OSC Geotechnical Branch provides the following information as part of the project geotechnical report (as applicable):

1. General site description and summary of site geology.
2. Summary of the field investigation.
4. Laboratory tests and results.
5. Rock units encountered within the project limits.
6. Rock slope design analysis and recommendations.

- Type of rockslope design analysis conducted and limitation of the analysis. Also included will be any agreements with the region and other customers regarding the definition of acceptable risk
- The slope(s) required for stability
- Additional slope stabilization requirements (rock bolts, rock dowels, and so forth.)
- Rockslope ditch criteria (See Chapter 640)
- Assessment of rippability
- Blasting requirements including limitations on peak ground vibrations and air blast over-pressure, if required
- Usability of the excavated material including estimates of shrink and swell
- Constructibility issues associated with the rock excavation

The project office uses the geotechnical report to finalize the design decisions for the project, and the completion of the PS&E design for the rockslope elements of the project.

(c) **PS&E Development.** Adequate geotechnical design information to complete the PS&E is typically obtained during the project design phase. Additional geotechnical work might be needed when right of way cannot be acquired, restrictions are included in permits, or other requirements are added that result in change to the design.

Special provisions, special blasting requirements, and plans details, if not received as part of the design phase geotechnical report, are developed with the assistance of the RME or the OSC Geotechnical Branch. The project designer uses this information in conjunction with the design phase geotechnical report to complete the PS&E documents. The RME and the OSC Geotechnical Branch review the contract plans before the PS&E review begins, if requested. Otherwise, they will review the contract plans during the normal PS&E review process.

(13) **Bridge Foundations**

(a) **Project Definition.** The OSC Geotechnical Branch supports the project definition process to develop reasonably accurate estimates of bridge substructure costs. For major projects and for projects that are located in areas with little or no existing geotechnical information, a field review
is recommended. The region’s office responsible for project definition coordinates field reviews. Subsurface exploration (drilling) is usually not required at this time, but might be needed if cost estimates cannot be prepared within an acceptable range of certainty.

The Bridge and Structures Office, once they have received the necessary site data from the region’s project office, is responsible for delivering the following project information to the OSC Geotechnical Branch:

- Alternative alignments and/or locations of bridge structures.
- A preliminary estimate of channelization (structure width).
- Known environmental constraints.

The Bridge and Structures and region offices can expect to receive the following from the OSC Geotechnical Branch:

- Summary or copies of existing geotechnical information.
- Identification of geotechnical hazards (slides, liquefiable soils, soft soil deposits, and so forth.).
- Identification of permits that might be required for subsurface exploration (drilling).
- Conceptual foundation types and depths.
- If requested, an estimated cost and time to complete a geotechnical foundation report.

The Bridge Office uses this information to refine preliminary bridge costs. The region’s project office uses the estimated cost and time to complete a geotechnical foundation report to develop the project delivery cost and schedule.

(b) Project Design. The OSC Geotechnical Branch assists the Bridge and Structures Office with preparation of the bridge Preliminary Plan. Geotechnical information gathered for project definition will normally be adequate for this phase, as test holes for the final bridge design cannot be drilled until accurate pier location information is available. For selected major projects, a type, size, and location (TS&L) report might be prepared which usually requires some subsurface exploration to provide a more detailed, though not final, estimate of foundation requirements.

The Bridge Office is responsible for delivering the following project information, based on bridge site data received from the region’s project office, to the OSC Geotechnical Branch:

- Anticipated pier locations
- Approach fill heights
- For TS&L, alternate locations alignments/structure types

The Bridge Office can expect to receive:

- Conceptual foundation types, depths and capacities
- Permissible slopes for bridge approaches
- For TS&L, a summary of site geology and subsurface conditions, and more detailed preliminary foundation design parameters and needs
- If applicable or requested, erosion or scour potential

The Bridge Office uses this information to complete the bridge preliminary plan. The region’s project office confirms right of way needs for approach embankments. For TS&L, the geotechnical information provided is used for cost estimating and preferred alternate selection. The preliminary plans are used by the OSC Geotechnical Branch to develop the site subsurface exploration plan.

(c) PS&E Development. During this phase, or as soon as a 95 percent preliminary plan is available, subsurface exploration (drilling) is performed and a geotechnical foundation report is prepared to provide all necessary geotechnical recommendations needed to complete the bridge PS&E.

The Bridge Office is responsible for delivering the following project information to the OSC Geotechnical Branch:
• 95 percent preliminary plans (concurrent with distribution for region approval)
• Estimated foundation loads and allowable settlement criteria for the structure, when requested

The Bridge Office can expect to receive:
• Bridge geotechnical foundation report

The Bridge and Structures Office uses this information to complete the bridge PS&E. The region’s project office reviews the geotechnical foundation report for construction considerations and recommendations that might affect region items, estimates, staging, construction schedule, or other items.

Upon receipt of the structure PS&E review set, the OSC Geotechnical Branch provides the Bridge and Structures Office with a Summary of Geotechnical Conditions for inclusion in Appendix B of the contract.

(14) Geosynthetics
See Chapter 530 for geosynthetic design guidance.

(15) Washington State Ferries Projects
(a) Project Design. The OSC Geotechnical Branch assists the Washington State Ferries (WSF) division with determining the geotechnical feasibility of all offshore facilities, terminal facility foundations, and bulkhead walls. For upland retaining walls and grading, utility trenches, and pavement design, the RME assists WSF with determining geotechnical feasibility.

In addition to the site data identified in Section 510.04(4), as applicable, the following information is supplied by WSF to the OSC Geotechnical Branch or the RME, as appropriate, with the request for the project geotechnical report:
• A plan showing anticipated structure locations as well as existing structures.
• Relevant historical data for the site.
• A plan showing utility trench locations.
• Anticipated utility trench depths.

WSF can expect to receive:
• Proposed roadway profiles.

WSF uses this information to complete the project design report, design decisions, and estimated project budget and schedule.

WSF is responsible for obtaining any necessary permits or right of entry agreements needed to access structure locations for the purpose of subsurface exploration (for example, test hole drilling). The time required for obtaining permits and rights of entry must be considered when developing project schedules. Possible permits and agreements might include but are not limited to:
• City, county or local agency use permits.
• Sensitive area ordinance permits.

(b) PS&E Development
Subsurface exploration (drilling) is performed and a geotechnical foundation report is prepared to provide all necessary geotechnical recommendations needed to complete the PS&E.

The designer requests a geotechnical report from the OSC geotechnical branch or the RME, as appropriate. The site data indicated in 510.04(4), as applicable, is provided along with the following information:
• A plan showing final structure locations as well as existing structures.
• Proposed structure loadings.
WSF can expect to receive:

- Results of any borings or laboratory tests conducted.
- A description of geotechnical site conditions.
- Final foundation types, depths and capacities.
- Final wall types and geotechnical designs/parameters for each wall.
- Assessment of constructibility issues to be considered in foundation selection and when assembling the PS&E.
- Pile driving information - driving resistance and estimated overdrive.
- Surfacing depths and/or pavement repair and drainage schemes.

WSF uses this information to complete the PS&E.

Upon receipt of the WSF PS&E review set, the OSC Geotechnical Branch provides WSF with a Summary of Geotechnical Conditions for inclusion in Appendix B of the Contract. A Final Geotechnical Project Documentation package is assembled by the OSC Geotechnical Branch and sent to WSF or the Plans Branch, as appropriate, for reproduction and sale to prospective bidders.

510.06 Geotechnical Work by Others

Geotechnical design work conducted for the design of structures or other engineering works by other agencies or private developers within the right of way is subject to the same geotechnical engineering requirements as for engineering works performed by WSDOT. Therefore, the provisions contained within this chapter also apply in principle to such work. All geotechnical work conducted for engineering works within the WSDOT right of way or that otherwise directly impacts WSDOT facilities must be reviewed and approved by the OSC Geotechnical Services Branch or the RME.

510.07 Surfacing Report

Detailed criteria and methods that govern pavement rehabilitation can be found in *WSDOT Pavement Guide for Design, Evaluation and Rehabilitation*, Volume 1, pages 2-22 through 2-26. The RME provides the surfacing report to the region’s project office. This report provides recommended pavement types, surfacing depths, pavement drainage recommendations, and pavement repair recommendations.

510.08 Documentation

(1) Design Documentation

When a project requires investigation of soils or surfacing materials, the results of the investigations are to be preserved in the project file. (See Chapter 330.) This includes all reports, forms, and attachments.

- Materials source report and approvals
- Geotechnical reports
- Surfacing report

(2) Final Geotechnical Project Documentation and Geotechnical Information Included as Part of the Construction Contract

Once a project PS&E is near completion, all of the geotechnical design memorandums and reports are compiled together to form the Final
Geotechnical Project Documentation, to be published for the use of prospective bidders. The detailed process for this is located in the Plans Preparation Manual.

Geotechnical information included as part of the contract generally consists of the final project boring logs, and, as appropriate for the project, a Summary of Geotechnical Conditions. Both of these items are provided by the OSC Geotechnical Services Branch.
Material Source Development Plan

*Figure 510-1*
520 Design of Pavement Structure

520.01 Introduction

Detailed criteria and methods that govern pavement design are in the WSDOT Pavement Guide for Design, Evaluation and Rehabilitation.

520.02 Estimating Tables

Figures 520-1 through 520-5b are to be used when detailed estimates are required. They are for pavement sections, shoulder sections, stockpiles, and asphalt distribution. Prime coats and tack coats are in Figure 520-2a.
### Unit Dry Weight

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Truck Measure</th>
<th>Compacted on Roadway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/yd³</td>
<td>t/ yd³</td>
</tr>
<tr>
<td>Ballast</td>
<td>3100</td>
<td>1.55</td>
</tr>
<tr>
<td>Crushed Surfacing Top Course</td>
<td>2850</td>
<td>1.43</td>
</tr>
<tr>
<td>Crushed Surfacing Base Course</td>
<td>2950</td>
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</tr>
<tr>
<td>Screened Gravel Surfacing</td>
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<td></td>
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<tr>
<td><strong>Gravel Base</strong></td>
<td>3400</td>
<td>1.70</td>
</tr>
<tr>
<td>Shoulder Ballast</td>
<td>2800</td>
<td>1.40</td>
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<tr>
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<td>2900</td>
<td>1.45</td>
</tr>
<tr>
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<td>2600</td>
<td>1.30</td>
</tr>
<tr>
<td>Mineral Aggregate 1 3/4&quot; - 3/4&quot;</td>
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<td>1.30</td>
</tr>
<tr>
<td>Mineral Aggregate 1 1/2&quot; - 3/4&quot;</td>
<td>2550</td>
<td>1.28</td>
</tr>
<tr>
<td>Mineral Aggregate 1&quot; - 3/4&quot;</td>
<td>2500</td>
<td>1.25</td>
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<tr>
<td>Mineral Aggregate 3/4&quot; - 1/2&quot;</td>
<td>2400</td>
<td>1.20</td>
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<td>Mineral Aggregate 1 1/4&quot; - 1/2&quot;</td>
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<td>1.28</td>
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<td>1.25</td>
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<tr>
<td>Mineral Aggregate 5/8&quot; - 1/4&quot;</td>
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<td>1.33</td>
</tr>
<tr>
<td>Mineral Aggregate 1/2&quot; - 1/4&quot; or 4&quot;</td>
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<td>1.30</td>
</tr>
<tr>
<td>Mineral Aggregate 1/4&quot; or 4&quot; - 0</td>
<td>2900</td>
<td>1.45</td>
</tr>
<tr>
<td>Concrete Aggr. No. 2 (1 1/4&quot; - 4&quot;)</td>
<td>3000</td>
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</tr>
<tr>
<td>Concrete Sand (Fine Aggregate)</td>
<td>2900</td>
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</tr>
<tr>
<td>Crushed Cover Stone</td>
<td>2850</td>
<td>1.43</td>
</tr>
</tbody>
</table>

** 3,700 lb/yd³ (1.85 tons/yd³) is recommended as the most suitable factor; however, if the grading approaches the coarseness of ballast, the factor would approach 3,800 lb/yd³ (1.90 tons/yd³), and if the grading contains more than 45% sand, the factor would decrease, approaching 3,400 lb/yd³ (1.70 tons/yd³) 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, corrections should be applied in the following order:

For specific gravity:

\[ \text{Wt.} = \text{tabular wt.} \times \text{specific gravity on surface report} \]

For water content:

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

Required quantities should be increased by 10 percent to allow for waste if they are to be stockpiled.

Attention should be directed 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*
<table>
<thead>
<tr>
<th>Class of Mix</th>
<th>Depth (ft)</th>
<th>Spread per yd²</th>
<th>Tons/Mile per Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>A, B, E, F &amp; G</td>
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<td>137</td>
<td>0.0685</td>
</tr>
<tr>
<td>D</td>
<td>0.04</td>
<td>55</td>
<td>0.0275</td>
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### Prime Coats and Tack Coats

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<th>Application</th>
<th>Type of Asphalt</th>
<th>Application gal² per yd²</th>
<th>Tons per yd²</th>
<th>Tons/Mile Width (ft)</th>
<th>Application lb per yd²</th>
<th>Tons/Mile Width (ft)</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Prime Coat</td>
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<td>0.25</td>
<td>0.001004</td>
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<td>6.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Tack Coat</td>
<td>CSS-1</td>
<td>0.05</td>
<td>0.000208</td>
<td>1.2</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Class D</td>
<td>CSS-1</td>
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<td>0.000417</td>
<td>2.4</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Fog Seal</td>
<td>CSS-1</td>
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<td>0.000167</td>
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<td>1.1</td>
<td>1.2</td>
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<tr>
<td>Total</td>
<td>CSS-1</td>
<td>0.14</td>
<td>0.000584</td>
<td>3.4</td>
<td>3.8</td>
<td>4.1</td>
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### Specific Data

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<th>Width (ft)</th>
<th>Depth of Pavement (ft)</th>
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<td>0.25</td>
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<td>0.30</td>
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<tr>
<td>0.35</td>
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<td>0.40</td>
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<td>723</td>
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<tr>
<td>0.50</td>
<td>804</td>
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<td>0.80</td>
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<td>2410</td>
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<tr>
<td>1.55</td>
<td>2490</td>
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<td>3930</td>
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<tr>
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<td>4010</td>
</tr>
</tbody>
</table>

*Based on 137 lb/ yd² of 0.10 ft compacted depth = 2.05 tons/yd³

1. The specific gravity of the aggregate will affect the weight of aggregate in the completed mix.
2. The percentage of fine mineral in the coarse aggregate will affect the ratio of coarse to fine. If the coarse aggregate produced contains an excessive amount of fines (1/4” to 0), the percentage of coarse aggregate should be increased and the fines decreased accordingly.
3. Quantities shown do not provide for widening, waste from stockpile, or thickened edges.
4. See miscellaneous tables for the average weights of mineral aggregates used in calculation of this data.
5. The column “Type of Asphalt” is shown for the purpose of conversion to proper weights for the asphalt being used and does not imply that the particular grade shown is required for the respective treatment.
6. Quantities shown are retained asphalt.
### Asphalt Distribution (tons/mile)\(^1\)

<table>
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<tr>
<th>Asphalt Grade</th>
<th>@ 60(^\circ) F (ft)</th>
<th>0.05</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
<th>0.35</th>
<th>0.40</th>
<th>0.45</th>
<th>0.50</th>
<th>0.55</th>
<th>0.60</th>
<th>0.65</th>
<th>0.70</th>
<th>0.75</th>
<th>0.80</th>
<th>0.85</th>
<th>0.90</th>
<th>0.95</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000</td>
<td>11</td>
<td>1.35</td>
<td>2.70</td>
<td>4.05</td>
<td>5.40</td>
<td>6.75</td>
<td>8.10</td>
<td>9.45</td>
<td>10.80</td>
<td>12.15</td>
<td>13.50</td>
<td>14.85</td>
<td>16.20</td>
<td>17.55</td>
<td>18.90</td>
<td>20.25</td>
<td>21.60</td>
<td>22.95</td>
<td>24.30</td>
<td>25.65</td>
<td>27.00</td>
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<tr>
<td>3000</td>
<td>12</td>
<td>1.47</td>
<td>2.95</td>
<td>4.42</td>
<td>5.89</td>
<td>7.36</td>
<td>8.84</td>
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<td>11.78</td>
<td>13.26</td>
<td>14.73</td>
<td>16.20</td>
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<td>6.75</td>
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<td>14.85</td>
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<td>18.90</td>
<td>20.25</td>
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<td>22.95</td>
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<td>26.51</td>
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<td>29.46</td>
</tr>
</tbody>
</table>

\(^1\) Quantities of asphalt shown should be applied on the basis of 60\(^\circ\) temperature and recomputed to the application temperature for the particular grade.
### Bituminous Surface Treatment

<table>
<thead>
<tr>
<th>Class of Mk</th>
<th>Type of Application</th>
<th>Average Application</th>
<th>Mineral Aggregate&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Average Spread</th>
<th>Asphalt&lt;sup&gt;2,5,6&lt;/sup&gt;</th>
<th>Basic&lt;sup&gt;4&lt;/sup&gt; Asphalt Used</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lb/yd&lt;sup&gt;2&lt;/sup&gt;</td>
<td>gal/yd&lt;sup&gt;2&lt;/sup&gt;</td>
<td>t/mi</td>
<td>gal/mi</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Prime Coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crushed Screenings 3/4&quot; - 1/2&quot;</td>
<td>35</td>
<td>0.0146</td>
<td>0.48</td>
<td>2787</td>
<td>11.2</td>
</tr>
<tr>
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<td>Tack Coat</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>Crushed Screenings 1/2&quot; - 1/4&quot;</td>
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<tr>
<td>B</td>
<td>Seal Coat</td>
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<tr>
<td></td>
<td>Crushed Screenings 5/8&quot; - 1/4&quot;</td>
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<td>2933</td>
<td>12.2</td>
</tr>
<tr>
<td></td>
<td>Crushed Screenings 1/4&quot; - 0&quot;</td>
<td>5</td>
<td>0.0017</td>
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1. Quantities shown do not provide for widening, waste from stockpile, or thickened edges.
2. Quantities of asphalt shown should be applied on the basis of 60°F temperature and recomputed to the application temperature for the particular grade.
3. See miscellaneous tables for average weights of material aggregates and weights of mineral aggregate in stockpile.
4. The column “Basic Asphalt Used” is shown for the purpose of conversion to proper weights for the asphalt being used and does not imply that the particular grade shown is required for the respective treatment.
5. For cutbacks, decrease asphalt by 25 percent.
6. For stress absorbing membrane (rubberized asphalt), increase asphalt by 25 percent.

---

**Estimating — Bituminous Surface Treatment**

*Figure 520-3*
W_s = Shoulder Width - (Varies 4 ft, 6 ft, 8 ft, 10 ft, 12 ft)
d = Depth of Section - (Varies 0.05 ft to 2 ft)
S = Side Slope (H:V) - (Varies 2:1, 3:1, 4:1, and 6:1)
S_1 = Top Shoulder Slope - (Varies -0.02 ft/ft or -0.05 ft/ft)
S_2 = Bottom Shoulder Slope - (Varies -0.02 ft/ft or -0.05 ft/ft)

**Formula for Shoulder Section**

\[
\text{Tons/mile.} = (A)(K) \quad K = \left(\frac{5280}{27}\right)(1.85 \text{ tons/yd}^2) \\
A = \frac{d + W_s (1/S - S_1)}{2(1 - SS_2)} - \frac{W_s^2}{2} \left(\frac{1}{1/S - S_1}\right)
\]

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<th>S_1 = S_2</th>
<th>Formula</th>
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</thead>
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<td>-0.02 ft/ft</td>
<td>(A = \frac{d + W_s (1/S - 0.02)}{2(1 - 0.02 S)} - \frac{W_s^2}{2} \left(\frac{1}{1/S - 0.02}\right))</td>
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<tr>
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<td>-0.02 ft/ft, S_2 = -0.05 ft/ft</td>
<td>(A = \frac{d + W_s (1/S - 0.02)}{2(1 - 0.005 S)} - \frac{W_s^2}{2} \left(\frac{1}{1/S - 0.02}\right))</td>
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<td>-0.05 ft/ft, S_2 = -0.02 ft/ft</td>
<td>(A = \frac{d + W_s (1/S - 0.05)}{2(1 - 0.02 S)} - \frac{W_s^2}{2} \left(\frac{1}{1/S - 0.05}\right))</td>
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<td>-0.05 ft/ft</td>
<td>(A = \frac{d + W_s (1/S - 0.05)}{2(1 - 0.05 S)} - \frac{W_s^2}{2} \left(\frac{1}{1/S - 0.05}\right))</td>
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Limit: Positive Values of A only when \(d = W_s(0.03)\)

**EXAMPLE: Shoulder Section**

Given - Shoulder Width 8 ft
Top Course 0.25 ft
Base Course 0.80 ft
Total Depth 1.05 ft
Side Slope 3:1
Shoulder Slope -0.05
Subgrade Slope -0.02

Depth 1.05 ft (Case 3) = 3070 tons/mile
Top Course 0.25 ft (Case 4) = 763 tons/mile
Base Course = 2307 tons/mile

Top Course = 763 tons/mile
Base Course = 2307 tons/mile

**Estimating — Base and Surfacing Typical Section**

Formulæ and Example

*Figure 520-4*
## Shoulder Section

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### Estimating — Base and Surfacing Quantities

*Figure 520-5a*
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Estimating — Base and Surfacing Quantities

*Figure 520-5b*
### Shoulder Section

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*Tabulated quantities are based on compacted weight of 1.85 tons/yd³*

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**Estimating — Base and Surfacing Quantities**

*Figure 520-5c*
### Shoulder Section

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*Tabulated quantities are based on compacted weight of 1.85 tons/yd³*

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Estimating — Base and Surfacing Quantities

*Figure 520-5d*
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**Figure 520-5e**

Estimating — Base and Surfacing Quantities
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Estimating — Base and Surfacing Quantities

*Figure 520-5f*
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*Tabulated quantities are based on compacted weight of 1.85 tons/yd³

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*Tabulated quantities are based on compacted weight of 1.85 tons/yd³

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**Estimating — Base and Surfacing Quantities**

*Figure 520-5g*
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*Tabulated quantities are based on compacted weight of 1.85 tons/yd³

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<td>15629</td>
<td>16063</td>
<td>16497</td>
<td>16931</td>
<td>17365</td>
</tr>
</tbody>
</table>

*Tabulated quantities are based on compacted weight of 1.85 tons/yd³

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**Figure 520-5h**

**Estimating — Base and Surfacing Quantities**
530  Geosynthetics

530.01 General

Geosynthetics include a variety of manufactured products that are used in drainage, earthwork, erosion control, and soil reinforcement applications.

Several geosynthetic applications are addressed in the Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications). These applications are as follows:

- Low survivability underground drainage
- Moderate survivability underground drainage
- Separation
- Soil stabilization
- Moderate survivability permanent erosion control
- High survivability permanent erosion control
- Ditch lining
- Temporary silt fence

The Standard Specifications address geosynthetic properties as well as installation requirements and are not site specific. Geosynthetic properties provided in the Standard Specifications are based on the range of soil conditions likely to be encountered in the state of Washington for the applications defined. Other applications, such as prefabricated edge drains, pond liners, and geotextile retaining walls, are currently handled by special provision.

Design responsibilities are discussed in 530.05 below and illustrated in Figures 530-4 and 5.

This chapter does not address applications where geosynthetics are used to help establish vegetation through temporary prevention of erosion (vegetation mats).

530.02 References

Highway Runoff Manual, M 31-15, WSDOT

Hydraulics Manual, M 23-03, WSDOT

Pavement Guide for Design, Evaluation and Rehabilitation, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

530.03 Geosynthetic Types and Characteristics

Geosynthetics include woven and nonwoven geotextiles, geogrids, geonets, geomembranes, and geocomposites. Terms used in the past for these construction materials include fabrics, filter fabric, or filter cloth which are for the most part synonymous with the newer term geotextile.

Photographs of the various types of geosynthetics are provided in Figure 530-6.

Woven geotextiles consist of slit polymer tapes, monofilament fibers, fibrillated yarns, or multifilament yarns simply woven into a mat. Woven geotextiles generally have relatively high strength and stiffness and, except for the monofilament wovens, relatively poor drainage characteristics.

Nonwoven geotextiles consist of a sheet of continuous or staple fibers entangled randomly into a felt in the case of needle-punched nonwovens, and pressed and melted together at the fiber contact points in the case of heat-bonded nonwovens. Nonwoven geotextiles tend to have low to medium strength and stiffness with high elongation at failure, and relatively good drainage characteristics. The high elongation characteristic gives them superior ability to deform around stones and sticks.
Geosynthetics consist of a polymer grid mat constructed either of coated yarns or punched and stretched polymer sheet and usually have high strength and stiffness. They are used primarily for soil reinforcement.

Geonets are similar to geogrids but are typically lighter weight, weaker, and have smaller mesh openings. They are used in light reinforcement applications or are combined with drainage geotextiles to form a drainage structure.

Geomembranes consist of impervious polymer sheets that are typically used to line ponds or landfills, or in some cases are placed over moisture sensitive swelling clays to control moisture.

Geocomposites include prefabricated edge drains, wall drains, and sheet drains, that consist typically of a cusped or dimpled polyethylene drainage core wrapped in a geotextile. The geotextile wrap keeps the core clean so that water can freely flow through the drainage core. The drainage core acts as a conduit. Prefabricated edge drains are used in place of shallow geotextile wrapped trench drains at the edges of the roadway to provide subgrade and base drainage. Wall drains and sheet drains are typically placed between the back of the wall and the soil to drain the soil retained by the wall.

530.04 Geosynthetic Function Definitions and Applications

The function of the geosynthetic varies with the application. See Figure 530-7 for pictorial representations of the various applications. The geosynthetic must be designed with its function(s) in the given application in mind. Typical geosynthetic functions include filtration, drainage, separation, reinforcement, and erosion control. Definitions of these functions and examples of applications where these functions are dominant are as follows:

**Geosynthetic filtration** is defined as the passage of water through the geosynthetic relatively unimpeded (permeability or permittivity) without allowing passage of soil through the geosynthetic (retention). This is the primary function of geotextiles in underground drainage applications.

**Drainage** is defined as the carrying of water in the plane of the geosynthetic as a conduit (transmissivity). This is a primary function of geocomposite drains and in some cases thick nonwoven needle-punched geotextiles placed in underground drainage applications where water must be transported away from a given location by the geosynthetic itself.

**Separation** is defined as the prevention of the mixing of two dissimilar materials. This is a primary function of geotextiles placed between a fine-grained subgrade and a granular base course beneath a roadway.

**Reinforcement** is defined as the strengthening of a soil mass by the inclusion of elements (geosynthetics) that have tensile strength. This is the primary function of high strength geotextiles and geogrids in geosynthetic reinforced wall or slope applications, or in roadways placed over very soft subgrade soils that are inadequate to support the weight of the construction equipment or even the embankment itself.

**Geosynthetic erosion control** is defined as the minimizing of surficial soil particle movement due to the flow of water over the surface of bare soil or due to the disturbance of soil caused by construction activities under or near bodies of water. This is the primary function of geotextiles used as silt fences or placed beneath riprap or other stones on soil slopes. Silt fences keep eroded soil particles on the construction site, whereas geotextiles placed beneath riprap or other stones on soil slopes prevent erosion from taking place at all. In general, the permanent erosion control methods described in this chapter are only used where more natural means (such as the use of biodegradable vegetation mats to establish vegetation to prevent erosion) are not feasible.

These functions control some of the geosynthetic properties, such as apparent opening size (AOS) and permittivity, and in some cases load-strain characteristics.
The application will also affect the geosynthetic installation conditions. These installation conditions influence the remaining geosynthetic properties needed, based on the survivability level required.

**Geosynthetic survivability** is defined as the ability of the geosynthetic to resist installation conditions without significant damage, such that the geosynthetic can function as intended. Survivability affects the strength properties of the geosynthetic required.

### 530.05 Design Approach for Geosynthetics

Four questions must be answered to complete a geosynthetic design:

- Is a geosynthetic really needed?
- What geosynthetic properties will ensure that the geosynthetic functions as intended?
- Where should the geosynthetic be located?
- Will maintenance of the geosynthetic, or the structure of which it is a part, be needed? And, if so, how will it be maintained?

The site conditions and purpose for the geotextile are reviewed to determine whether or not a geotextile is needed.

- For most drainage, separation, soil stabilization, permanent erosion control, and silt fence applications, if a geotextile is needed the geotextile properties in the Standard Specifications can be used.
- In some situations where soil conditions are especially troublesome or in critical or high risk applications, a project specific design may be needed.
- The location of the geosynthetic will depend on how it is intended to function. (See Figure 530-7 for examples.)
- Consider the flow path of any ground water or surface water when locating the geotextile as well as selecting the geotextile to be used. For example, in permanent erosion control applications, water may flow to the geotextile from the existing ground as well as from the surface through wave action, stream flow, or overland sheet flow. For saturated fine sandy or silty subgrades, water must be able to flow from the subgrade through the geotextile soil stabilization layer during the pumping action caused by traffic loads.

Background information and the answers to each of these questions, or at least guidance to obtaining the answers to these questions, are provided for each Standard Specification application as follows:

#### (1) Underground Drainage, Low and Moderate Survivability

Geotextile used for underground drainage must provide filtration to allow water to reach the drain aggregate without allowing the aggregate to be contaminated by finer soil particles.

Geotextile filtration properties are a function of the soil type. For underground drainage applications, if the subgrade soil is relatively clean gravel or coarse sand, a geotextile is probably not required. At issue is whether or not there are enough fines in the surrounding soil to eventually clog the drain rock or drain pipe if unrestricted flow toward the drain is allowed.

To approximately match the geotextile filtration properties to various soil types, specifications for three classes of Construction Geotextile for Underground Drainage are available in the Standard Specifications. For underground drainage applications, use the gradation of the soil, specifically the percent by weight passing the #200 sieve, to select the drainage geotextile class required. Base selection of the appropriate class of geotextile on the following table:

<table>
<thead>
<tr>
<th>Percent Passing the #200 Sieve</th>
<th>Geotextile Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 15%</td>
<td>A</td>
</tr>
<tr>
<td>15% to 50%</td>
<td>B</td>
</tr>
<tr>
<td>Greater than 50%</td>
<td>C</td>
</tr>
</tbody>
</table>

**Selection Criteria for Geotextile Class**

*Figure 530-1*
Obtain soil samples for geotextile underdrain design every 300 ft along the roadway alignment, using hand holes, and at major soil type transitions. This may be spread to every 1,000 ft if the soil conditions appear to be uniform. Use existing soil data where feasible instead of taking new soil samples.

If soil conditions vary widely along the alignment where underground drainage geotextile is anticipated, different classes of drainage geotextile may be required for specific sections of a continuous system.

Strength properties for the underground drainage geotextile depend on the survivability level required to resist installation stresses.

Low survivability designates that the installation stresses placed on the geotextile will be relatively low, requiring only moderate geotextile strength to resist potentially damaging installation conditions. Examples of low survivability level underground drainage applications include:

- Trench drains
- Drains placed behind walls or other structures to drain the backfill
- A geotextile filter sheet placed behind a gabion wall to prevent fines from being washed through the gabion wall face. Trench depths, or the height of the geotextile filter sheet behind gabion walls, must be less than or equal to 6 ft for the low survivability level.

In moderate survivability applications, significant installation stresses may occur, requiring higher geotextile strength. Examples of the moderate survivability application include:

- Trench drains with a depth of greater than 6 ft
- A geotextile filter sheet behind a gabion wall with a height greater than 6 ft
- Any area drain

An area drain is defined as a geotextile placed over or under a horizontal to moderately sloping (1.5H:1V or flatter slope) layer of drainage aggregate. Examples of area drains include:

- Drainage layers over cut-and-cover tunnels
- Rock buttress drainage
- Permeable base beneath highway pavement (see the Pavement Guide for Design, Evaluation and Rehabilitation for additional information on permeable bases)
- A parking lot drainage layer

Note that pipe wrapping (the geotextile is wrapped around the surface of the pipe) is not included as an underground drainage application.

Locate the geotextile such that it will function as intended. For example, if the objective is to keep the drainage aggregate surrounding a drain pipe clean, locate the geotextile such that it completely separates the drainage aggregate from more silty surrounding soils, which may include native soils as well as relatively silty roadway base or fill materials.

Consider the flow path of any ground water or surface water when locating the geotextile.

The flow path from the geotextile, as part of the ground water drainage, is typically directed to a surface water conveyance system. Design of surface water conveyance is guided by the Hydraulics Manual. The surface water conveyance must be low enough to prevent backflow and charging of the ground water drainage; typically by matching inverts of ground water drainage to crowns of surface water conveyance pipes. A 1 ft allowance is usually applied when connecting to open water or ditches.

(2) Separation

Geotextile used for separation must prevent penetration of relatively fine grained subgrade soil into the ballast or other roadway or parking lot surfacing material to prevent contamination of the surfacing material (the separation function). This application may also apply to situations other than beneath roadway or parking lot surfacing where it is not necessary for water to drain through the geotextile unimpeded (filtration), but where separation of two dissimilar materials is required.
Separation geotextile should only be used in roadway applications where the subgrade is workable such that it can be prepared and compacted as required in Section 2-06.3 of the Standard Specifications, but without removal and replacement of the subgrade soil with granular material. Such removal and replacement defeats the purpose of the geotextile separator.

Separation geotextile placed beneath roadway surfacing is feasible if the subgrade resilient modulus is greater than 5,800 psi and if a saturated fine sandy, silty, or clayey subgrade is not likely to be present. Note that the feasibility of separation geotextile may be dependent on the time of year and weather conditions expected when the geotextile is to be installed.

For separation applications, a geotextile is not needed if the subgrade is dense and granular (silty sands and gravels), but is not saturated fine sands. In general, a separation geotextile is not needed if the subgrade resilient modulus is greater than 15,000 psi.

(3) Soil Stabilization
Geotextile used for soil stabilization must function as a separator, a filtration layer, and to a minor extent as a reinforcement layer. This application is similar to the separation application, except that the subgrade is anticipated to be softer and wetter than in the separation application.

Soil stabilization geotextile is used in roadway applications if the subgrade is too soft and wet to be prepared and compacted as required in Section 2-06.3 of the Standard Specifications. Soil stabilization geotextile is placed directly on the soft subgrade material, even if some overexcavation of the subgrade is performed. Backfill to replace the overexcavated subgrade is not placed below the geotextile soil stabilization layer, as this would defeat the purpose of the geotextile.

The need for soil stabilization geotextile should be anticipated if the subgrade resilient modulus is less than or equal to 5,800 psi, or if a saturated fine sandy, silty, or clayey subgrade is likely to be present.

Consider the flow path of any ground water or surface water when locating the soil stabilization geotextile and when selecting the geotextile to be used. For saturated fine sandy or silty subgrades, water must be able to flow from the subgrade through the geotextile soil stabilization layer during the pumping action caused by traffic loads.

Even if the subgrade is not anticipated to be saturated based on available data, if the subgrade is silty or clayey and it is anticipated that the geotextile will be installed during prolonged wet weather, a soil stabilization geotextile may still be needed.

Soil stabilization geotextile should not be used for roadway fills greater than 5 ft in height or if extremely soft and wet silt, clay, or peat is anticipated at the subgrade level. (Such deposits may be encountered in wetlands, for example.) In such cases the reinforcement function becomes more dominant, requiring that a site-specific design be performed.

(4) Permanent Erosion Control, Moderate and High Survivability
The primary function of geotextile used for permanent erosion control is to protect the soil beneath it from erosion due to water flowing over the protected soil.

The need for a permanent erosion control geotextile depends on the type and magnitude of water flow over the soil being considered for protection, the soil type in terms of its erodability, and the type and amount of vegetative cover present. (See the Highway Runoff Manual.)

The source of flowing water could be streams, man-made channels, wave action, or runoff. Water may also flow from the soil behind the geotextile depending on the ground water level.

If ground water cannot escape through the geotextile, an erosion control system failure termed ballooning (resulting from water pressure buildup behind the geotextile) or soil piping could occur. Therefore, the geotextile must have good filtration characteristics.
Three classes of permanent erosion control geotextile are available to approximately match geotextile filtration characteristics to the soil. In order to select the drainage geotextile class, determine the gradation of the soil, specifically the percent by weight passing the #200 sieve. Base selection of the appropriate class of geotextile using Figure 530-1.

A minimal amount of soil sampling and testing is needed to determine the geotextile class required. Permanent erosion control geotextile generally does not extend along the roadway alignment for significant distances as does underground drainage geotextile. One soil sample per permanent erosion control location is sufficient. If multiple erosion control locations are anticipated along a roadway alignment, soil sampling requirements for underground drainage can be applied.

If soil conditions vary widely along the alignment where permanent erosion control geotextile is anticipated, different classes of erosion control geotextile may be required for specific sections of a continuous system.

Examples of the permanent erosion control application are the placement of geotextile beneath riprap or gabions along drainage channels, shorelines, waterways, around bridge piers, and under slope protection for highway cut or fill slopes.

If a moderate survivability geotextile is to be used, the geotextile must be protected by a 12 in aggregate cushion and be placed on slopes of 2H:1V or flatter to keep installation stresses to a relatively low level. Large stones can cause significant damage to a moderate survivability geotextile if the geotextile is not protected in this manner. If these conditions are not met, then a high survivability erosion control geotextile must be used.

(5) Ditch Lining

The primary function of the geotextile in a ditch lining application is to protect the soil beneath it from erosion.

This ditch lining application is limited to man-made ditches less than 16 ft wide at the top with side slopes of 2H:1V or flatter. (If the ditch does not meet these requirements, then permanent erosion control, moderate or high survivability geotextile must be used.) It is assumed that only quarry spall sized stones or smaller will be placed on the geotextile so only a moderate survivability geotextile will be required.

Filtration is not a significant function in this application. Since the ditch is relatively shallow, it is expected that the main water source will be the water carried by the ditch, and little water will pass through the geotextile.

Another application with a similar geotextile function is the placement of geotextile below culvert outlets to prevent erosion at the outlet.

(6) Temporary Silt Fence

The primary function of geotextile used in a temporary silt fence is to prevent eroded material from being transported away from the construction site by runoff water. The silt fence acts primarily as a temporary dam and secondarily as a filter.

In some cases, depending on the topography, the silt fence may also function as a barrier to direct flow to low areas at the bottom of swales where the water can be collected and temporarily ponded. It is desirable to avoid the barrier function as much as possible, as silt fences are best suited to intercepting sheet flow rather than concentrated flows as would occur in swales or intermittent drainage channels.

To function as intended, the silt fence should have a low enough permeability to allow the water to be temporarily retained behind the fence allowing suspended soil particles in the water to settle to the ground. If the retention time is too long, or if the flow rate of water is too high, the silt fence could be overtopped thus allowing silt laden water to escape. Therefore, a minimal amount of water must be able to flow through the fence at all times.

Temporary water ponding is considered the primary method of silt removal and the filtration capabilities of the fence are the second line of defense. However, removal of silt sized particles from the water directly by the geotextile creates severe filtration conditions for the geotextile, forcing the geotextile to either blind or allow the fines to pipe through the geotextile. (Blinding is
the coating of the geotextile surface with soil particles such that the openings are effectively plugged.) If the geotextile openings (AOS) are designed to be small enough to capture most of the suspended soil particles, the geotextile will likely blind, reducing the permeability enough to allow water to overtop the fence. Therefore, it is best to allow some geotextile openings that are large enough to allow the silt sized particles to easily pass through. Even if some silt particles pass through the fence, the water flow rate below the fence will be decreased and the volume of silt laden water passing through the geotextile is likely to be relatively small and the water is partially filtered.

The geotextile apparent opening size (AOS) and permittivity are typically used to specify the filtration performance of geotextiles. The geotextile function in silt fence applications is more complex than this and AOS and permittivity do not relate directly to how well a silt fence will perform. However, nominal values of AOS and permittivity can be specified such that the types of geotextile products known to perform satisfactorily in this application are selected. Such values are provided in the Standard Specifications.

The source of load on the geotextile is from silt buildup at the fence and water ponding. The amount of strength required to resist this load depends on whether or not the geotextile is supported with a wire or polymer grid mesh between the fence posts. Obviously, unsupported geotextile must have greater strength than supported geotextile. If the strength of the geotextile or its support system is inadequate, the silt fence could fail. Furthermore, unsupported geotextile must have enough stiffness such that it does not deform excessively and allow silt laden water to go over the top of the fence.

The need for a silt fence can be anticipated where construction activities will disturb and expose soil that could erode. The ground surface is considered disturbed if vegetative cover is at least partially removed over a significant area by construction activities. Consider whether or not silt laden runoff water from the disturbed area can reach an environmentally sensitive area or a man-made storm water system. If the exposed soil is a clean sand or gravel or if a significant zone of heavy vegetative cover separates the exposed soil from the environmentally sensitive area, a silt fence may not even be needed. Obtain assistance from the Olympia Service Center (OSC) Hydraulics Section for help in determining whether or not a silt fence is needed in such situations.

The feasibility of a geotextile silt fence depends on the magnitude of water flow to the fence, the steepness of the slope behind the fence and whether or not flow is concentrated at the fence. If the silt fence is not feasible, alternative erosion control methods may be required. (See the Highway Runoff Manual.)

Consider all feasible erosion control options in terms of potential effectiveness and economy before making the final decision to use a silt fence. Select the best option for the site conditions, including site geometry and contours, soil type, and rainfall potential. Consider silt fences for temporary erosion control in disturbed areas in the following circumstances:

- Fully covering disturbed areas temporarily with polyethylene sheeting or other temporary covering is not feasible or practical.
- Permanent ground cover for disturbed areas is not yet established.
- Runoff water reaches the silt fence primarily as sheet flow rather than as concentrated flows, with the exception of some ditch and swale applications.
- Slopes above the silt fence are not steeper than 1.5H:1V.
- The sheet flow length (length of slope contributing runoff water to the silt fence) is not too long.

Maximum sheet flow lengths allowed for silt fences are provided in the following table which is based on the typical 2-year 24-hour design storm for Washington resulting in a 24-hour rainfall of 3 in.
The sheet flow length represents the area contributing runoff water from precipitation. The sheet flow length is defined in Figure 530-8. The sheet flow lengths provided in Figure 530-2 were determined assuming a bare soil condition, with the soil classified as a silt. These are worst case assumptions because less runoff would be expected for sand or gravel soils or if some vegetation is present.

The sheet flow length is usually equal to or greater than the disturbed soil slope length. However, undisturbed sloping ground above the disturbed slope area may also contribute runoff to the silt fence area. The length of undisturbed sloping ground above the disturbed slope to included in the total contributing slope length depends on the amount and type of vegetation present, the slope steepness, and the degree of development above the slope.

If unsure whether the proposed silt fence meets the requirements in Figure 530-2, contact the OSC Hydraulics Section for assistance.

### Maximum Sheet Flow Lengths for Silt Fences

*Figure 530-2*

<table>
<thead>
<tr>
<th>Slope</th>
<th>Sheet Flow Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5H:1V</td>
<td>100 ft</td>
</tr>
<tr>
<td>2H:1V</td>
<td>115 ft</td>
</tr>
<tr>
<td>4H:1V</td>
<td>150 ft</td>
</tr>
<tr>
<td>6H:1V</td>
<td>200 ft</td>
</tr>
</tbody>
</table>

### Maximum Contributing Area for Ditch and Swale Applications

*Figure 530-3*

<table>
<thead>
<tr>
<th>Average or Ditch Swale Grade</th>
<th>Ditch or Swale Storage Length</th>
<th>Allowable Contributing Area per Foot of Ditch or Swale Storage Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>16%</td>
<td>13 ft</td>
<td>200 ft²</td>
</tr>
<tr>
<td>10%</td>
<td>20 ft</td>
<td>250 ft²</td>
</tr>
<tr>
<td>5%</td>
<td>40 ft</td>
<td>300 ft²</td>
</tr>
<tr>
<td>4%</td>
<td>50 ft</td>
<td>400 ft²</td>
</tr>
<tr>
<td>3%</td>
<td>65 ft</td>
<td>500 ft²</td>
</tr>
<tr>
<td>2%</td>
<td>100 ft</td>
<td>600 ft²</td>
</tr>
<tr>
<td>1%</td>
<td>200 ft</td>
<td>1,000 ft²</td>
</tr>
</tbody>
</table>

Temporary silt fences may also be used in ditch or swale applications. If the area contributing runoff to the fence exceeds the value determined from Figure 530-3, hydraulic overload will occur. The ditch or swale storage length and width are defined in Figure 530-9. The assumptions used in the development of Figure 530-3 are the same as those used for Figure 530-2 in terms of the design storm and ground conditions.

As an example, if a site has a 13-ft wide ditch with an average slope of 2%, the fence can be located such that 7,800 ft² of area drain to it. If it appears that the area draining to the fence will be larger than the allowable, it may be possible to divide the contributing area into smaller areas and add a silt fence for each smaller area as shown in Figure 530-10.

The minimum storage length for the ditch behind each silt fence must be maintained. If this is not possible, it may be necessary to use an alternate erosion control structure as described in the Highway Runoff Manual or to develop a special silt fence design.
Figure 530-3 was developed with the assumption that water will be able to pond to a depth of at least 2 ft behind the fence. If this is not the case (the ditch or swale depth is less than 2 ft), the table cannot be used. Furthermore, the ditch depth must be greater than the height of the silt fence at its lowest point within the ditch. Otherwise, there will not be enough storage available behind the fence and water will circumvent the fence by flowing around it.

Locate silt fences on contour as much as possible. At the ends of the fence turn it up hill such that it captures the runoff water and prevents water from flowing around the end of the fence. This is illustrated in Figure 530-11.

Silt fences are designed to capture up to a 2 ft depth of water behind the fence. Therefore, the ground line at the ends of the fence must be at least 2 ft above the ground line at the lowest part of the fence. This 2 ft requirement applies to ditches as well as to general slope erosion control.

If the fence must cross contours (except for the ends of the fence) use gravel check dams placed perpendicular to the back of the fence to minimize concentrated flow and erosion along the back of the fence. (See Figure 530-12.)

- The gravel check dams are approximately 1 ft high at the back of the fence and be continued perpendicular to the fence at the same elevation until the top of the dam intercepts the ground surface behind the fence.
- Locate the gravel check dams every 10 ft along the fence.
- In general, the slope of the fence line is not be steeper than 3H:1V.
- For the gravel check dams, use Crushed Surfacing Base Course Section 9-03.9(3)), Gravel Backfill for Walls Section 9-03.12(2), or Shoulder Ballast Section 9-03.9(2)).

If the silt fence application is considered critical (such as when the fence is placed immediately adjacent to environmentally sensitive areas such as streams, lakes, or wetlands) place a second silt fence below the first silt fence to capture any silt that passes through the first fence and/or place straw bails behind the silt fence. Locate silt fences at least 7 ft from an environmentally sensitive area. Where this is impossible, and a silt fence must be used, a special design may be necessary.

Temporary silt fences are sometimes used to completely encircle underground drainage inlets or other similar features to prevent silt from entering the drainage system. This is acceptable, but the silt fence functions primarily as a barrier, and not as a ponding or filtering mechanism, unless the drainage inlet is in a depression that is large enough to allow water to pond behind the silt fence.

- If the drainage inlet and silt fence are not in a large enough depression, silt laden water will simply be directed around the fence and must be captured by another fence or sedimentation pond downslope.
- If the depression is deep, locate the silt fence no more than 2 ft below the top of the depression to prevent overtopping. A site-specific design may be needed if the silt fence is located deeper than 2 ft within the depression.

It may be necessary to relocate silt fences during the course of a construction project as cuts and fills are built or as disturbed areas change. An erosion control/silt fence plan that accounts for the anticipated construction stages (and eventual removal) should be developed. Do not assume that one silt fence location can routinely be used for the entire life of the contract. Periodically check the locations in the field during the construction project and field-adjust the silt fence locations as necessary to ensure that the silt fence functions as intended.

(7) Standard Specification Geotextile Application Identification in the Plans

Identify the geotextile in the contract plan detail in a way that ties it to the appropriate Standard Specification application. For example:

- If a geotextile is to be used to line an underground trench drain 3 ft in depth and the native soil has less than 15% passing the #200 sieve, identify the geotextile on the...
plan sheet as “Construction Geotextile for Underground Drainage, Low Survivability, Class A.”

- If the geotextile is to be placed beneath riprap on a slope without a cushion layer between the geotextile and the riprap and the native soil contains 35% passing the #200 sieve, identify the geotextile on the plan sheet as “Construction Geotextile for Permanent Erosion Control, High Survivability, Class B.”

- If the geotextile is to be placed between the roadway base course and a moist silt subgrade with a resilient modulus of 6,500 psi, and the roadway is planned to be constructed during the dry summer and early fall months, identify the geotextile on the plan sheet as “Construction Geotextile for Separation.”

(8) Site-Specific Designs (All Applications)

A site-specific design is required:

- For all reinforcement applications
- For applications not covered by the Standard Specifications

Consider a site-specific design:

- For high risk applications
- For exceptionally large geotextile projects: if the geotextile quantity in a single application is over 35,000 yd², or over 85,000 yd² for the separation application
- For severe or unusual soil or ground water conditions
- If the soil in the vicinity of the proposed geotextile location consists of alternate thin layers of silt or clay with potentially water-bearing sand layers on the order of 1 to 3 in in thickness or less
- If the soil is known through past experience to be problematic for geosynthetic drains
- For drains in native soil behind structures except drains contained within granular backfill
- For drains designed to stabilize unstable slopes
- For drains designed to mitigate frost heave

In such cases, obtain assistance from the OSC Materials Laboratory Geotechnical Branch. To initiate the special design provide a plan and cross-section showing:

- The geosynthetic structure to be designed
- Its relative location to other adjacent structures that it could potentially affect
- Its intended purpose
- Any soil data in the vicinity

Consider a site-specific design for temporary silt fences:

- If silt fence must be used in intermittent streams or where a significant portion of the silt fence functions as a barrier that directs flow to the lower portions of the silt fence
- If the fence must be located on steep slopes
- In situations not meeting the requirements in Figures 530-2 and 3
- If the 2 year, 24 hour design storm for the site is greater than the 3 in assumed for the development of Figures 530-2 and 3
- Where concentrated flow is anticipated
- If closer than 7 ft from an environmentally sensitive area
- If more than 2 ft depth of storage is needed

For a site-specific temporary silt fence design, obtain assistance from the OSC Hydraulics Section. To initiate the design, send the following information to the OSC Hydraulics Section and a copy to the OSC Materials Laboratory Geotechnical Branch:

- Plan sheets showing proposed silt fence locations and grading contours
- Estimate of the area contributing runoff to each silt fence, including percentage and general type of vegetative cover within the contributing area
- Any available site soil information
For all site-specific designs of applications not covered by the Standard Specifications, complete plans and special provisions are needed. In general, for site-specific designs of Standard Specification applications, only a minor modification of the appropriate geotextile property table will be needed.

### 530.06 Design Responsibility

The design responsibility and process for geotextile design are illustrated in Figures 530-4 and 5. The Regional Project Development Office, in particular the Regional Project Manager, is responsible to initiate and develop all Standard Specification geotextile designs, except for roadway separation and soil stabilization applications, which are initiated and developed by the Regional Materials Laboratory.

The Regional Materials Laboratory assists the Regional Project Manager with Standard Specifications underground drainage and permanent erosion control designs.

The Regional Environmental Design Section assists with Standard Specifications permanent erosion control and temporary silt fence designs.

Once the Regional Project Manager or Materials Laboratory has determined that a geotextile is appropriate, development of a Standard Specification geotextile design includes the development of plan details showing the plan location and cross-section of the geotextile installation. Standard details for geotextiles as provided in the Plans Preparation Manual may be used or modified to adapt to the specific project situation. Note that only minimum dimensions for drains are provided in these standard details.

Site-specific geosynthetic designs and applications not addressed by the Standard Specifications are designed by the region with the assistance of the OSC Materials Laboratory Geotechnical Branch or the OSC Hydraulic Section as described in 530.05.

Design assistance by the Geotechnical Branch or Hydraulics Section for site-specific design of Standard Specifications applications includes determination of geosynthetic properties and other advice as needed to complete the geosynthetic plans and any special provisions required.

The Geotechnical Branch is fully responsible to develop and complete the geosynthetic design, plan details that can be used to develop the contract plan sheets, and special provisions for geosynthetic reinforced walls, slopes, and embankments; deep trench drains for landslide stabilization; and other applications that are an integral part of an OSC geotechnical design. The Regional Project Manager incorporates the plan details and special provisions into the PS&E.

### 530.07 Documentation

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

- Soil information
- Erosion control/silt fence plan

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Design Manual
April 1998
English Version
Geosynthetics
Page 530-11
Design Process for Drainage and Erosion Control
Geotextiles and Nonstandard Applications

*Figure 530-4*

Regional Project Manager (RPM) defines application

- Underground drainage
- Permanent erosion control or ditch lining
- Other applications not fully defined in Standard Specifications

RPM Makes preliminary assessment of need for geotextile

- Needed
  - RPM assesses need for geotextile — See *Highway Runoff Manual*
  - OSCGB provides design input, including special provisions and plan details as needed, to RPM with cc to RML
  - RPM completes design and develops PS&E

- Not needed
  - End
  - RPM assesses installation conditions anticipated and selects survivability level
  - RPM selects/modifies appropriate plan detail from standard plans and includes in PS&E

RML assesses site conditions and obtains soil samples

- Is site-specific design required?
  - Yes
    - Samples/site data submitted to OSCGB for testing and design input
    - OSCGB completes design and sends it to RPM with cc to RML
  - No, use Standard Specs.
    - RML tests soil samples, selects geotextile class, and returns design information to RPM
    - RPM assesses installation conditions anticipated and selects survivability level

RPM = Regional Project Manager
RML = Regional Materials Laboratory
OSCGB = OSC Geotechnical Branch
Regional Project Manager (RPM) defines application

Separation/soil stabilization

RML assesses site conditions, obtains soil samples as needed, assesses need for geotextile, and determines if Standard Specifications apply

Geotextile needed

Not needed

Is site-specific design required?

Yes

No, use Standard Specs.

OSCGB assists with geotextile property selection

RML includes geotextile design requirements in geotechnical or resurfacing report

RPM assesses need for geotextile silt fence — See Highway Runoff Manual for additional information (This is generally addressed as part of permitting process)

Temporary silt fence (sediment control)

Silt fence needed

Not needed

RMP assesses if Standard Specification design applies

No, do site specific design

Yes, use Stand. Specs.

Apply other erosion control measures as required

RPM submits site data to OSC Hydraulics Section Who completes silt fence design and submits design to RMP

RPM selects/modified appropriate details from standard plans and completes silt fence plans

RPM completes standard silt fence design

Design Process for Separation, Soil Stabilization, and Silt Fence

Figure 530-5

RPM = Regional Project Manager
RML = Regional Materials Laboratory
OSCGB = OSC Geotechnical Branch
Examples of Various Geosynthetics

Figure 530-6a

Slit Film Woven Geotextile

Monofilament Woven Geotextile

Multifilament Woven Geotextile
Examples of Various Geosynthetics

Figure 530-6b

Needle Punched Nonwoven Geotextile

Heat Bonded Nonwoven Geotextile

Geocomposite Drains (Geotextile With Core)

Extruded and Woven Geogrids
Geotextile Application Examples

Figure 530-7a

a. Underground drainage, low survivability (roadway trench drain)

b. Underground drainage, moderate survivability (area drain beneath buttress)

c. Underground drainage, moderate survivability (geotextile sheet drain)

d. Underground drainage, moderate survivability (area drain beneath parking lot or roadway)

e. Underground drainage, low survivability (wrapped drain behind foundation)

f. Underground drainage, moderate survivability (deep trench drain for slope stabilization)
g. Separation or soil stabilization for new roadway (depends on subgrade condition)

h. Separation or soil stabilization for widened roadway (depends on subgrade condition)

i. Permanent erosion control, moderate survivability

j. Permanent erosion control, high survivability

Geotextile Application Examples
Figure 530-7b
k. Ditch lining

l. Silt fence not immediately adjacent to environmentally sensitive area

m. Silt fence immediately adjacent to environmentally sensitive area

**Geotextile Application Examples**

*Figure 530-7c*
n. Prefabricated edge drain for roadway

o. Prefabricated drain strip behind wall face

p. Geosynthetic wall

q. Geosynthetic reinforced slope

r. Geosynthetic reinforced embankment

s. Geosynthetic subgrade reinforcement for temporary roads
Definition of Slope Length

Figure 530-8

*May need to be included as part of slope length depending on vegetative cover, slope steepness, and degree of development above slope.
Definition of Ditch or Swale Storage Length and Width

(a) Storage Length

(b) Storage Width
Method to keep contributing area to ditch or swale within allowable limits if contributing area too large based on Figure 530-3.

Silt Fences for Large Contributing Area

Figure 530-10
Silt fence plan and profile illustrating how to insure silt fence will capture runoff water and not allow water to run around ends of fence.

Silt Fence End Treatment

Figure 530-11
Gravel Check Dams for Silt Fences

Figure 530-12

(a) Profile

(b) Cross-Section A-A
610
Highway Capacity

610.01 General
610.02 Definitions and Symbols
610.03 Design

610.01 GENERAL
The term “capacity" is used to express the maximum number of vehicles that have a reasonable expectation of passing over a section of a lane or a roadway during a given time period under prevailing roadway and traffic conditions. Highway capacity is of vital concern in the design of highways. A knowledge of highway capacity is essential to the proper fitting of a planned highway to the requirements of traffic. It helps both in the selection of highway type and in determining dimensional needs such as number of lanes.

The purpose of this section is to provide the user with enough information to perform a preliminary capacity analysis for basic highway sections. This chapter also gives a basis for determining the need for more detailed capacity analysis.

This Design Manual chapter does not cover preliminary capacity analysis for highway portions with signal spacing of less than 2 miles and those within 2,500 feet of interchange ramps.

610.02 DEFINITIONS AND SYMBOLS
(1) Definitions
Average Daily Traffic (ADT). The volume of traffic passing a point or segment of a highway, in both directions, during a period of time, divided by the number of days in the period and factored to represent an estimate of traffic volume for an average day of the year.

Directional Design Hour Volume (DDHV). The traffic volume for the peak hour in the peak direction of flow; usually a forecast of the relevant peak hour volume. (Units of DDHV are vehicles per hour. DDHV should be rounded to the nearest 50 vph.)

Freeway. A divided highway facility that has a minimum of two lanes for the exclusive use of traffic in each direction and full control of access.

Level of Service (LOS). A qualitative measure describing the operational conditions within a traffic stream, generally described in terms of such factors as speed, travel time, freedom to maneuver, comfort and convenience, safety, and others. See Figure 610-1 for appropriate design levels of service for different highway types.

Multilane Highway. A highway with at least two lanes for the exclusive use of traffic in each direction, with or without partial control of access, that may have periodic interruptions to flow at signalized intersections.

Peak Hour Factor (PHF). The ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour. It is the measure of peaking characteristics of a highway section or intersection.

Service Flow Rate (SFR). The maximum hourly rate of flow that can be accommodated past a point or short uniform segment of traffic lane (for multilane) or the entire roadway (for a two-lane facility), under prevailing traffic, roadway, and control conditions while maintaining a stated level of service; value is specific to a given level of service.

Terrain.
(a) Level Terrain. Any combination of grades and horizontal and vertical alignment permitting heavy vehicles to maintain approximately the same speed as passenger cars; this generally includes short grades of no more than 1 to 2 percent.

(b) Rolling Terrain. Any combination of grades and horizontal or vertical alignment causing heavy vehicles to reduce their speeds substantially below those of passenger cars, but not causing heavy vehicles to operate at crawl speeds for any significant length of time.

(c) Mountainous Terrain. Any combination of grades and horizontal and vertical alignment causing heavy vehicles to operate at crawl speeds for significant distances or at frequent intervals.

Heavy vehicle is defined as any vehicle having more than four tires touching the pavement. Crawl speed is the maximum sustained speed which heavy vehicles can maintain on an extended upgrade of a given percent.

(2) Symbols
K The percentage of ADT occurring in the peak hour.
D The percentage of peak hour traffic in the heaviest direction of flow.
KD The product of K and D.
fₑ Adjustment factor to account for the effect of the highway’s access and egress points (intersections, driveways, ramps) and whether or not it is a divided highway. (See Figure 610-2.)
610.03 DESIGN

(1) Design Responsibility

District Location Project Engineer's office initiates the process of highway capacity determination and performs the capacity analysis for the highway segment under consideration. If the capacity analysis goes beyond the scope of this chapter, the district Traffic Design Office or the Travel Data Office of the headquarters Planning, Research and Public Transportation Division should be requested to do the analysis. This request should be made as soon as possible to ensure that the capacity analysis is completed during the design report stage.

(2) Two-Lane Rural Highway

The objective of capacity analysis for two-lane rural highways is to determine the design level of service for a given segment for future sets of conditions.

- Determine the appropriate design level of service from Figure 610-1.
- Select the appropriate maximum allowable ADT directly from Figure 610-3 for the highway's level of service, K factor (percent of ADT occurring in peak traffic) and terrain type. No computations are needed at this stage.
- Compare the maximum allowable ADT to the expected ADT at design year. If the maximum allowable ADT is less than the design year ADT, a more detailed capacity analysis is warranted.

(3) Multi-Lane Highway

- Determine the DDHV, given the anticipated ADT during the design year, by the formula:
  \[ DDHV = ADT \times KD \]
  where
  \[ KD = \begin{array}{ll}
  0.11 & \text{for rural} \\
  0.08 & \text{for suburban} \\
  0.05 & \text{for urban}
  \end{array} \]

  Use these general values when specific values for the particular corridor are unavailable. Generally, multi-lane highways with less than ten uncontrolled access points (driveways, intersections, ramps) per mile (on one side) are considered to be "rural" while those with more than ten uncontrolled access points per mile are considered to be suburban.

- Select an appropriate value of the service flow rate per lane (SFL) from Figure 610-4 for the highway's level of service (from Figure 610-1), environment type (urban, suburban, or rural) and terrain type.

- Determine the required number of lanes in each direction, N, from the formula:
  \[ N = \frac{DDHV}{(SFL \times PHF)} \]
  where \( f_E \) is found in Figure 610-2 and PHF in Figure 610-5. Round the value, "N", to the nearest whole number.

- Compare 2N to the number of lanes proposed. The proposed number of lanes should be greater than or equal to 2N. Otherwise, a more detailed capacity analysis is warranted.

(4) Basic Freeway Sections

- Determine the DDHV, given the anticipated ADT during the design year, by the formula:
  \[ DDHV = ADT \times KD \]
  where
  \[ KD = \begin{array}{ll}
  0.11 & \text{for rural freeways} \\
  0.07 & \text{for suburban freeways} \\
  0.05 & \text{for urban freeways}
  \end{array} \]

  Use these values when specific values for the particular corridor are unavailable.

- Select an appropriate value of the service flow rate per lane, SFL, from Figure 610-6 for the prevailing truck percentage and terrain and for the required LOS (from Figure 610-1).

- Determine the required number of lanes in one direction, N, from the formula:
  \[ N = \frac{DDHV}{(SFL \times PHF)} \]
  where PHF can be obtained from Figure 610-5. Round the value, "N", to the nearest whole number.

- Compare 2N to the number of lanes proposed. The proposed number of lanes should be greater than or equal to 2N. Otherwise, a more detailed capacity analysis is warranted.

(5) Miscellaneous Highway Sections

For the capacity analysis of intersections, highways with signal spacing of 2 miles or less, highways within 2,500 feet of interchange ramps, ramps, weaving sections, transit systems, and bicycle and pedestrian trails, refer to the Highway Capacity Manual (Special Report No. 209, Washington, D.C.: Highway Research Board, 1985). Refer to Chapter 910 for channelization guidelines. The district Traffic Design Office or the Travel Data Office of the Headquarters Planning, Research and Public Transportation Division should be requested to do the capacity analysis on these miscellaneous highway sections.
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<tr>
<th>Highway Type 2</th>
<th>Rural Level</th>
<th>Rural Rolling</th>
<th>Rural Mountainous</th>
<th>Urban and Suburban</th>
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<td>B</td>
<td>B</td>
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<td>Minor Arterial</td>
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<td>B</td>
<td>C</td>
<td>C</td>
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<tr>
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<td>C</td>
<td>D</td>
<td>D</td>
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<tr>
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</tr>
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</table>

**NOTES:**

(1) Refer to 610.02 and Chapter 440 for definitions of these area types.

(2) Refer to Chapters 120 & 440 for definitions of these highway types.

**TYPE OF AREA AND APPROPRIATE LEVEL OF SERVICE**

Figure 610-1

<table>
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<th>Type</th>
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<th>Partial Access Control</th>
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<td>Undivided</td>
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<td>Rural</td>
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<tr>
<td>Suburban</td>
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**ADJUSTMENT FACTOR FOR TYPE OF MULTILANE HIGHWAY AND DEVELOPMENT ENVIRONMENT, \( f_E \)**

Figure 610-2
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<th>C</th>
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**NOTES:**

(1) Assumed conditions include 60/40 directional split, 14 percent trucks, 4 percent RV's and no buses.

(2) 20 percent, no passing zones.

(3) 40 percent, no passing zones.

(4) 60 percent, no passing zones.

(5) Use for rural two-lane highways, when k-factor is unavailable.

**MAXIMUM ADT VS. LEVEL OF SERVICE AND TYPE OF TERRAIN FOR TWO-LANE RURAL HIGHWAYS\(^1\)**

Figure 610-3
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<td>1,300</td>
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<td>1,200</td>
<td>1,000</td>
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<td></td>
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</tbody>
</table>

**NOTES:**

(1) Service flow rates are in units of vehicles per hour per lane (vphpl).

(2) Truck percentages should include both the single units (two and three axle trucks and buses) and the combinations (trucks with trailers and trailer combinations).

---

**SERVICE FLOW RATE PER LANE (SFL)$^1$ FOR MULTILANE HIGHWAYS**

Figure 610-4
<table>
<thead>
<tr>
<th>LEVEL OF SERVICE</th>
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<td>Mountainous Terrain</td>
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<td>1,500</td>
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<td>700</td>
</tr>
</tbody>
</table>

NOTES:

(1) Service flow rates are in units of vehicles per hour per lane (vphpl).

(2) Truck percentage should include both the single units (two and three axle trucks and buses) and the combinations (trucks with trailers and trailer combinations).

SERVICE FLOW RATES PER LANE (SFL) FOR FREeways¹

Figure 610-6
620 Geometric Plan Elements

620.01 General
This chapter provides guidance on the design of horizontal alignment, frontage roads, number of lanes, the arrangement of the lanes, and pavement transitions. See the following chapters for additional information:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>430</td>
<td>All roadway width requirements for modified design level</td>
</tr>
<tr>
<td>440</td>
<td>Lane and shoulder width requirements for full design level</td>
</tr>
<tr>
<td>640</td>
<td>Open highway and ramp lane widths on turning roadways for full design level</td>
</tr>
<tr>
<td>640</td>
<td>Superelevation rate and transitions</td>
</tr>
<tr>
<td>650</td>
<td>Sight distance</td>
</tr>
<tr>
<td>910</td>
<td>Shy distance requirements for curbs and islands</td>
</tr>
</tbody>
</table>

620.02 References
Washington Administrative Code (WAC) 468-18-040, “Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings”
Utilities Manual, M 22-87, WSDOT
Plans Preparation Manual, M 22-31, WSDOT
Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT, FHWA; including the Washington State Modifications to the MUTCD, M 24-01, WSDOT

620.03 Definitions
auxiliary lane The portion of the roadway adjoining the traveled way for parking, speed change, turning, storage for turning, weaving, truck climbing, passing, and other purposes supplementary to through-traffic movement
basic number of lanes The minimum number of general purpose lanes designated and maintained over a significant length of highway
frontage road An auxiliary road that is a local road or street located on the side of a highway for service to abutting property and adjacent areas and for control of access
outer separation The area between the outside edge of the through highway lanes and the inside edge of a frontage road
turning roadway A curve on an open highway, a curve on a ramp, or a connecting roadway between two intersecting legs of an intersection

620.04 Horizontal Alignment
(1) General
Horizontal and vertical alignments (Chapter 630) are the primary controlling elements for highway design. It is important to coordinate these two elements with design speed, drainage, intersection design, and aesthetic principles in the early stages of design.

Figures 620-1a and 1c show both desirable and undesirable alignment examples for use with the following considerations:

(a) Make the highway alignment as direct as possible and still blend with the topography while considering developed and undeveloped properties, community boundaries, and environmental concerns.
(b) Make highway alignment consistent by:
• Using gentle curves at the end of long tangents.
• Using a transition area of moderate curvature between the large radius curves of rural areas and the small radius curves of populated areas.
• Making horizontal curves visible to approaching traffic.

(c) Avoid minimum radii and short curves unless:
• Restrictive conditions are present and are not readily or economically avoidable.
• On two-lane highways, minimum radii will result in tangent sections long enough for needed passing.

(d) Avoid any abrupt change in alignment. Design reverse curves with an intervening tangent long enough for complete superelevation transition for both curves. See Chapter 640 for more information on superelevation transitions.

(e) Avoid the use of curves in the same direction connected by short tangents (broken back curves); substitute a single larger curve.

(f) Avoid compound curves on open highway alignment if a simple curve can be obtained. When compound curves are used, make the shorter radius at least two-thirds the longer radius. Make the total arc length of a compound curve not less than 500 ft.

(g) On divided multilane highways, take advantage of independent alignment to produce a flowing alignment along natural terrain.

(h) The preferred locations for bridges, interchanges, intersections, and temporary connections are on tangent sections in clear view of the driver.

(i) On two-lane, two-way highways, strive for as much passing sight distance as possible. (See Chapter 650.)

(2) Horizontal Curve Radii

Design speed is the governing element of horizontal curves. For guidance regarding design speed selection see Chapter 440 for full design level, Chapter 430 for modified design level, and Chapter 940 for ramps.

Use the following factors to determine the radius for a curve:
• Stopping sight distance where sight obstructions are on the inside of a curve. The following are examples of sight obstructions: median barrier, bridges, walls, cut slopes, wooded areas, buildings, and guardrail. See Chapter 650 to check for adequate stopping sight distance for the selected design speed.
• Superelevation is the rotation or banking of the roadway cross section to overcome part of the centrifugal force that acts on a vehicle traversing a curve. Design information on the relationship between design speed, radius of curve, and superelevation is in Chapter 640.
• Coordinate vertical and horizontal alignment (see Chapter 630).
• For aesthetic reasons, on open highways, the desirable minimum curve length is 1,500 ft and the maximum is around 5,000 ft. See Figures 620-1a through 1c.

Spiral curves, although no longer used on new highway construction or major realignment, still exist on Washington highways. Spirals were used to transition between tangents and circular curves with the curvature rate increasing from tangent to curve and decreasing from curve to tangent. Spirals do not pose an operational concern and may remain in place.

620.05 Distribution Facilities

(1) General

In addition to the highway under consideration, other facilities can be provided to distribute traffic to and from the highway and to fulfill access requirements. Highway flexibility can be augmented by:
• Frontage roads
• Collector distributor roads
• On and off connections
• Parallel arterial routes with connections between them and the highway under consideration
• Loop highways around large metropolitan areas

A city or county may be asked to accept a proposed distribution facility as a city street or county road. Plan and design these facilities according to the applicable standards as shown in the following:

• Chapter 468-18 WAC
• Local Agency Guidelines
• The standards of the city or county in which the facility will be located

(2) Frontage Roads

Frontage roads constructed as part of highway development may serve any of the following purposes:

• To reestablish continuity of an existing road severed by the highway.
• To provide service connections to adjacent property that would otherwise be isolated as a result of construction of the highway.
• To control access to the highway.
• To maintain circulation of traffic on each side of the highway.
• To segregate local traffic from the higher speed through traffic and intercept driveways of residences and commercial establishments along the highway.
• To relieve congestion on the arterial highway during periods of high use or in emergency situations.

Additional guidelines for auxiliary roads are in Chapters 330 and 1420. Frontage roads are generally not permanent state facilities. They are usually turned back to the local jurisdiction. Refer to the Utilities Manual for turnback procedures.

Outer separations function as buffers between the through traffic on the highway and the local traffic on the frontage road. The width is governed by requirements for grading, signing, barriers, aesthetics, headlight glare, and ramps. Where possible, make the separation wide enough to allow for development on both sides of the frontage road. Wider outer separations also move the intersection with the frontage road and a cross road farther from the intersection with the through roadway.

Where two-way frontage roads are provided, a driver on the highway must contend with approaching traffic on the right (opposing frontage road traffic) as well as opposing traffic on the left. Make the outer separation wide enough to minimize the effects of approaching traffic, particularly the headlight glare. With one-way same-direction frontage roads, the outer separation need not be as wide as with two-way frontage roads.

Wide separations lend themselves to landscape treatment and can enhance the appearance of both the highway and the adjoining property.

A substantial width of outer separation is particularly advantageous at intersections with cross streets. The wider separation reduces conflicts with pedestrians and bicycles.

Where ramp connections are provided between the through roadway and the frontage road, the minimum outer separation width will depend on design requirements for the ramp termini.

620.06 Number of Lanes and Arrangement

(1) General

The basic number of lanes is designated and maintained over a length of highway. The total number of lanes is the basic number of lanes plus any auxiliary lanes required to meet:

• Level of service (volume-capacity).
• Lane balance.
• Flexibility of operation.
(2) Basic Number of Lanes

Keep the basic number of lanes constant over a highway route, or a significant portion thereof, regardless of changes in traffic volume. See Chapter 440 for the minimum number of lanes for each functional class of highway.

Change the basic number of lanes only for general changes in traffic volume over a substantial length of the route. The recommended location for a reduction in the basic number of lanes is on a tangent section between interchanges or intersections.

To accommodate high traffic volumes for short distances, such as between adjacent interchanges, use auxiliary lanes. When consecutive sections between interchanges require auxiliary lanes, consider increasing the basic number of lanes through the entire length.

(3) Auxiliary Lanes

Auxiliary lanes are added to the basic number of lanes to allow additional traffic movements on short segments. These added lanes are based primarily on volume-to-capacity relationships (Chapter 610).

To ensure efficient operation of auxiliary lanes see the following:

910 Left and right turn lanes and storage for turning
940 Weaving and auxiliary lanes associated with interchanges
1010 Truck climbing and passing lanes

- Supplement the transition with traffic control devices.
- Reduce the number of lanes by dropping only one at a time from the right side in the direction of travel. (When dropping a lane on the left side, an approved deviation is required.) See the MUTCD when more than one lane in a single direction must be dropped.
- Use the following formula to determine the minimum length of the lane transition for high speed conditions (45 mph or more):
  \[ L = V T \]
  
  Where:
  
  \[ L = \text{length of transition (ft)} \]
  \[ V = \text{design speed (mph)} \]
  \[ T = \text{tangential offset width (ft)} \]

  - Use a tangential rate of change of 1:25 or flatter for low speed conditions (less than 45 mph).

To widen a lane or to increase the number of lanes, a tangential rate of change in the range of 1:4 to 1:15 is sufficient. Aesthetics are the main consideration.

(2) Median Width Transitions

Whenever two abutting sections have different median widths, use long, smooth transitions (\( L = V T \) or flatter). When horizontal curves are present, this can be accomplished by providing the transition throughout the length of the curve. When required on a tangent section, the transition may be applied about the center line or on either side of the median based on whether or not the abutting existing section is programmed for the wider median in the future. To satisfy aesthetic requirements, make the transition length as long as feasible.

620.07 Pavement Transitions

(1) Lane Transitions

To narrow a lane or to reduce the number of lanes, a transition is required. The following guidelines apply:

- Locate transitions where decision sight distance exists, preferably on a tangent section and on the approach side of any crest vertical curve (except the end of climbing lanes which are transitioned in accordance with Chapter 1010).

620.08 Procedures

When the project will realign the roadway, develop horizontal alignment plans for inclusion in the PS&E. Show the following as needed to maintain clarity and provide necessary information:
• Horizontal alignment details (tangent bearing, curve radius, and superelevation rate)
• Stationing
• Number of lanes
• Intersections, road approaches, railroad crossings, and interchanges (Chapters 910, 920, 930, and 940)
• Existing roadways and features affecting or affected by the project

See the *Plans Preparation Manual* for additional plan requirements.

Justify any realignment of the roadway. Include the reasons for the realignment, profile considerations, alternatives considered, and the reasons the selected alignment was chosen.

When the project will change the number of lanes, include a capacity analysis supporting the number selected (Chapter 610) with the justification for the number of lanes.

Include with the justification for a frontage road any traffic analyses performed, the social, environmental, and economic considerations, the options considered, and the reasons for the final decision.

**620.09 Documentation**

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

- Alignment justification
- Number of lanes justification
- Frontage road justifications
Alignment Examples
Figure 620-1a

Desirable - Vertical Curves Lengthened

Undesirable - Minimum Vertical Curves Used
Alignment Examples
Figure 620-1b
Alignment Examples
Figure 620-1c
630.01 General
Vertical alignment (roadway profile) consists of a series of gradients connected by vertical curves. It is mainly controlled by:

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

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

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Subject</th>
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</thead>
<tbody>
<tr>
<td>440</td>
<td>Maximum grade for each functional class</td>
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<tr>
<td>620</td>
<td>Horizontal alignment</td>
</tr>
<tr>
<td>650</td>
<td>Sight distance</td>
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</tbody>
</table>

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

Plants Preparation Manual, M 22-31, WSDOT

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

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

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

630.03 Vertical Alignment

(1) Design Controls

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

- Use a smooth grade line with gradual changes, consistent with the class of highway and character of terrain. Avoid numerous breaks and short grades.
- Avoid “roller coaster” or “hidden dip” profiles by use of gradual grades made possible by heavier cuts and fills or by introducing some horizontal curvature in conjunction with the vertical curvature.
- Avoid grades that will affect truck speeds and, therefore, traffic operations.
- Avoid broken back grade lines with short tangents between two vertical curves.
- Use long vertical curves to flatten grades near the top of long steep grades.
- Where at-grade intersections occur on roadways with moderate to steep grades, it is desirable to flatten or reduce the grade through the intersection.
- Establish the subgrade at least 1 ft above the high water table (real or potential) or as recommended by the region Materials Engineer. Consider the low side of superelevated roadways.
• When a vertical curve takes place partly or wholly in a horizontal curve, coordinate the two as discussed in 630.02(5).

(2) **Minimum Length of Vertical Curves**

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

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

(3) **Maximum Grades**

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

(4) **Minimum Grades**

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

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

(5) **Length of Grade**

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

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

(6) **Alignment on Structures**

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

630.04 **Coordination of Vertical and Horizontal Alignments**

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

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

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

- Do not introduce a sharp horizontal curve at or near the low point of a pronounced sag vertical curve. The road ahead is foreshortened and any horizontal curve that is not flat assumes an undesirably distorted appearance. Further, vehicular speeds, particularly of trucks, often are high at the bottom of grades and erratic operation may result, especially at night.

- On two-lane roads, the need for safe passing sections (at frequent intervals and for an appreciable percentage of the length of the roadway) often supersedes the general desirability for combination of horizontal and vertical alignment. Work toward long tangent sections to secure sufficient passing sight distance.

- On divided highways, consider variation in width of median and the use of independent alignments to derive the design and operational advantages of one-way roadways.

- Make horizontal curvature and profile as flat as feasible at intersections where sight distance along both roads is important and vehicles may have to slow or stop.

- In residential areas, design the alignment to minimize nuisance factors to the neighborhood. Generally, a depressed facility makes a highway less visible and less noisy to adjacent residents. Minor horizontal adjustments can sometimes be made to increase the buffer zone between the highway and clusters of homes.

- Design the alignment to enhance attractive scenic views of the natural and manmade environment, such as rivers, rock formations, parks, and outstanding buildings.

When vertical and horizontal curves are coordinated, plot profiles of the edges of pavement to ensure smooth transitions.

630.05 Airport Clearance

For a proposed highway construction or alteration in the vicinity of a public or military airport, early contact by the region with the airport authorities is required so that advance planning and design work can proceed within the required FAA regulations (Chapter 240).

630.06 Railroad Crossings

When a highway crosses a railroad at grade, design the highway grade so that a low-hung vehicle will not damage the rails or get hung up on the tracks. Figure 630-3 gives guidance on designing highway grades at railroad crossings. For more information on railroad-highway crossings, see Chapter 930.

630.07 Procedures

When the project will modify the vertical alignment, develop vertical alignment plans for inclusion in the PS&E to a scale suitable for showing vertical alignment for all proposed roadways including ground line, grades, vertical curves, and superelevation. See the Plans Preparation Manual for additional requirements.

When justifying any modification to the vertical alignment, include the reasons for the change, alternatives considered (if any) and why the selected alternative was chosen. When the profile is a result of new horizontal alignment, consider vertical and horizontal alignments together and document the profile with the horizontal alignment justification.

630.08 Documentation

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

- Vertical alignment revision justification
Coordination of Horizontal and Vertical Alignments

When horizontal and crest vertical curves coincide, a satisfactory appearance results.

When horizontal and sag vertical curves coincide, a satisfactory appearance results.

This combination is deficient for several reasons:
- The curve reversal is on a crest making the second curve less visible.
- The tangent is too short for the superelevation transition.
- The flat area of the superelevation transition will be near the flat grade in the crest.

Coordination of Horizontal and Vertical Alignments
Figure 630-1a
**Profile with Tangent Alignment**

Avoid designing dips on an otherwise long uniform grade.

**Sharp Angle Appearance**

This combination presents a poor appearance. The horizontal curve looks like a sharp angle.

**Disjointed Effect**

A disjointed effect occurs when the beginning of a horizontal curve is hidden by an intervening crest while the continuation of the curve is visible in the distance beyond the intervening crest.
Desirable Coordination of Vertical and Horizontal Curves and the Use of Flowing Alignment

Undesirable - Vertical and Horizontal Curves Not Coordinated and Using Minimums

Coordination of Horizontal and Vertical Alignments

Figure 630-1c
Grade Length

Figure 630-2
Grading at Railroad Crossings

Figure 630-3

Detail A-A

Plane of the rails

Limits of the roadway surface

Outside rails

30 ft

3 in max

6 in max
### 640 Geometric Cross Section

**640.01 General**

Geometric cross sections for state highways are governed by functional classification criteria, traffic volume, and whether the highway is in a rural or urban area. See Chapter 440 for guidance on selecting a design class.

High Occupancy Vehicle (HOV) lanes must be considered when continuous through lanes are to be added within the limits of an urban area over 200,000 population (Chapter 1050).

When a state highway within an incorporated city or town is a portion of a city street, the design features must be developed in cooperation with the local agency. For city streets and county roads that are not part of the state highway system, use Chapter 468-18 WAC and the Local Agency Guidelines.

See the following chapters for additional information:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Subject</th>
</tr>
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<tbody>
<tr>
<td>430</td>
<td>all roadway widths for modified design level</td>
</tr>
<tr>
<td>440</td>
<td>lane and shoulder widths for full design level</td>
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<tr>
<td>910</td>
<td>shy distances for curbs and islands</td>
</tr>
<tr>
<td>940</td>
<td>lane and shoulder widths for ramps</td>
</tr>
</tbody>
</table>

**640.02 References**

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

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

- Plans Preparation Manual, WSDOT, M 22-31

- Highway Runoff Manual, M 31-16, WSDOT

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

- Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT


- A Policy on Geometric Design of Highways and Streets (Green Book), 1994, AASHTO

**640.03 Definitions**

- **auxiliary lane** The portion of the roadway adjoining the through lanes for parking, speed change, turning, storage for turning, weaving, truck climbing, and other purposes supplementary to through-traffic movement.

- **high pavement type** Portland cement concrete pavement or asphalt cement concrete on a treated base.

- **intermediate pavement type** Asphalt cement concrete pavement on an untreated base.

- **lane** A strip of roadway used for a single line of vehicles.

- **lane width** The lateral design width for a single lane, striped as shown in the Standard Plans and the Standard Specifications. The width of an existing lane is measured from the edge of traveled way to the center of the lane line or between the centers of successive lane lines.
low pavement type  Bituminous surface treatment.

median  The portion of a divided highway separating the traveled ways for traffic in opposite directions.

outer separation  The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road.

roadway  The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

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.

shoulder width  The lateral width of the shoulder, measured from the outside edge of the outside lane to the edge of the roadway.

superelevation  The rotation of the roadway cross section in such a manner as to overcome part of the centrifugal force that acts on a vehicle traversing a curve.

superelevation runoff  The length of highway needed to accomplish the change in cross slope from a level section to a fully superelevated section, or vice versa.

superelevation transition length  The length of highway needed to change the cross slope from normal crown or normal pavement slope to full superelevation.

tangent runout  The length of highway needed to change the cross slope from normal crown to a section with adverse crown removed (level).

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.

turning roadway  A curve on an open highway, a ramp, or the connecting portion of roadway between two intersecting legs of an intersection.

640.04  Roadways

The cross sections shown in Figures 640-3, 4, 5, 6a, and 6b represent minimum standards for full design level.

For the specific type of roadway section see Chapter 440 and for pavement type details see the Pavement Guide.

(1) Traveled Way Cross Slope

The cross slope on tangents and curves is a main element in cross section design. The cross slope or crown on tangent sections and large radius curves is complicated by two contradicting controls. Reasonably steep cross slopes are desirable to aid in water runoff and to minimize ponding as a result of pavement imperfections and unequal settlement. However, steep cross slopes are undesirable on tangents because of the tendency for vehicles to drift to the low side of the roadway. Cross slopes greater than 2% are noticeable in steering and increase susceptibility to sliding to the side on icy or wet pavements.

A 2% cross slope is normally used for tangents and large radius curves on high and intermediate pavement types.

In some areas, a somewhat steeper cross slope may be desirable to improve roadway runoff, although it is undesirable operationally. For these areas, with justification, a 2.5% cross slope may be used.

On low pavement types, such as bituminous surface treatment, the cross slope may be increased to 3% to allow for reduced construction control and greater settlement.

Superelevation on curves is determined by the design speed and the radius of the curve. See 640.05 for guidance on superelevation design.

(2) Turning Roadway Widths

The roadway on a curve may need to be widened to make the operating conditions comparable to those on tangents. There are two main reasons to do this. One is the offtracking of vehicles, such as trucks and buses. The other is the increased difficulty drivers have in keeping their vehicles in the center of the lane.
(a) **Two-lane two-way roadways.** Figure 640-7a shows the desirable traveled way width $W$ for two-lane two-way roadways. For values of $R$ between those given, interpolate $W$ and round up to the next foot.

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

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

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

To keep widths to a minimum, traveled way widths for Figures 640-8a and 8b were calculated using the WB-40 design vehicle. When volumes are high for both trucks larger than the WB-40 and other traffic, consider using the widths from Figures 640-7a and 7b.

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

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

Build shoulder pavements at full depth for one-lane one-way roadways because, to keep widths to a minimum, traveled way widths were calculated using the WB-40 design vehicle which may force larger vehicles to encroach on the shoulders.

(d) **Other roadways.**

- For multilane two-way undivided roadways use the following:
  \[
  W = \frac{W_a \times N}{2}
  \]
  Where:
  - $W =$ The multilane roadway width.
  - $W_a =$ The width from 640.04(2)(a) for a two-lane two-way roadway.
  - $N =$ The total number of lanes.

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

- For three-lane ramps with HOV lanes, see Chapter 1050.

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

If the total roadway width deficiency is less than 2 ft on existing roadways that are to remain in place, correction is not required.

When widening

- Traveled way widening may be constructed on the inside of the traveled way or divided equally between the inside and outside.

- Place final marked center line, and any central longitudinal joint, midway between the edges of the widened traveled way.

- Provide widening throughout the curve length.

- For widening on the inside, make transitions on a tangent, where possible.

- For widening on the outside, develop the widening by extending the tangent. This avoids the appearance of a reverse curve that a taper would create.

- For widening of 6 ft or less, use a 1:25 taper, for widths greater than 6 ft use a 1:15 taper.
(3) Shoulders

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

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

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

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

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

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

640.05 Superelevation

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

(1) Superelevation Rates for Open Highways and Ramps

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

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

• Figure 640-11b, Superelevation Rate (6% Max), may be used under the following conditions:
  1. Urban conditions without limited access
  2. Mountainous areas or locations that normally experience regular accumulations of snow and ice
  3. Short-term detours (generally implemented and removed in one construction season). For long-term detours, consider a higher rate up to 10%, especially when associated with a main line detour.

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

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

Round the selected superelevation rate to the nearest full percent.

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

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

**Figure 640-1**

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Minimum Radius for Normal Crown Section (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>2,640</td>
</tr>
<tr>
<td>30</td>
<td>3,340</td>
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<td>70</td>
<td>14,690</td>
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<tr>
<td>80</td>
<td>18,080</td>
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</table>

**Design Speed (mph)**

<table>
<thead>
<tr>
<th>Side Friction Factor $f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
</tr>
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<td>25</td>
</tr>
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<tr>
<td>70</td>
</tr>
<tr>
<td>80</td>
</tr>
</tbody>
</table>

### (2) Existing Curves

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

$$ R = \frac{6.69 V^2}{e + f} $$

Where:

- $R$ = The minimum allowable radius of the curve in feet.
- $V$ = Design speed in mph
- $e$ = Superelevation rate in percent
- $f$ = Side friction factor from Figure 640-2

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

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

Address deficient superelevation as provided in 640.05 (1).

### (3) Turning Movements at Intersections

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

### (4) Superelevation Runoff for Highway Curves

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

Provide transitions for all superelevated highway curves as specified in Figures 640-13a through 13e. Which transition to use depends on the location of the pivot point, the direction of the curve, and the roadway cross slope.
Consider the profile of the edge of traveled way. To be pleasing in appearance, do not let it appear distorted. The combination of superelevation transition and grade may result in a hump or dip in the profile of the edge of traveled way. When this happens, the transition may be lengthened to eliminate the hump or dip. If the hump or dip cannot be eliminated this way, pay special attention to drainage in the low areas.

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

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

### (5) Superelevation Runoff for Ramp Curves

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

Superelevation transition lengths (LT) given in Figures 640-14a and 14b are for a single 15-ft lane. They are based on maximum cross slope change between the pivot point and the edge of the traveled way over the length of the superelevation transition. Maximum relative slopes for specific design speeds are similar to those given for highway curves.

Use the distances given in the LT column for LR wherever possible. The LR distances will give the maximum allowable rate of cross slope change. Use the LB distances only with justification where the LT distance cannot be achieved.

For ramps wider than 15 ft, adjust the LR distance by the equation for LR. If the result is larger than the LT distance, round upward to the next whole 5 ft or 10 ft increment; if it is smaller, use the LT distance.

### 640.06 Medians and Outer Separations

#### (1) Purpose

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

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

#### (2) Design

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

When the horizontal and vertical alignments of the two roadways of a divided highway are independent of each other, determine median slopes in conformance with Figure 640-3. Unnecessary clearing, grubbing, and grading
within wide medians is undesirable. Give preference to selective thinning and limited reshaping of the natural ground. For slopes into the face of traffic barriers, see Chapter 710.

In areas where land is expensive, make an economic comparison of wide medians to narrow medians with their barrier requirements. Consider right of way, construction, maintenance, and accident costs. The widths of medians need not be uniform. Make the transition between median widths as long as feasible.

Independent horizontal and vertical alignment, rather than parallel alignment, is desirable.

When using concrete barriers in depressed medians or on curves, provide for surface drainage on both sides of the barrier. The transverse notches in the base of precast concrete barrier are not intended to be used as a drainage feature but rather as pick-up points when placing the sections.

640.07 Roadsides
(1) Side Slopes

The Cut Slope Selection tables on Figures 640-3, 4, 5, and 6b are for preliminary estimates or where no other information is available. Design the final slope as recommended in the soils or geotechnical report.

When designing side slopes, fit the slope selected for any cut or fill into the existing terrain to give a smooth transitional blend from the construction to the existing landscape. Slopes flatter than recommended are desirable, especially within the Design Clear Zone. Slopes not steeper than 4H:1V, with smooth transitions where the slope changes, will provide a reasonable opportunity to recover control of an errant vehicle. Where mowing is contemplated, slopes must not be steeper than 3H:1V. If there will be continuous traffic barrier on a fill slope, and mowing is not contemplated, the slope may be steeper than 3H:1V.

In cases of unusual geological features or soil conditions, treatment of the slopes will depend upon results of a review of the location by the region’s Materials Engineer.

Do not disturb existing stable cut slopes just to meet the slopes given in the Cut Slope Selection tables on Figures 640-3, 4, 5, and 6b. When an existing slope is to be revised, document the reason for the change.

If borrow is required, consider obtaining it by flattening cut slopes uniformly on one or both sides of the highway. Where considering wasting excess material on an existing embankment slope, consult the region’s Materials Engineer to verify that the foundation soil will support the additional material.

In all cases, provide for adequate drainage from the roadway surface and adequate drainage in ditches. See 640.07(d) for details on drainage ditches in embankment areas.

At locations where vegetated filter areas or detention facilities will be established to improve highway runoff water quality, provide appropriate slope, space, and soil conditions for that purpose. See the Highway Runoff Manual for design criteria and additional guidance.

Rounding, as shown in the Standard Plans, is required at the top of all roadway cut slopes, except for cuts in solid rock. Unless Class B slope treatment is called for, Class A slope treatment is used. Call for Class B slope treatment where space is limited, such as where right of way is restricted.

(2) Roadway Sections in Rock Cuts

Typical sections for rock cuts, illustrated in Figures 640-16a and 16b, are guides for the design and construction of roadways through rock cuts. Changes in slope or fallout area are recommended when justified. Base the selection of the appropriate sections on an engineering study and the recommendations of the region’s Materials Engineer and Landscape Architect.

Olympia Service Center Materials Lab concurrence is required.

There are two basic design treatments applicable to rock excavation (Figures 640-16a and 16b). Design A applies to most rock cuts. Design B is a talus slope treatment.
(a) **Design A.** This design is shown in stage development to aid the designer in selecting an appropriate section for site conditions in regard to backslope, probable rockfall, hardness of rock, and so forth.

The following guidelines apply to the various stages shown in Figure 640-16a.

- **Stage 1** is used where the anticipated quantity of rockfall is small, adequate fallout width can be provided, and the rock slope is 1/2H:1V or steeper. Controlled blasting is recommended in conjunction with Stage 1 construction.

- **Stage 2** is used when a “rocks in the road” problem exists or is anticipated. Consider it on flat slopes where rocks are apt to roll rather than fall.

- **Stage 3** represents full implementation of all protection and safety measures applicable to rock control. Use it only when extreme rockfall conditions exist.

Show Stage 3 as ultimate stage for future construction on the PS&E plans if there is any possibility that it will be needed.

The use of Stage 2 or 3 alternatives (concrete barrier) is based on the designer’s analysis of the particular site. Considerations include maintenance, size and amount of rockfall, probable velocities, availability of materials, ditch capacity, adjacent traffic volumes, distance from traveled lane, and impact severity. Incorporate removable sections in the barrier at approximately 200 ft intervals. Appropriate terminal treatment is required (Chapter 710).

Occasionally, the existing ground above the top of the cut is on a slope approximating the design cut slope. The height (H) is to include the existing slope or that portion that can logically be considered part of the cut. The cut slope selected for a project must be that required to effect stability of the existing material.

Benches may be used to increase slope stability; however, the use of benches may alter the design requirements for the sections given in Figure 640-16a.

The necessity for benches, their width, and vertical spacing is established only after an evaluation of slope stability. Make benches at least 20 ft wide. Provide access for maintenance equipment at the lowest bench, and to the higher benches if feasible. Greater traffic benefits in the form of added safety, increased horizontal sight distance on curves, and other desirable attributes may be realized from widening a cut rather than benching.

(b) **Design B.** A talus slope treatment is shown in Design B (Figure 640-16b). The rock protection fence is placed at any one of the three locations shown but not in more than one position at a particular location. The exact placement of the rock protection fence in talus slope areas requires considerable judgment and should be determined only after consultation with the region’s Materials Engineer.

- **Fence position a** is used when the cliff generates boulders less than 0.25 cy³ in size, and the length of the slope is greater than 350 ft.

- **Fence position b** is the preferred location for most applications.

- **Fence position c** is used when the cliff generates boulders greater than 0.25 cy³ in size, regardless of the length of the slope. On short slopes, this may require placing the fence less than 100 ft from the base of the cliff.

- Use of gabions may be considered instead of the rock protection shown in fence position a. However, gabion treatment is considered similar to a wall and, therefore, requires appropriate face and end protection for safety (Chapter 710).

Use of the alternate shoulder barrier is based on the designer’s analysis of the particular site. Considerations similar to those given for Design A alternatives apply.

Rock protection treatments other than those described above may be required for cut slopes that have relatively uniform spalling surfaces, consult with the region’s Materials Engineer.
(3) **Stepped Slopes**

Stepped slopes are a construction method intended to promote early establishment of vegetative cover on the slopes. They consist of a series of small horizontal steps or terraces on the face of the cut slope. Soil conditions dictate the feasibility and necessity of stepped slopes. They are to be considered only on the recommendation of the region’s Materials Engineer (Chapter 510). Consult region’s landscape personnel for appropriate design and vegetative materials to be used. See Figure 640-17 for stepped slope design details.

(4) **Drainage Ditches in Embankment Areas**

Where it is necessary to locate a drainage ditch adjacent to the toe of a roadway embankment, consider the stability of the embankment. A drainage ditch placed immediately adjacent to the toe of an embankment slope has the effect of increasing the height of the embankment by the depth of the ditch. In cases where the foundation soil is weak, the extra height could result in an embankment failure. As a general rule, the weaker the foundation and the higher the embankment, the farther the ditch should be from the embankment. Consult the region’s Materials Engineer for the proper ditch location.

When topographic restrictions exist, consider an enclosed drainage system with appropriate inlets and outlets. Do not steepen slopes to provide lateral clearance from toe of slope to ditch location, thereby necessitating traffic barriers or other protective devices.

Maintenance operations are also facilitated by adequate width between the toe of the slope and an adjacent drainage ditch. Where this type of facility is anticipated, provide sufficient right of way for access to the facility and place the drainage ditch near the right of way line.

Provide for disposition of the drainage collected by ditches in regard to siltation of adjacent property, embankment erosion, and other undesirable effects. This may also apply to cut slope top-of-slope ditches.

(5) **Bridge End Slopes**

Bridge end slopes are determined by several factors, including: location, fill height, depth of cut, soil stability, and horizontal and vertical alignment. Close coordination between the OSC Bridge and Structures Office and the region is necessary to ensure proper slope treatment (Chapter 1120).

Early in the preliminary bridge plan development, determine preliminary bridge geometrics, end slope rates, and toe of slope treatments. Figure 640-18a provides guidelines for use of slope rates and toe of slope treatments for overcrossings. Figure 640-18b shows toe of slope treatments to be used on the various toe conditions.

640.08 **Roadway Sections**

Provide a typical section for inclusion in the PS&E for each general type used on the main roadway, ramps, detours, and frontage or other roads. See the Plans Preparation Manual for requirements.

640.09 **Documentation**

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

- Justification for cross slopes other than 2% on tangents.
- Justification for shoulder cross slopes not the same as the cross slopes for the adjacent lane.
- Documentation of superelevation maximum rate being used and justification for a rate other than 10% maximum.
- Justification for the use of LB on ramp curves when the minimum transition cannot be achieved.
- Documentation of the reasons for modifying an existing cut slope.
- Engineering study and recommendations for rock cuts.
- Materials Engineer recommendation for stepped slopes.
- Materials Engineer recommendation for ditch location at the toe of fill.
(1) See Figures 640-10a and 10b for shoulder details. See Chapter 440 for minimum shoulder width.

(2) Generally, the crown slope will be as follows:
- Four-lane highway — slope all lanes away from the median.
- Six-lane highway — slope all lanes away from the median unless high rainfall intensities would indicate otherwise.
- Eight-lane highway — slope two of the four directional lanes to the right and two to the left unless low rainfall intensities indicate that all four lanes could be sloped away from the median.

(3) See Chapter 440 for minimum number and width of lanes. See Figures 640-8a and 8b and 640.04(2) for turning roadway width.

(4) See Figures 640-15a and 15c for median details. See Chapter 440 for minimum median width.

(5) Where practical, consider flatter slopes for the greater fill heights and ditch depths.

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

(7) Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. See Chapter 700 for clear zone and barrier requirements.

(8) Fill slopes as steep as 1 1/2H:1V may be used where favorable soil conditions exist. See Chapter 700 for clear zone and barrier requirements.

(9) This table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the soils or geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

### Fill and Ditch Slope Selection

<table>
<thead>
<tr>
<th>Height of fill/depth of ditch (ft)</th>
<th>Slope not steeper than (H:V)</th>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>6 : 1</td>
</tr>
<tr>
<td>10 - 20</td>
<td>4 : 1</td>
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<td>20 - 30</td>
<td>3 : 1 (6)</td>
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<tr>
<td>over 30</td>
<td>2 : 1 (6) (8)</td>
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### Cut Slope Selection

<table>
<thead>
<tr>
<th>Height of cut (ft)</th>
<th>Slope not steeper than (H:V)</th>
</tr>
</thead>
<tbody>
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<td>5 - 20</td>
<td>3 : 1</td>
</tr>
<tr>
<td>over 20</td>
<td>2 : 1 (7)</td>
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</table>

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**Divided Highway Roadway Sections**  
*Figure 640-3*
See Figures 640-10a and 10b for shoulder details. See Chapter 440 for minimum shoulder width.

See Chapter 440 for minimum number and width of lanes. See Figures 640-7a and 7b and 640.04(2) for turning roadway width.

See Chapter 440 for minimum median width.

Where practical, consider flatter slopes for the greater fill heights and ditch depths.

Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. See Chapter 700 for clear zone and barrier requirements.

Fill slopes up to 1 1/2H:1V may be used where favorable soil conditions exist. See Chapter 700 for clear zone and barrier requirements.

Widen and round foreslopes steeper than 4H:1V as shown on Figure 640-10b.

This table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the soils or geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

### Fill and Ditch Slope Selection

<table>
<thead>
<tr>
<th>Height of fill/depth of ditch (ft)</th>
<th>Slope not steeper than (H:V)</th>
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<td>5 - 20</td>
<td>4 : 1</td>
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<td>20 - 30</td>
<td>3 : 1 (7)</td>
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<tr>
<td>over 30</td>
<td>2 : 1 (6) (7)</td>
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### Cut Slope Selection

<table>
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<tr>
<th>Height of cut (ft)</th>
<th>Slope not steeper than (H:V)</th>
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**Undivided Multilane Highway Roadway Sections**

*Figure 640-4*
See cut slope selection

Design Class P-3, P-4, P-5, M-2, M-3, M-4, C-2, C-3, C-4

Two-Lane Highway Roadway Sections

Fill and Ditch Slope Selection

(1) See Figures 640-10a and 10b for shoulder details. See Chapter 440 for minimum shoulder width.

(2) See Chapter 440 for minimum width of lanes. See Figures 640-7a and 7b and 640.04(2) for turning roadway width.

(3) The minimum ditch depth is 2 ft for Design Class P-3 and 1.5 ft for Design Class P-4, P-5, M-2, M-3, M-4, C-2, C-3, and C-4.

(4) Where practical, consider flatter slopes for the greater fill heights.

(5) Fill slopes up to $1\frac{1}{2}H:1V$ may be used where favorable soil conditions exist. See Chapter 700 for clear zone and barrier requirements.

(6) Cut slopes steeper than $2H:1V$ may be used where favorable soil conditions exist or stepped construction is used. See Chapter 700 for clear zone and barrier requirements.

(7) Widen and round foreslopes steeper than $4H:1V$, as shown on Figure 640-10b.

(8) This table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the soils or geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

### Fill Slope Selection

<table>
<thead>
<tr>
<th>Design class of highway</th>
<th>P-3, P-4, M-2, C-2</th>
<th>P-3, P-4, M-3, M-4, C-3, C-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of fill/depth of ditch (ft)</td>
<td>Slope not steeper than (H:V)</td>
<td>Slope not steeper than (H:V)</td>
</tr>
<tr>
<td>0 - 10</td>
<td>6 : 1</td>
<td>4 : 1</td>
</tr>
<tr>
<td>10 - 20</td>
<td>4 : 1</td>
<td>4 : 1</td>
</tr>
<tr>
<td>20 - 30</td>
<td>3 : 1 (7)</td>
<td>3 : 1 (7)</td>
</tr>
<tr>
<td>over 30</td>
<td>2 : 1 (5) (7)</td>
<td>2 : 1 (5) (7)</td>
</tr>
</tbody>
</table>

### Cut Slope Selection

<table>
<thead>
<tr>
<th>Design class of highway</th>
<th>P-3, P-4, M-2, C-2</th>
<th>P-3, P-4, M-3, M-4, C-3, C-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of cut (ft)</td>
<td>Slope not steeper than (H:V)</td>
<td>Slope not steeper than (H:V)</td>
</tr>
<tr>
<td>0 - 5</td>
<td>6 : 1</td>
<td>4 : 1</td>
</tr>
<tr>
<td>5 - 20</td>
<td>3 : 1</td>
<td>2 : 1 (6)</td>
</tr>
<tr>
<td>over 20</td>
<td>2 : 1 (6)</td>
<td>2 : 1 (6)</td>
</tr>
</tbody>
</table>

---

*Geometric Cross Section*

*Page 640-12 English Version December 1998*
Ramp Roadway Sections

For notes, dimensions, and slope selection tables see Figure 640-6b

**Ramp Roadway Sections**
*Figure 640-6a*
(1) See Figures 640-10a and 10b for shoulder details. See Chapter 940 for minimum shoulder widths.

(2) See Chapter 940 for minimum ramp lane widths.
   • For one-lane ramp turning roadways see Figures 640-9a thru 9c for traveled way width.
   • For two-lane one-way ramp turning roadways, see Figures 640-8a & 8b for traveled way width.
   • For two-way ramps treat each direction as a separate one-way roadway.

(3) The minimum median width of a two-lane, two-way ramp is not less than that required for traffic control devices and their respective shy distances.

(4) Minimum ditch depth is 2 ft for design speeds over 40 mph and 1.5 ft for design speeds of 40 mph or less. Rounding may be varied to fit drainage requirements when minimum ditch depth is 2 ft.

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

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

(7) Where practical, consider flatter slopes for the greater fill heights and ditch depths.

(8) Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. See Chapter 700 for clear zone and barrier requirements.

(9) Fill slopes as steep as 1 1/2 H:1V may be used where favorable soil conditions exist. See Chapter 700 for clear zone and barrier requirements.

(10) This table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the soils or geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

Special Design

This special design is to be used only when restrictions (high right of way costs or physical features that are difficult or costly to correct) require its consideration.

<table>
<thead>
<tr>
<th>Height of fill/depth of ditch (ft)</th>
<th>Slope not steeper than (H:V) (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10</td>
<td>6 : 1</td>
</tr>
<tr>
<td>10 - 20</td>
<td>4 : 1</td>
</tr>
<tr>
<td>20 - 30</td>
<td>3 : 1 (5)</td>
</tr>
<tr>
<td>over 30</td>
<td>2 : 1 (5) (9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cut slope Selection (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of cut (ft)</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>0 - 5</td>
</tr>
<tr>
<td>5 - 20</td>
</tr>
<tr>
<td>over 20</td>
</tr>
</tbody>
</table>
Traveled Way Width for Two-Way Two-Lane Turning Roadways

Figure 640-7a

<table>
<thead>
<tr>
<th>Radius on center line of traveled way (ft)</th>
<th>Design traveled way width (W) (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000 to tangent</td>
<td>24</td>
</tr>
<tr>
<td>2,999</td>
<td>25</td>
</tr>
<tr>
<td>2,000</td>
<td>26</td>
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<tr>
<td>200</td>
<td>36</td>
</tr>
<tr>
<td>150</td>
<td>40</td>
</tr>
</tbody>
</table>
Traveled Way Width for Two-Way Two-Lane Turning Roadways

Figure 640-7b
<table>
<thead>
<tr>
<th>Radius on center line of traveled way (ft)</th>
<th>Design traveled way width (W) (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000 to tangent</td>
<td>24</td>
</tr>
<tr>
<td>1,000</td>
<td>25</td>
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<tr>
<td>999</td>
<td>26</td>
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<tr>
<td>150</td>
<td>31</td>
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<tr>
<td>100</td>
<td>34</td>
</tr>
</tbody>
</table>

Figure 640-8a

Traveled Way Width for Two-Lane One-Way Turning Roadways

Design Manual
December 1998
Geometric Cross Section
English Version
Page 640-17
Traveled Way Width for Two-Lane One-Way Turning Roadways

Figure 640-8b
(1) On tangents, the minimum lane width may be reduced to 12 ft.
(2) The width given is for a radius on the outside edge of the traveled way. When the radius is on the inside edge of traveled way, the width may be 17.7 ft.
(3) The width given is for a radius on the outside edge of the traveled way. When the radius is on the inside edge of traveled way, the width may be 18 ft.
(4) The width given is for a radius on the outside edge of the traveled way. When the radius is on the inside edge of traveled way, the width may be 19 ft.
Traveled Way Width for One-Lane Turning Roadways

Figure 640-9b

NOTE: All Radii are to the outside edge of traveled way.
NOTE: All Radii are to the outside edge of traveled way.
Shoulder Details

*AP = angle point in the subgrade.
For notes, see Figure 640-10a
Shoulder Details

Figure 640-10b

(1) Shoulder cross slopes are normally the same as the cross slopes for adjacent lanes. See 640.04(3) in the text for examples, additional information, and requirements of locations where it may be desirable to have a shoulder cross slope different than the adjacent lane.

(2) Widening and shoulder rounding outside the usable shoulder is required when foreslope is steeper than 4H:1V.

(3) See Chapter 440 for shoulder width.

(4) See Chapter 910 for shy distance.

(5) See Chapter 1020 for additional requirements for sidewalks.

(6) It is preferred that curb not be used on high speed facilities (posted speed >40 mph).

(7) Paved shoulders are required wherever asphalt concrete curb is placed. Use it only where necessary to control drainage from roadway runoff. See the Standard Plans for additional details and dimensions.

(8) When rounding is required, use it uniformly on all ramps and crossroads, as well as the main roadway.

End rounding on the crossroad just beyond the ramp terminals and at a similar location where only a grade separation is involved.

(9) When widening beyond the edge of usable shoulder is required for asphalt concrete curb, barrier, or other purposes, additional widening for shoulder rounding is not required.

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

(11) On divided multilane highways see Figures 640-15a and 15c or additional details and requirements for median shoulders.

Shoulder Widening for Guardrail

Shoulder Rounding

Normal foreslope

Paved

Curb

Shoulder widening (2)

End rounding (9)

Normal foreslope

Paved

Widening (8) (9)

Steeper than 4H:1V

Normal foreslope

Shoulder usable shoulder

Normal foreslope

Shoulder Widening for Guardrail

Normal foreslope

Paving optional without curbing

Pave when AC curb is used

Normal foreslope

(10)
**Superelevation Rates (10% max)**

*Figure 640-11a*

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Radius (ft)</td>
<td>100</td>
<td>160</td>
<td>240</td>
<td>330</td>
<td>430</td>
<td>560</td>
<td>700</td>
<td>880</td>
<td>1100</td>
<td>1640</td>
<td>2380</td>
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</table>
Superelevation Rates (6% max)

Figure 640-11b

<table>
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<th>Design Speed (mph)</th>
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<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
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<th>55</th>
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<th>70</th>
<th>80</th>
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<td>Minimum Radius (ft)</td>
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<td>670</td>
<td>840</td>
<td>1070</td>
<td>1340</td>
<td>2050</td>
<td>3060</td>
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</table>
Superelevation Rates (8% max)

Figure 640-11c

<table>
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<th>Design Speed (mph)</th>
<th>20</th>
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<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
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<th>55</th>
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<th>70</th>
<th>80</th>
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<tbody>
<tr>
<td>Minimum Radius (ft)</td>
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<td>180</td>
<td>260</td>
<td>350</td>
<td>470</td>
<td>610</td>
<td>770</td>
<td>970</td>
<td>1210</td>
<td>1830</td>
<td>2680</td>
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</table>
### Superelevation Rates for Turning Roadways at Intersections

**Figure 640-12**

<table>
<thead>
<tr>
<th>Curve Radius (ft)</th>
<th>15 mph</th>
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<th>40 mph</th>
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<td></td>
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<td></td>
</tr>
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<td>90</td>
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<td>2 - 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>2 - 5</td>
<td>2 - 8</td>
<td>4 - 10</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>230</td>
<td>2 - 4</td>
<td>2 - 6</td>
<td>3 - 8</td>
<td>6 - 10</td>
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<td>2 - 3</td>
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<td>2</td>
<td>2</td>
<td>2 - 3</td>
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<td>40 mph</td>
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<td>170</td>
<td>180</td>
<td>195</td>
<td>210</td>
<td>225</td>
</tr>
</tbody>
</table>

*Min LR* 65 80 115 115 130 150 165 165 180 215 230

*Based on one 12 ft lane between the pivot point and the edge of traveled way. When the distance exceeds 12 ft use the following equation to obtain LR:

\[
LR = L_B(1 + 0.04167X)
\]

Where:

\(X\) = The distance in excess of 12 ft between the pivot point and the furthest edge of traveled way, in meters

---

**Superelevation Transitions for Highway Curves**

*Figure 640-13a*
Design B² Pivot Point on Edge of Pavement
Inside of Curve Crowned Section

C = Normal crown(%)  
S = Superelevation rate (%)  
N = Number of lanes between points  
W = Width of lane

Superelevation Transitions for Highway Curves
Figure 640-13b
Superelevation Transitions for Highway Curves

**Design C**

\[ \text{WCN} \]

**Design C**

\[ \text{WSN} \]

C = Normal crown(%)  
S = Superelevation rate (%)  
N = Number of lanes between points  
W = Width of lane

Superelevation Transitions for Highway Curves  
*Figure 640-13c*
Superelevation Transitions for Highway Curves

Design $D^1$

Design $D^2$

$C = $ Normal crown ($\%$)

$S = $ Superelevation rate ($\%$)

$N = $ Number of lanes between points

$W = $ Width of lane

Superelevation Transitions for Highway Curves

Figure 640-13d
Transition profiles for typical six lanes with median

Design E

\[ C = \text{Normal crown(\%)} \]
\[ S = \text{Superelevation rate (\%)} \]
\[ N = \text{Number of lanes between points} \]
\[ W = \text{Width of lane} \]
Superelevation Transitions for Ramp Curves

**Figure 640-14a**

Length of transition in feet for Design Speed of:

<table>
<thead>
<tr>
<th>S (%)</th>
<th>20 mph</th>
<th>25 mph</th>
<th>30 mph</th>
<th>35 mph</th>
<th>40 mph</th>
<th>45 mph</th>
<th>50 mph</th>
<th>≥ 55 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L&lt;sub&gt;B&lt;/sub&gt;</td>
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<td>L&lt;sub&gt;B&lt;/sub&gt;</td>
<td>L&lt;sub&gt;T&lt;/sub&gt;</td>
<td>L&lt;sub&gt;B&lt;/sub&gt;</td>
<td>L&lt;sub&gt;T&lt;/sub&gt;</td>
<td>L&lt;sub&gt;B&lt;/sub&gt;</td>
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<td>80</td>
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<td>85</td>
<td>80</td>
<td>115</td>
<td>85</td>
<td>115</td>
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</tbody>
</table>

Table 1  Pivot Point on Center Line — Curve in Direction of Normal Pavement Slope

LR=LP<sub>R</sub>*<sup>2</sup>/<sup>(2+S)</sup> Where: x = width of lane greater than 15 ft.

W<sub>L</sub> = width of ramp lane

Superelevation Transitions for Ramp Curves
### Table 3 Pivot Point on Edge of Lane — Curve in Direction of Normal Pavement Slope

<table>
<thead>
<tr>
<th>S (%)</th>
<th>L_B</th>
<th>L_T</th>
<th>L_B</th>
<th>L_T</th>
<th>L_B</th>
<th>L_T</th>
<th>L_B</th>
<th>L_T</th>
<th>L_B</th>
<th>L_T</th>
<th>L_B</th>
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<th>L_B</th>
<th>L_T</th>
<th>L_B</th>
<th>L_T</th>
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</thead>
<tbody>
<tr>
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<td>65</td>
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<td>80</td>
<td>25</td>
<td>115</td>
<td>25</td>
<td>115</td>
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<td>130</td>
<td>30</td>
<td>150</td>
<td>30</td>
<td>165</td>
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</tr>
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<td>130</td>
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</tr>
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<td>6</td>
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<td>105</td>
<td>105</td>
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<td>115</td>
<td>120</td>
<td>120</td>
<td>130</td>
<td>130</td>
<td>140</td>
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<td>145</td>
<td>145</td>
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<td>160</td>
<td>170</td>
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<tr>
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<td>195</td>
<td>195</td>
<td>210</td>
<td>210</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>9</td>
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<td>160</td>
<td>170</td>
<td>170</td>
<td>180</td>
<td>180</td>
<td>195</td>
<td>195</td>
<td>210</td>
<td>210</td>
<td>225</td>
<td>225</td>
<td>240</td>
<td>240</td>
<td>255</td>
<td>255</td>
</tr>
<tr>
<td>10</td>
<td>180</td>
<td>180</td>
<td>190</td>
<td>190</td>
<td>205</td>
<td>205</td>
<td>220</td>
<td>220</td>
<td>235</td>
<td>235</td>
<td>255</td>
<td>255</td>
<td>270</td>
<td>270</td>
<td>290</td>
<td>290</td>
</tr>
</tbody>
</table>

\[ L_R = L_B \times (1 + 0.04167x) \]

Where: \( x \) = width of lane greater than 15 ft.

\( W_L = \) width of ramp lane

### Superelevation Transitions for Ramp Curves

*Figure 640-14b*
For notes, see Figure 640-15c

Divided Highway Median Sections

Design A Crowned Median

Design B Depressed Median

Alternate Design 1 Treatment on Curves

Alternate Design 2 No Fixed Pivot Point (2)
Design C Minimum Nonpaved Median for 4 or More Lanes (2)

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

For notes, see Figure 640-15c
(1) See Chapter 440 for minimum median width.

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

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

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

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

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

(7) See Chapter 440 for minimum shoulder width.

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

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

Cut heights less than 20 ft. shall be treated as a normal roadway unless otherwise determined by the Region Materials Engineer.

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

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

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

Ordinarily, place fence within a zone of 100 ft to 200 ft maximum from Base of cliff measured along slope.

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

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

Roadway Sections in Rock Cuts, Design B
Figure 640-16b
Notes:
(1) Staked slope line - Maximum slope 1:1.
(2) Step rise - height variable · 1 ft to 2 ft
(3) Step tread - width = staked slope ratio x step rise.
(4) Step termini - width = 1/2 step tread width.
(5) Slope rounding.
(6) Overburden area - variable slope ratio.

Roadway Sections With Stepped Slopes
Figure 640-17
<table>
<thead>
<tr>
<th>Bridge End Condition</th>
<th>Toe of Slope End Slope Rate</th>
<th>Lower Roadway Treatment (1)</th>
<th>Slope Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Piers on Fill</td>
<td>Height</td>
<td>Posted speed Treatment of lower roadway.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rate</td>
<td>&gt; 50 mph</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤ 35 ft</td>
<td>Rounding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 35 ft</td>
<td>≤ 50 mph</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1³/₄H:1V</td>
<td>No rounding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2H:1V (2)</td>
<td>No rounding, toe at center line of the lower roadway ditch.</td>
<td>(4)</td>
</tr>
<tr>
<td>End Piers in Cut</td>
<td>Match lower roadway slope.(3)</td>
<td>No rounding, toe at center line of the lower roadway ditch.</td>
<td>(4)</td>
</tr>
<tr>
<td>Lower Roadway in Cut</td>
<td>Match lower roadway slope.(3)</td>
<td>No rounding, toe at center line of the lower roadway ditch.</td>
<td>(4)</td>
</tr>
<tr>
<td>Ends in Partial Cut and Fill</td>
<td>When the cut depth is &gt; 8 ft and length is &gt; 100 ft, match cut slope of the lower roadway.</td>
<td>When the cut depth is &gt; 8 ft and length is &gt; 100 ft, no rounding, toe at center line of the lower roadway ditch.</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>When the cut depth is ≤ 5 ft or the length is ≤ 100 ft, it is designers choice.</td>
<td>When the cut depth is ≤ 5 ft or the length is ≤ 100 ft, it is designers choice.</td>
<td>(4)</td>
</tr>
</tbody>
</table>

Notes:
(1) See Figure 640-18b
(2) Slope may be 1³/₄H:1V in special cases.
(3) In interchange areas, continuity may require variations.
See 640.07.
Bridge End Slopes

*Figure 640-18b*
650 Sight Distance

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, sight distance is considered in terms of passing sight distance, stopping sight distance, and decision sight distance.

See the following chapters for additional information:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>910</td>
<td>Sight distance at intersections at grade</td>
</tr>
<tr>
<td>920</td>
<td>Sight distance at road approaches</td>
</tr>
<tr>
<td>930</td>
<td>Sight distance at railroad crossings</td>
</tr>
<tr>
<td>1020</td>
<td>Sight distance for paths and trails</td>
</tr>
</tbody>
</table>

650.02 References

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

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

650.03 Definitions

sight distance The length of highway visible to the driver

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

650.04 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 is 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.

Passing sight distance is calculated for a passenger car using an eye height of 3.50 ft and an object height of 4.25 ft. Figure 650-1 gives the passing sight distances for various design speeds.

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Passing Sight Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>935</td>
</tr>
<tr>
<td>30</td>
<td>1,085</td>
</tr>
<tr>
<td>35</td>
<td>1,280</td>
</tr>
<tr>
<td>40</td>
<td>1,475</td>
</tr>
<tr>
<td>50</td>
<td>1,770</td>
</tr>
<tr>
<td>60</td>
<td>2,065</td>
</tr>
<tr>
<td>70</td>
<td>2,460</td>
</tr>
</tbody>
</table>

Passing Sight Distance

Figure 650-1
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 (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 650-6 gives the length of crest vertical curve needed to provide passing sight distance for two-lane highways.

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 3.60 ft or more above the roadway surface. When the length of curve is greater than the passing sight distance and the sight restriction is more than half the passing sight distance into the curve, use the following formula to determine if the object is close enough to the roadway to be a restriction to passing sight distance:

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

Where:

- \(M\) = The distance from the center line of the roadway to the obstruction
- \(R\) = Radius of the curve
- \(S\) = The passing sight distance from Figure 650-1

When the length of curve is less than the passing sight distance or the sight restriction is less than half the passing sight distance into the curve, the desired sight distance may be available with a lesser \(M\) distance. When this occurs, the sight distance can be checked graphically.

(4) **No-Passing Zone Markings**

A knowledge of practices for marking no-passing zones on two-lane roads is helpful in designing a safe highway. The values in Figure 650-1 are the passing sight distances starting at the point the pass begins. The values in the MUTCD are lower than the Figure 650-1 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 650-1 and MUTCD values require careful review by the designer.

650.05 **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.

Stopping sight distance is calculated for a passenger car using an eye height of 3.50 ft and an object height of 0.50 ft. For various design speeds, Figure 650-2 gives the design stopping sight distances, the minimum curve length for a one percent grade change to provide the sight distance for a crest (\(K_C\)) and sag (\(K_S\)) vertical curve, and the minimum length of vertical curve for the design speed (\(VCL_m\)). Figure 650-3 gives the values for existing stopping sight distance and the associated \(K_C\) and \(K_S\).

Provide for design stopping sight distance (Figure 650-2) at all points on all highways and on all intersecting roadways.
Design Stopping Sight Distance

*Figure 650-2*

Existing stopping sight distance (Figure 650-3) is used when the vertical and horizontal alignments are unchanged and the sight obstruction is existing.

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Design Stopping Sight Distance (ft)</th>
<th>KC</th>
<th>KS</th>
<th>VCL_m (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>165</td>
<td>20</td>
<td>28</td>
<td>75</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
<td>30</td>
<td>36</td>
<td>90</td>
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<td>35</td>
<td>260</td>
<td>51</td>
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<td>105</td>
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<td>40</td>
<td>330</td>
<td>82</td>
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</tr>
<tr>
<td>50</td>
<td>460</td>
<td>159</td>
<td>105</td>
<td>150</td>
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<td>60</td>
<td>655</td>
<td>323</td>
<td>159</td>
<td>180</td>
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<tr>
<td>70</td>
<td>855</td>
<td>550</td>
<td>215</td>
<td>210</td>
</tr>
<tr>
<td>80</td>
<td>1,050</td>
<td>830</td>
<td>271</td>
<td>240</td>
</tr>
</tbody>
</table>

Design Stopping Sight Distance on Grades

*Figure 650-4*

(2) Effects of Grade

The grade of the highway has an effect on the stopping sight distance. The vehicle stopping distance is increased on downgrades and decreased on upgrades. Figure 650-4 gives the stopping sight distances for grades steeper than three percent. When evaluating sight distance with a changing grade, use the grade for which the longest sight distance is needed.

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Stopping Sight Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down Grades</td>
<td>Up Grades</td>
</tr>
<tr>
<td>25</td>
<td>165</td>
</tr>
<tr>
<td>30</td>
<td>195</td>
</tr>
<tr>
<td>35</td>
<td>260</td>
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<td>40</td>
<td>330</td>
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<td>50</td>
<td>490</td>
</tr>
<tr>
<td>60</td>
<td>690</td>
</tr>
<tr>
<td>70</td>
<td>920</td>
</tr>
<tr>
<td>80</td>
<td>1,130</td>
</tr>
</tbody>
</table>

(3) Crest Vertical Curves

Use Figure 650-7 to find the minimum crest vertical curve length to provide stopping sight distance when given the algebraic difference in grades. The length can also be determined by multiplying the algebraic difference in grades by the KC value from Figure 650-2 for design or 650-3 for existing (L=KC*A). Both the figure and the equation give approximately the same length of curve. Neither the figure nor the equation uses 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 on Figure 650-7 may be used to find the minimum curve length.
When a new crest vertical curve is built or an existing one is rebuilt, provide Design Stopping Sight Distance from Figure 650-2. An existing crest vertical curve with Existing Stopping Sight Distance from Figure 650-3 may remain in place.

(4) Sag Vertical Curves

Use Figure 650-8 to find the minimum length for a sag vertical curve when given the stopping sight distance and the algebraic difference in grades. The minimum length for a sag vertical curve can also be determined by multiplying the algebraic difference in grades by the $K_s$ value from Figure 650-2 for design or 650-3 for existing ($L = K_s \times A$). Both the figure and the equation give approximately the same length of curve. Neither the figure nor the equation uses 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 on Figure 650-8 may be used to find the minimum length of curve.

When a new sag vertical curve is built or an existing one is rebuilt, provide Design Stopping Sight Distance from Figure 650-2. An existing sag vertical curve with Existing Stopping Sight Distance from Figure 650-3 may remain in place.

(5) Horizontal Curves

Use Figure 650-9 to check for adequate stopping sight distance where sight obstructions are on the inside of a curve. A stopping sight distance obstruction is any object 2 ft or greater above the roadway surface (such as median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings). Figure 650-9 (both the equation and the graph) 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 less than half the stopping sight distance into the curve, the desired sight distance may be available with a lesser $M$ distance. When this occurs, the sight distance can be checked graphically.

Provide Design Stopping Sight Distance from Figure 650-2 for horizontal curves as follows:

- For all new roadways
- When the roadway is widened
- When there is an alignment shift
- For new features (such as median barrier, bridges, walls, or guardrail)
- When additional right of way is required for roadside improvements

When design stopping sight distance is not required, existing features that have Existing Stopping Sight Distance from Figure 650-3, may remain in place.

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 a likelihood for error in information reception, decision making, or control actions. Example highway features include interchanges and intersections; changes in cross section at toll plazas, drop lanes, etc.; and areas of concentrated demand where sources of information compete, as 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 650-5 where highway features require complex driving decisions.
<table>
<thead>
<tr>
<th>Design speed (mph)</th>
<th>Decision Sight Distance for Maneuvers (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>30</td>
<td>230</td>
</tr>
<tr>
<td>40</td>
<td>345</td>
</tr>
<tr>
<td>50</td>
<td>510</td>
</tr>
<tr>
<td>60</td>
<td>690</td>
</tr>
<tr>
<td>70</td>
<td>900</td>
</tr>
<tr>
<td>80</td>
<td>1,100</td>
</tr>
</tbody>
</table>

**Decision Sight Distance**

*Figure 650-5*

The maneuvers in Figure 650-5 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; 3.50 ft eye height and 0.50 ft object height. Use the equations on Figures 650-7, 8, and 9 to determine the decision sight distance at vertical and horizontal curves.
Formulas:

When $S$ is less than $L$

\[ L = \frac{AS^2}{3093} \]

When $S$ is greater than $L$

\[ L = 2S - \frac{3093}{A} \]

$S =$ Sight distance in feet

$L =$ Length of vertical curve in feet

$A =$ Algebraic difference of grades in percent

Passing Sight Distance for Crest Vertical Curves

*Figure 650-6*
Stopping Sight Distance for Crest Vertical Curves

Figure 650-7

When $S > L$

$L = 2S - 1329/A$

(not used in figure)

When $S < L$

$L = AS^2/1329$

$L =$ Curve length (ft)

$A =$ Algebraic grade difference (percent)

$S =$ Sight distance (ft)

\[
\begin{array}{c|c}
S & \text{Length of Vertical Curve (ft)} \\
165 & 0 \text{ ft} \\
200 & 0 \text{ ft} \\
225 & 0 \text{ ft} \\
250 & 0 \text{ ft} \\
275 & 0 \text{ ft} \\
300 & 0 \text{ ft} \\
325 & 0 \text{ ft} \\
350 & 0 \text{ ft} \\
375 & 0 \text{ ft} \\
400 & 0 \text{ ft} \\
425 & 0 \text{ ft} \\
450 & 0 \text{ ft} \\
475 & 0 \text{ ft} \\
500 & 0 \text{ ft} \\
525 & 0 \text{ ft} \\
550 & 0 \text{ ft} \\
575 & 0 \text{ ft} \\
600 & 0 \text{ ft} \\
625 & 0 \text{ ft} \\
650 & 0 \text{ ft} \\
675 & 0 \text{ ft} \\
700 & 0 \text{ ft} \\
725 & 0 \text{ ft} \\
750 & 0 \text{ ft} \\
775 & 0 \text{ ft} \\
800 & 0 \text{ ft} \\
825 & 0 \text{ ft} \\
850 & 0 \text{ ft} \\
875 & 0 \text{ ft} \\
900 & 0 \text{ ft} \\
925 & 0 \text{ ft} \\
950 & 0 \text{ ft} \\
975 & 0 \text{ ft} \\
1000 & 0 \text{ ft} \\
1025 & 0 \text{ ft} \\
1050 & 0 \text{ ft} \\
1075 & 0 \text{ ft} \\
1100 & 0 \text{ ft} \\
1125 & 0 \text{ ft} \\
1150 & 0 \text{ ft} \\
1175 & 0 \text{ ft} \\
1200 & 0 \text{ ft} \\
1225 & 0 \text{ ft} \\
1250 & 0 \text{ ft} \\
1275 & 0 \text{ ft} \\
1300 & 0 \text{ ft} \\
1325 & 0 \text{ ft} \\
1350 & 0 \text{ ft} \\
1375 & 0 \text{ ft} \\
1400 & 0 \text{ ft} \\
1425 & 0 \text{ ft} \\
1450 & 0 \text{ ft} \\
1475 & 0 \text{ ft} \\
1500 & 0 \text{ ft} \\
1525 & 0 \text{ ft} \\
1550 & 0 \text{ ft} \\
1575 & 0 \text{ ft} \\
1600 & 0 \text{ ft} \\
1625 & 0 \text{ ft} \\
1650 & 0 \text{ ft} \\
1675 & 0 \text{ ft} \\
1700 & 0 \text{ ft} \\
1725 & 0 \text{ ft} \\
1750 & 0 \text{ ft} \\
1775 & 0 \text{ ft} \\
1800 & 0 \text{ ft} \\
1825 & 0 \text{ ft} \\
1850 & 0 \text{ ft} \\
1875 & 0 \text{ ft} \\
1900 & 0 \text{ ft} \\
1925 & 0 \text{ ft} \\
1950 & 0 \text{ ft} \\
1975 & 0 \text{ ft} \\
2000 & 0 \text{ ft} \\
2025 & 0 \text{ ft} \\
2050 & 0 \text{ ft} \\
2075 & 0 \text{ ft} \\
2100 & 0 \text{ ft} \\
2125 & 0 \text{ ft} \\
2150 & 0 \text{ ft} \\
2175 & 0 \text{ ft} \\
2200 & 0 \text{ ft} \\
2225 & 0 \text{ ft} \\
2250 & 0 \text{ ft} \\
2275 & 0 \text{ ft} \\
2300 & 0 \text{ ft} \\
2325 & 0 \text{ ft} \\
2350 & 0 \text{ ft} \\
2375 & 0 \text{ ft} \\
2400 & 0 \text{ ft} \\
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2975 & 0 \text{ ft} \\
3000 & 0 \text{ ft} \\
\end{array}
\]
When $S > L$

$$L = 2S - \frac{400 + 3.5S}{A}$$

(not used in figure)

When $S < L$

$$L = \frac{AS^2}{400 + 3.5S}$$

$L$ = Curve length (feet)

$A$ = Algebraic grade difference (percent)

$S$ = Sight distance (feet)
Height of eye: 3.50 ft
Height of object: 0.50 ft
Line of sight is normally 2.00 ft above centerline of inside lane at point of construction provided no vertical curve is present in horizontal curve.

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

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

\( S \leq \) Length of curve

Angle is expressed in degrees

Horizontal Stopping Sight Distance

Figure 650-9
700 Roadside Safety

700.01 General
Roadside safety addresses the area outside of the roadway and is an important component of total highway design. The roadside environment is significant to safety as illustrated by the fact that nearly one third of the fatal accidents are single vehicle run-off-the-road accidents. 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. 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 the 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 or earth berms only when other measures cannot reasonably be accomplished. See Chapter 710 for additional information on traffic barriers.

700.02 References
Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
Roadside Management Manual, M 25-30, WSDOT
Roadside Design Guide, AASHTO

700.03 Definitions
ADT The average daily traffic for the design year under consideration.
clear run-out area The area at 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 slope.
Design Clear Zone is the minimum target value used in highway design.
critical slope A slope on which a vehicle is likely to overturn. Slopes steeper than 3H:1V are considered critical slopes.
hazard A side slope, a fixed object, or water that, when struck, would result in unacceptable impact forces on the vehicle occupants or place the occupants in a hazardous position. It 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 a 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
The clear zone is a primary consideration when analyzing hazards. The intent is to provide as much clear, traversable recovery area as practical. The Design Clear Zone values shown in Figure 700-1 are used to judge the adequacy of the existing clear zone and to provide a minimum target value for highway design. These values are not to be used as justification to compromise or take away from the existing clear zone.

A Design Clear Zone inventory is required for all projects indicating evaluate upgrade (EU) or Full Design Level (F) for the clear zone columns on the design matrices. (See Chapter 325.) Use the Design Clear Zone Inventory form (Figure 700-2) to inventory the roadside for potential hazards. Identify the hazards and propose corrective actions. Eliminating the hazard is the preferred action. Analyze a roadside hazard to determine if further mitigation is necessary even when it is beyond the values in Figure 700-1. When locating a highway appurtenance (such as a sign bridge, bridge pier, or sign post) in an otherwise recoverable area, use the values in Figure 700-1 as guidance in determining the need for mitigation.

The Design Clear Zone 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 may 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:

1. The Design Clear Zone distance for a 10H:1V cut section based on speed and ADT, or
2. A horizontal distance of 5 ft beyond the beginning of the back slope.

When a back slope steeper than 3H:1V continues for 5 ft beyond the beginning of the back slope (as is the case with a redirectional land form), it is not necessary to use the 10H:1V cut slope criteria.

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

(c) For ditch sections with foreslopes steeper than 4H:1V and back slopes 3H:1V or flatter, the Design Clear Zone distance is the distance established using the recovery area formula (Figure 700-3). (See 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 histories.
- Locations with pedestrian and bicycle usage. See Chapter 1020.02(c) (pedestrian) and 1020.03(6)(a)4 (bicycle).
• Playgrounds, monuments, and other locations with high social or economic value may require mitigation such as a barrier.

Use of a traffic barrier for obstacles other than those described below requires justification in the design file.

(1) Side Slopes

(a) Fill Slopes. Fill slopes can present a hazard to an errant vehicle with the degree of severity dependant 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 may 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 nonstandard slope, that result is not justification for a deviation.

For example, if the ADT is 4000 and the embankment height is 10 ft, barrier would 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 may compound the hazard. Where barrier is not cost effective, use the recovery area formula to evaluate fixed objects on critical slopes less than 10 ft 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 could 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. Some potential options are:

• Redirectional land form.
• 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 supports.
• Nonbreakaway luminaire supports.
• Trees having a diameter of 4 in or more measured at 6 in above the ground surface.
• Fixed objects extending above the ground surface by more than 4 in; for example, boulders, concrete bridge rails, piers, and retaining walls.
• Existing nonstandard guardrail (see Chapter 710).
• Drainage items, such as culvert and pipe ends.

Remove objects that are hazards when feasible. Focus on the area within the Design Clear Zone but do not exclude consideration of objects outside this area. 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 redirectional landform, longitudinal barrier, or impact attenuator.

(a) **Trees.** When evaluating new plantings or existing trees, consider the maximum allowable diameter of 4 in measured at 6 in 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 Management 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 standard height of mailboxes from the ground to the bottom of the mailbox is 40 in. This height may vary from 40 to 48 in if requested by the mail carrier. Include a note in the contract plans that gives the height desired if it is to be different from the standard height. 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 access controlled highways in accordance with Chapter 1420. A turnout, as shown on Figure 700-6, is not required on access controlled facilities with shoulders of 6 ft or more where only one mailbox is to be installed. On highways without access control, 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 (NDCBU) 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 in extending out of the side slope.

Bars may 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 in measured parallel to the direction of travel.
2. Multiple cross culvert openings that exceed 30 in each, measured parallel to the direction of travel.
3. Culvert approximately parallel to the roadway has an opening that exceeds 24 in 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 sign supports behind existing or planned traffic barrier installations to eliminate the need for breakaway supports. Place them at least 25 ft 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 supports. 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.
(3) Water

Water with a depth of 2 ft 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.

700.06 Median Considerations

Medians must be analyzed for the potential of an errant vehicle to cross the median and encounter on-coming traffic. Median barriers are normally used on access controlled, multilane, high-speed, high traffic volume facilities. These facilities generally have posted speeds of 50 mph or greater. Median barrier is not normally placed on collector highways or other facilities that do not have controlled access. Providing access through median barrier requires openings and, therefore, end-treatments.

In the absence of cross median accident data, on access controlled, high-speed, multilane, high traffic volume facilities that have relatively flat, unobstructed medians, use Figure 700-7 to determine if median barrier is warranted.

As indicated in Figure 700-7, the need for median barrier is based on a combination of ADT and median widths. At low ADTs, the probability of a vehicle crossing the median is relatively low. Thus, for ADTs less than 20,000, use of median barrier is optional. Likewise, for relatively wide medians, the probability of a vehicle crossing the median is also relatively low. Thus, for median widths greater than 30 ft, use of median barrier is optional. Consider cable barrier in these wide medians. Median barrier is not recommended for medians wider than 50 ft unless there is a history of across-the-median accidents.

When median barrier is warranted for a median of less than 6 ft on an existing facility, median widening is required to provide median width of 8 ft. An approved deviation is required for the use of a median barrier in a median of less than 6 ft.

Consider a wider median when the barrier casts a shadow on the roadway and hinders 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 620 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 910, considering enforcement needs.

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 two 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 Olympia Service Center Design Office for additional guidance on the design and placement of roadway rumble strips.
Document justification for using roadway rumble strips in the project file.

(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. A comparison of rolled-in rumble strips and milled-in Continuous Shoulder Rumble Strips (CSRS) has determined that CSRS, although more expensive, are more cost effective. CSRS are the standard design.

Rumble strips may be used when an analysis indicates a problem with run-off-the-road accidents due to inattentive or fatigued drivers. Consider them on both shoulders of rural divided highways. CSRS are required on both the right and left shoulders of rural Interstate highways.

Lack of required CSRS 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 CSRS will result in inadequate shoulder strength.
- When shoulders will be less than 4 ft wide on the left and 6 ft wide on the right.

When CSRS are used, discontinue them where no edge strip is present such as at intersections and where curb and gutter are present.

**(2) Headlight Glare**

Headlight glare from opposing traffic can cause safety problems. Glare can be reduced by the use of wide medians, separate alignments, earth mounds, plants, standard and tall barriers, and by devices known as glare screens specifically designed to reduce glare. Consider long term maintenance when selecting the treatment for glare. When considering earth mound and planting to reduce glare, see the *Roadside Management Manual* for additional guidance. When considering glare screens, see Chapter 620 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 ft, 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 700-8).

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

- Design Clear Zone inventory and evaluation documents
- Justification for barrier use not meeting criteria in 700.05
- Hydraulic evaluation for culvert bars
- Median accident evaluation and barrier warrant determination
- Median width deviation for barrier placement
- Roadway rumble strip justification
- Conditions for CSRS DE
- Glare screen justification

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* When the fill section slope is steeper than 4H:1V but not steeper than 3H:1V, the clear zone distance modified by the recovery area formula (shown on Figure 710-3) and is referred to as the recovery area. The basic philosophy behind the recovery area formula is that a vehicle can traverse these slopes but cannot recover (control steering) and therefore, the horizontal distance of these slopes is added to the clear zone distance to form the recovery area.
# Design Clear Zone Inventory

<table>
<thead>
<tr>
<th>Region</th>
<th>SR</th>
<th>Control Section</th>
<th>MP to MP</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
<th>Responsible Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Number</th>
<th>MP to MP</th>
<th>Distance From Traveled Way L R</th>
<th>Description</th>
<th>Corrective Actions Considered (2)</th>
<th>Estimated Cost to Correct</th>
<th>Correction Planned (1)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Only one "Yes" or "No" per item number. Corrections not planned must be explained on reverse side.
2. A list of Location 1 & 2 Utility Objects is forwarded to the Region Utility Office for coordination per Control Zone Guidelines.

DOT Form 410-026 EF
Revised 6/97
<table>
<thead>
<tr>
<th>Item Number</th>
<th>Reasons for Not Taking Corrective Action</th>
</tr>
</thead>
</table>

Design Clear Zone Inventory Form

*Figure 700-2, Sheet 2 of 2*
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 ft or less.

**Formula:**

Recovery Area =  (shoulder width) + (horizontal distance)  
+ (Design Clear Zone distance - 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  
Recovery Area =  (shoulder width) + (horizontal distance)  
+ (Design Clear Zone distance - shoulder width)  
=  8 + 12 + (17 - 8)  
=  29 ft
Cut Section with Ditch (foreslope 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 ft  
2. 5 ft horizontal beyond beginning of backslope, 22 ft  

Design Clear Zone = 23 ft  

Case 1

Cut Section with Ditch (foreslope 3H:1V or steeper and backslope steeper than 3H:1V)

Conditions: NA  

Criteria: 10 ft horizontal beyond beginning of backslope  

Design Clear Zone = 19 ft  

Case 2

Cut Section with Ditch (foreslope 3H:1V or steeper and backslope not steeper than 3H:1V)

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

Criteria: Use Recovery Area Formula  

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

Case 3

Design Clear Zone for Ditch Sections  

*Figure 700-4*
Guidelines for Embankment Barrier

Figure 700-5

Note: Routes with ADTs under 400 may be evaluated on a case by case basis.
Mailbox Location and Turnout Design

Figure 700-6

Mailbox Location
Detail A

Edge of all-weather surface at mail stop

Direction of traffic

1 ft (min)

0.5 ft - 1 ft

14 ft (min)

3 ft (min)

6 ft (min)

C of first mailbox

Variable

C of last mailbox

30 ft min to C of road approach or intersection

Mailbox Turnout

Direction of traffic

Edge of traveled way

Edge of shoulder

4:1

10 ft Desirable
8 ft (min)

2.5:1

14 ft (min)

6 ft (min)

Variable

See Detail A

Mailbox Location and Turnout Design

Figure 700-6
Glare Screens

Figure 700-8
Traffic barriers are used to reduce the severity of accidents that occur when an errant vehicle leaves the traveled way. However, traffic barriers are obstacles that the vehicle will encounter and must only be used when justified by accident history or the criteria in Chapter 700.

**References**

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

*Roadside Design Guide*, AASHTO

*Bridge Design Manual*, M 23-50, WSDOT

*Traffic Manual*, M 51-02, WSDOT

**Definitions**

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

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

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

*Guardrail transition* A section of barrier used to produce a gradual stiffening of a flexible or semi-rigid barrier as it connects to a more rigid barrier or fixed object.

*Impact attenuator system* A device that acts primarily to bring an errant vehicle to a stop at a deceleration rate tolerable to the vehicle occupants.

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

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

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

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

**Project Requirements**

This section identifies the barrier elements that must be addressed according to the Design Matrices in Chapter 325. Remove any barrier that is not needed based on accident history or the criteria in Chapter 700.
(1) **Basic Safety**

When the Basic Safety column of a Design Matrix applies to the project and the height of W-beam guardrail is or would be reduced to less than 24 in from the ground to the top of the rail element, adjust the height to the standard height as shown in the *Standard Plans*. If Type 1 Alternate W-beam guardrail is present, raise the rail element after each overlay.

(2) **Barrier Terminals and Transitions**

When the Terminal and Transition Section column of a Design Matrix applies to the project, the barrier terminals and transitions must meet the requirements found in the following sections:

- 710.06(2) Beam Guardrail Terminals
- 710.06(3) Beam Guardrail Transitions
- 710.08(2) Concrete Barrier Terminals
- Chapter 720 Impact Attenuators

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

(3) **Standard Run of Barrier**

When the basic design level (B) is indicated in the Standard Run column of a Design Matrix, see (1) above. When the full design level (F) is indicated, the barrier must meet the requirements found in the following sections:

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

Examples of nonstandard barriers include:

- W-beam guardrail with 12 ft 6 in post spacing and no blockouts.
- W-beam guardrail on concrete posts.
- Cable barrier on wood or concrete posts.
- Half-moon or C shape rail element.

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

(4) **Bridge Rail**

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

<table>
<thead>
<tr>
<th>Aluminum Rail Type</th>
<th>Curb Width</th>
<th>Curb Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 in or less</td>
<td>Greater than 9 in*</td>
<td></td>
</tr>
<tr>
<td>Type R, S, or SB</td>
<td>Bridge rail adequate</td>
<td>Bridge rail adequate</td>
</tr>
<tr>
<td>Type 1B or 1A</td>
<td>Bridge rail adequate</td>
<td>Upgrade bridge rail</td>
</tr>
<tr>
<td>Other</td>
<td>Consult the Bridge and Structures Office</td>
<td></td>
</tr>
</tbody>
</table>

*When the curb width is greater than 9 in, the aluminum rail must be able to withstand a 5 kip load.

**Type 7 Bridge Rail Upgrade Criteria**

*Figure 710-1*
Use an approved, crash tested concrete bridge rail on new bridges or bridges to be widened. The Bridge Design Manual provides examples of typical bridge rails. Consult the Bridge and Structures Office regarding bridge rail selection and design and for design of the connection to an existing bridge.

An existing bridge rail on a highway with a posted speed of 30 mph or less may remain in place if it is not located on a bridge over a National Highway System highway. All other bridge rails must be evaluated for strength and geometrics. (See 710.10 for guidance on retrofit techniques.)

The Type 7 bridge rail is common. Type 7 bridge rails have a curb, a vertical-face parapet, and an aluminum top rail. The curb width and the type of aluminum top rail dictate the adequacy of the Type 7 bridge rail as shown on Figure 710-1.

710.05 Barrier Design

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

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

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

(1) Shy Distance

Provide an additional 2 ft of widening for shy distance when a barrier is to be installed in areas where the roadway is to be widened and the shoulder width will be less than 8 ft. This shy distance is not required when the section of roadway is not being widened or the shoulders are at least 8 ft wide.

(2) Barrier Deflections

See Figure 710-2 for barrier deflection design values to be used when selecting a longitudinal barrier.

All barriers except rigid barriers (concrete bridge rails for example) will deflect when hit by an errant vehicle. The amount of deflection depends on the stiffness of the system. The deflected system must not become a hazard to oncoming traffic or allow the impacting vehicle to strike an object being shielded.

A rigid system must be used where deflection cannot be tolerated such as in narrow medians, at bridge piers, and for overhead sign structures. Runs of rigid concrete barrier can be cast-in-place, extruded with appropriate footings, or standard precast concrete barrier that is bolted or bracketed to the underlying material.

<table>
<thead>
<tr>
<th>Barrier Type</th>
<th>System Type</th>
<th>Deflection</th>
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</thead>
<tbody>
<tr>
<td>Cable barrier</td>
<td>Flexible</td>
<td>11.5 ft</td>
</tr>
<tr>
<td>Beam guardrail Types 1, 1a, 2, and 10</td>
<td>Semi-Rigid</td>
<td>3 ft</td>
</tr>
<tr>
<td>Two-sided W-beam guardrail Types 3 and 4</td>
<td>Semi-Rigid</td>
<td>2 ft</td>
</tr>
<tr>
<td>Concrete Barrier, Unanchored</td>
<td>Unrestrained</td>
<td>2 ft</td>
</tr>
<tr>
<td>Concrete Barrier, Anchored</td>
<td>Rigid</td>
<td>no deflection</td>
</tr>
</tbody>
</table>

Longitudinal Barrier Deflection

Figure 710-2
(3) **Flare Rate**

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

- To locate the barrier and its terminal as far from the traveled way as is feasible.
- To reduce the length of need.
- To redirect an errant vehicle without serious injuries to its occupants.
- To minimize a driver’s reaction to the introduction of an object near the traveled way.

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

<table>
<thead>
<tr>
<th>Posted Speed mph</th>
<th>Rigid System</th>
<th>Unrestrained Rigid System</th>
<th>Semi-Rigid System</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>20:1</td>
<td>18:1</td>
<td>15:1</td>
</tr>
<tr>
<td>60</td>
<td>18:1</td>
<td>16:1</td>
<td>14:1</td>
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<td>16:1</td>
<td>14:1</td>
<td>12:1</td>
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</tr>
<tr>
<td>40</td>
<td>11:1</td>
<td>10:1</td>
<td>9:1</td>
</tr>
</tbody>
</table>

**Longitudinal Barrier Flare Rates**

*Figure 710-3*

(4) **Length of Need**

The length of traffic barrier required to shield a hazard (length of need) is dependent on the location and geometrics of the hazard, direction(s) of traffic, posted speed, traffic volume, and type and location of traffic barrier.

When designing a barrier for a fill slope as recommended in Chapter 700, the length of need begins at the point where barrier is recommended. For fixed objects and water hazards, Figure 710-11 shows design parameters for determining the necessary length of a barrier for both adjacent and opposing traffic. Consider the flare rate, barrier deflection, and barrier end treatment to be used when determining the length of need.

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

If the end of the length of need is near an adequate cut slope, extend the barrier and embed it in the slope. Avoid gaps of 4 in or less. Short gaps are acceptable when the barriers are terminated in a cut slope. If the end of the length of need is near the end of an existing barrier, it is recommended that the barriers be connected to form a continuous barrier. Consider maintenance access when determining whether to connect barriers.

710.06 **Beam Guardrail**

(1) **Beam Guardrails**

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

Strong post W-beam guardrail (Types 1 through 4) and thrie beam guardrail (Type 10) are semi-rigid barriers used predominately on roadsides. They also have limited application as median barrier. Strong post beam guardrail that has been installed incorrectly can cause vehicle snagging or spearing. This can be avoided by lapping the rail splices in the direction of traffic as shown in the *Standard Plans*, by using crashworthy end treatments, and by blocking the rail away from the strong posts. In no case will more than two 8 in blockouts be permitted at any location.
On asphalt concrete pavements (where overlays are anticipated), the Type 1 Alternate guardrail can be used to allow raising of the guardrail without having to adjust the posts.

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

Keep the slope of the area between the edge of shoulder and the face of the guardrail as flat as possible. The preferred slope is 10H:1V or flatter. Do not place beam guardrail on a fill slope steeper than 6H:1V. On fill slopes between 6H:1V and 10H:1V, beam guardrail must not be placed within 12 ft of the break point. (See Figure 710-4.)

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

It is preferred that no curbs be installed in conjunction with beam guardrail. However, if a curb is necessary, the 3 in high curb is preferred. The 4 in high curb can only be used at locations where the 3 in curb will not be adequate. Do not use 6 in high curb in conjunction with beam guardrails. This policy applies to new installations. Existing 6 in high curb is allowed to remain in place. If work requires replacement of an existing 6 in curb, it must be replaced with a 3 in or 4 in curb, whichever is appropriate.

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

(2) Terminals and Anchors

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

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

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

The backslope required to install a BT must be 3H:1V or steeper and at least 4 ft in height above the roadway. Flare the guardrail into the backslope using a flare rate that meets the criteria
in 710.05(3). Provide a 10H:1V or flatter foreslope into the face of the guardrail and maintain the full guardrail height to the foreslope/backslope intersection. This may require filling ditches and installing culverts in front of the guardrail face.

(b) **Flared Terminal.** If a BT cannot be installed as described above, consider a flared terminal. (See Figure 710-13.) There are currently 2 acceptable sole source proprietary designs: the Slotted Rail Terminal (SRT) and the Flared Energy Absorbing Terminal (FLEAT 350).

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

The FLEAT 350 uses W-beam guardrail with a special end piece that fits over the end of the guardrail and wood breakaway and CRT posts. The end of the FLEAT 350 is offset from the tangent guardrail run by the use of a straight flare. When struck head on, the end piece is forced over the rail, bending the rail and forcing it away from the impacting vehicle.

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

The SRT is available in 2 designs based on the posted speed of the highway. For high speed highways (posted speed of 50 mph or greater) use an SRT-350 that has a 4 ft offset at the first post. For lower speed highways (posted speed of 45 mph or less), use an SRT-75 that has a 1.5 ft offset at the first post. The FLEAT 350 has a 4 ft offset at the first post.

When a flared terminal is specified, it is critical that embankment also be specified so that the area around the terminal can be flattened as shown on the Standard Plans. For every foot of height of the embankment, 13 cubic yards of “Embankment in Place” must be specified.

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

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

(c) **Nonflared Terminal.** Where widening to provide the offset for a flared terminal is not practical, consider a nonflared terminal. (See Figure 710-13.) There are currently 2 acceptable sole source proprietary designs; the ET 2000-LET and the Sequential Kinking Terminal (SKT-350). Both of these systems use W-beam guardrail with a special end piece that fits over the end of the guardrail and wood breakaway and CRT posts. When hit head-on, the end piece is forced over the rail and either flattens or bends the rail and then forces the rail away from the impacting vehicle.

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

While these terminals do not require an offset at the end, a 50:1 flare is recommended so that the end piece does not protrude into the shoulder. Three ft of widening is required at the end 2 posts to ensure that the system is properly anchored. For every foot of height of embankment, 3 cubic yards of “Embankment in Place” must be specified.

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

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

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

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

(e) Evaluating Existing Terminals. There are several older terminal designs that may be encountered on our highways. The predominant terminal on our highways is the Breakaway Cable Terminal (BCT). This system used a parabolic flare similar to the SRT with a Type 1 anchor. Type 1 anchor posts are wood set in a steel tube or a concrete foundation.

BCTs that have at least a 3 ft offset may remain in place unless the guardrail run or anchor is being reconstructed or reset. (Raising the rail element is not considered reconstruction or resetting.) BCTs with less than a 3 ft offset must be replaced.

Replace existing buried terminals that slope down such that the guardrail height is reduced to less than 24 in.

Replace guardrail ends that do not have a crashworthy design with a crash worthy guardrail terminal. Common features of noncrashworthy designs are as follows:

- No cable anchor.
- A cable anchored into concrete in front of the first post.

- Second post not breakaway (CRT).
- Design A end section (Design C end sections are acceptable to be left in place).
- Beam guardrail on both sides of the posts (two sided).

The old Type 3 anchor, which was primarily used at bridge ends. (See Figure 710-5.) This anchor consisted of a steel pipe mounted vertically in a concrete foundation. Bridge approach guardrail was then mounted on the steel pipe. On one-way highways, these anchors were usually positioned so that neither the anchor nor the bridge rail posed a snagging hazard. In these cases, the anchor may remain in place if a stiffened transition section is provided at the connection to the post. On two-way highways the anchor may present a snagging hazard. In these cases, install a connection from the anchor to the bridge rail if the offset from the bridge rail to the face of the guardrail is 18 in or less. If the offset is greater than 18 in, remove the anchor and install a new transition and connection.

(3) Transitions and Connections

When there is an abrupt change from one barrier type to a more rigid barrier type, a vehicle hitting the more flexible barrier is likely to be caught in the deflected barrier pocket and directed into the more rigid barrier. This is commonly referred to as pocketing. A transition stiffens the more flexible barrier by decreasing the post spacing, increasing the post size, and using stiffer beam elements to eliminate the possibility of pocketing.
When connecting beam guardrail to a more rigid barrier or a structure, or when a rigid object is within the deflection distance of the barrier, use the transitions and connections that are shown on Figures 710-6 and 7 and detailed in the Standard Plans. The transition pay item includes the connection.

### Guardrail Connections

**Figure 710-6**

(4) **Guardrail Placement Cases**

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

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

**Case 2** is used where there is two-way traffic. A crashworthy terminal is used on both ends. When SRT terminals are used on both ends, a minimum of 25 ft of guardrail is required between the terminal limits.

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

**Case 4** is used where guardrail on the approach to a bridge is be shifted laterally to connect with the bridge rail. A terminal is used on the approach end and a transition is required at the bridge end. A 50 ft curve is shown. However, the length of the curve is not critical and the only requirement is to provide a smooth curve that is not more abrupt than the allowable flare rate. (See Figure 710-3.)

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

**Case 6** is used on bridge approaches where opposing traffic is separated by a median that is 36 ft or wider. This case was designed so that the end of the guardrail would be outside of the clear zone for the opposing traffic.

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

**Case 9** is used on bridge approaches where opposing traffic is separated by a median less than 36 ft wide. This design, called a “Bull Nose Attenuator,” treats both bridge ends and the opening between the bridges. The “nose” is designed to collapse when struck head-on and the ribbon strength of the rail brings the vehicle to a controlled stop. Type 7 anchors are installed on each side of the nose to develop the ribbon strength.

Since an impacting vehicle will penetrate into the system, it is critical that no fixed object be located within the first 30 ft of the system. Table 1 on this standard plan gives the dimensions needed for a range of median widths.

**Case 10** (A, B, and C) is used at roadside hazards (such as bridge piers) when 3 ft or more is available from the face of the guardrail to the hazard. The approach end is the same for one-way or two-way traffic. Case 10A is used with two-way traffic and, therefore, a terminal is required on the trailing end. Case 10B is used for...
<table>
<thead>
<tr>
<th>Connecting W-beam guardrail to:</th>
<th>Transition</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bridge Rail</strong></td>
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<td>New</td>
<td>1*</td>
<td>D</td>
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<tr>
<td>Existing concrete</td>
<td>1*</td>
<td>Figure 710-6</td>
</tr>
<tr>
<td>Concrete parapet &gt; 500 mm</td>
<td>1*</td>
<td>Figure 710-6</td>
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<tr>
<td>Concrete Parapet &lt; 500 mm</td>
<td>2</td>
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<tr>
<td>Existing W-Beam Transition</td>
<td>2**</td>
<td>***</td>
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<tr>
<td>face of curb</td>
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<td></td>
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<tr>
<td>Trailing end, two way traffic</td>
<td>11, 12</td>
<td>na</td>
</tr>
<tr>
<td>only</td>
<td></td>
<td></td>
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<tr>
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<td>na</td>
</tr>
<tr>
<td>bridge rail</td>
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<tr>
<td>(curb exposed)</td>
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<tr>
<td>Trailing end, two way traffic</td>
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<tr>
<td>All if: Weak Post Intersection</td>
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<td>Figure 710-6</td>
</tr>
<tr>
<td>Design (see 710.06(4) cases 12</td>
<td></td>
<td></td>
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<tr>
<td>and 13)</td>
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* A Type 1a transition can be used where there is a problem placing a post within 2 ft 5 in from the end of the bridge in which case a B or E connection is required. When the E connection is to be used, a special detail for the end of the bridge is required. Contact the Bridge and Structures Office.

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

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

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

---

**Transitions and Connections**

*Figure 710-7*

One-way traffic when there is no need to extend guardrail past the bridge pier and a Type 4 anchor is used to end the guardrail. Case 10C is used for one-way traffic when the guardrail will extend for a distance past the bridge pier.

Case 11 (A, B, and C) is used at roadside hazards (such as bridge piers) when the guardrail is to be placed within 3 ft of the hazard. Since there is no room for deflection, the rail in front of the hazard must be considered a rigid system and a transition is necessary. The trailing end cases are the same as described for Placement Case 10.

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

Since an impacting vehicle will penetrate into the system, it is critical that no fixed objects be located within the clear area shown on the standard plan. The 25 ft along the side road is critical for the operation of this system.

**Case 14** shows the approach rail layout for a Service Level 1 bridge rail system. Type 20 guardrail is used and no transition is required.

**Case 15** is used to carry guardrail across a box culvert where there is insufficient depth to install standard posts for more than 17.7 ft. This design uses steel posts anchored to the box culvert to support the rail. Newer designs, Cases 19, 20 and 21, have replaced this design for shorter spans.

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

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

**Cases 19 and 20** are used where it is not possible to install a post at the 6 ft 3 in spacing. These designs omit one post (which allows a span of 11.5 ft) and use nested W-beam to stiffen the rail. The cases differ by the location of the splice. No cutting of the rail or offsetting of the splices is necessary or desirable.

**Case 21** is similar to Cases 19 and 20, except that it allows for two posts to be omitted which allows a span of 17.7 ft.

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

### 710.07 Cable Barrier

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

This system consists of three steel cables mounted to steel posts (weak posts). The maximum spacing for the steel posts is 16 ft on tangent sections and curves of 700 ft radius or greater. A deflection of 11.5 ft is anticipated with this post spacing. A smaller spacing is required on radii less than 700 ft. For tangent sections and large radius curves, the deflection can be reduced to 7 ft by reducing the post spacing to 4 ft.

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

Cable barrier can be installed in front of side slopes as steep as 2H:1V. This barrier is the only barrier that can be placed on a side slope steeper than 10H:1V within the 12 ft area immediately beyond the breakpoint. Do not place this barrier on a side slope steeper than 6H:1V. Figure 710-14 shows the placement of cable barrier.

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

The primary advantage of cable barrier is that it provides effective vehicle containment and redirection while imposing the lowest deceleration forces on the vehicle’s occupants. It also has advantages in heavy snowfall areas and it does not present a visual barrier.

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

### 710.08 Concrete Barrier

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

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

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

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

(1) Concrete Barrier Shapes

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

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

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

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

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

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

Concrete barrier Type 2 (see the Standard Plans) is a precast barrier that has the New Jersey shape on two sides and can be used for both median and shoulder installations. This barrier is 32 in in height, which includes 3 in for future pavement overlay.
Concrete barrier Type 5 is a precast barrier that has a single New Jersey face and is intended for use at bridge ends where the flat side is highly visible. Both designs are freestanding, unanchored units connected with steel pins through wire rope loops. For permanent installation, this barrier is placed on a paved surface and a 2 ft wide paved surface is provided beyond the barrier for its displacement during impact. (See Chapter 640.)

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

Precast barrier can be anchored where a more rigid barrier is desired. Anchoring methods are shown in the Standard Plans. Precast barrier used on the approach to bridge rail must be connected to the bridge rail by installing wire rope loops embedded 15 in into the bridge rail with epoxy resin.

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

(b) Single Slope Barrier. The single slope concrete barrier (see Figure 710-9) can be cast-in-place, slipformed, or precast. The most common construction technique for this barrier has been slipforming but some precast single slope barrier has been installed. The primary benefit of using precast barrier is that it can be used as temporary barrier during construction and then reset into a permanent location.

This barrier is considered a rigid system regardless of the construction method used. For new installations, the minimum height of the barrier above the roadway is 34 in which allows 2 in for future overlays. The minimum total height of the barrier section is 42 in with a minimum of 3 in embedded in the roadway wearing surface. This allows for use of the barrier between roadways with grade separations of up to 5 in. For greater grade separations, the barrier must have a depth of embedment equal to or greater than the grade separation or have an equivalent structural foundation.

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

(2) Concrete Barrier Terminals
Whenever possible, bury the end of the concrete barrier in the backslope. An earth berm can be used for a permanent installation, or as a tempo-
Redirectional land forms, also referred to as earth berms, redirect an errant vehicle. They are used to mitigate hazards located in depressed medians and may be used at roadside hazards when the slope, length, and height requirements can be met.

The Standard Plans shows a typical redirectional land form and identifies basic design features. Earth berm heights and slope rates are not fixed. Slopes adjacent to the hazard should be in the range of 2H:1V to 3H:1V. Flatter slopes may be used in the transition areas preceding the hazard. Berm heights over 10 ft are not recommended.

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

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

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

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

Approach barriers, transitions, and connections are usually required on all four corners of bridges carrying two-way traffic and on both corners of the approach end for one-way traffic. See 710.06(3) for guidance on transitions.
If the bridge rail system does not meet the criteria for strength and geometrics, modifications to improve its redirectional characteristics and its strength may be required. The modifications can be made using one of the retrofit methods described below.

(1) **Concrete Safety Shape**
Retrofitting with a new concrete bridge rail (see Figure 710-10) is costly and requires justification when no widening is proposed. Consult the Bridge and Structures Office for design details and to determine if the existing bridge deck and other superstructure elements are of sufficient strength to accommodate this bridge rail system.

![Safety Shaped Concrete Bridge Rail Retrofit](image)

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

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

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

Figure 710-15 shows typical installation criteria.

### 710.11 Other Barriers

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

Two different water filled barrier systems (Triton and Guardian) have been crash tested with the vehicle hitting the system at a 25 degree angle at 45 mph. The systems were deflected up to 13 ft. At lesser speeds and angles this deflection will be less. However, with this amount of deflection, use of water filled barrier will generally not be practical when a crashworthy barrier is required. Therefore, they cannot be considered a substitute for concrete barrier.

The minimum length of water filled barrier is 100 ft. The end 30 ft do not contribute to the length-of-need. One of the water filled systems, the Triton Barrier, can act as its own end treatment if the end module is left empty and the retaining pin is left out of the exposed end. The other system, the Guardian, requires a crashworthy end treatment or a TMA on the approach end.

(2) **Dragnet**
The Dragnet Vehicle Arresting Barrier consists of chain link or fiber net that is attached to energy absorbing units. When a vehicle hits the system, the Dragnet brings the vehicle to a controlled stop with a minimum of damage. Possible uses for this device are as follows:
• Reversible lane entrances and exits.
• Railroad crossings.
• Truck escape ramps (instead of arrester beds).
• T-intersections.
• Work zones.

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

710.12 Documentation

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

☐ Barrier selection.
☐ Shy distance requirements.
☐ Barrier length of need calculation.
☐ Long guardrail post justification.
☐ Barrier terminal and transition selection.
☐ Bridge rail evaluation and upgrade method.
Barrier Length of Need

Adjacent-Side Hazard
Barrier Parallel to Roadway

\[ X_1 = \frac{LH_1 - (L_2 + Y)}{(L_1/H_1) + (L_1/H_2)} \]

Opposite-Side Hazard
Barrier Parallel to Roadway

\[ X_2 = \frac{LH_2 - (L_5 + Y)}{(L_2/H_2) + (L_2/H_1)} \]

Adjacent-Side Hazard
Barrier Flare Begins at Hazard

\[ X_1 = \frac{LH_1 - (L_2 + Y)}{(1/F) + (L_1/H_1)} \]

Opposite-Side Hazard
Barrier Flare Begins at Hazard

\[ X_2 = \frac{LH_2 - (L_5 + Y)}{(1/F) + (L_2/H_2)} \]

Adjacent-Side Hazard
Barrier Flare Begins Before Hazard

\[ X_1 = \frac{(L_1 + L_1/F) - (L_2 + Y)}{(1/F) + (L_1/H_1)} \]

Opposite-Side Hazard
Barrier Flare Begins Before Hazard

\[ X_2 = \frac{(L_2 + L_4/F) - (L_5 + Y)}{(1/F) + (L_2/H_2)} \]

Barrier Length of Need

*Figure 710-11a*
L1 = Length of barrier parallel to roadway from adjacent-side hazard to beginning of barrier flare.
L2 = Distance from adjacent edge of lane to portion of barrier parallel to roadway.
L4 = Length of barrier parallel to roadway from opposite-side hazard to beginning of barrier flare.
L5 = Distance from center line of roadway to portion of barrier parallel to roadway.
LH1 = Distance from outside edge of lane to back side of adjacent-side hazard.
LH2 = Distance from center line of roadway to back side of opposite-side hazard.
LR = Runout length (measured parallel to roadway).
X1 = Length of need for barrier to shield an adjacent-side hazard.
X2 = Length of need for barrier to shield an opposite-side hazard.
F = Flare rate value.
Y = Offset distance required at the beginning of the length of need.

Different end treatments require different offsets.
For the SRT 350 and FLEAT 350, use Y = 1.8 ft.
For evaluating existing BCT's, use Y = 1.8 ft.
For the SRT 75, use Y = 0.5 ft.
No offset is required for the nonflared terminals, or impact attenuator systems. Use Y = 0.
Buried terminal end treatments are used with barrier flares and have no offset. Use Y = 0.

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Barrier Length of Need

*Figure 710-11b*
Beam Guardrail Post Installation
Figure 710-12

Notes:

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

Use cases 4, 5, and 6 when there is less than 2 ft shoulder widening from face of guardrail to the breakpoint.
Beam Guardrail Terminals

ET 2000-LET and SKT-350 are similar
Nonflared Terminal

SRT
Flared Terminal

FLEAT 350
Flared Terminal

Beam Guardrail Terminals

Figure 710-13
Cable Barrier Locations on Slopes

**Figure 710-14**

CASE 1

- Shoulder: Varies
- Not steeper than 10H:1V
- Not steeper than 2H:1V
- Type 1
- 1 ft min

CASE 2

- Shoulder: 10 ft min
- Not steeper than 6H:1V
- Not steeper than 2H:1V
- Type 1
- 1 ft min

CASE 3

- Shoulder: Less than 10 ft
- Not steeper than 6H:1V
- Not steeper than 2H:1V
- Type 2
- 1 ft min

CASE 4

- Shoulder: Varies
- No minimum
- Not steeper than 6H:1V
- Type 3
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<th>Steel or Wood Post</th>
<th>Wood bridge deck or Low Strength Concrete Deck</th>
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| 18 in or less              | Concrete Bridge Rail (existing) | Thrie beam mounted to existing bridge rail and blocked out to the face of curb
Height = 32 in | Thrie beam mounted to steel posts\(^2\) at the face of curb
Height = 32 in | Service Level 1 Bridge Rail\(^2\)
Height = 32 in
Curb or wheel guard must be removed |
| Greater than 18 in (curb-to-curb) | Thrie beam mounted to steel posts\(^2\) at the face of curb\(^1\)
Height = 32 in | Thrie beam mounted to steel posts\(^2\) in line with existing rail
Height = 35 in |

\(^1\) Thrie beam may be mounted to the bridge rail to accommodate pedestrians (height = 35 in).

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

Thrie Beam Bridge Rail Retrofit Criteria

*Figure 710-15*
Impact Attenuator Systems

720.01 Impact Attenuator Systems
Impact attenuator systems are protective systems that prevent errant vehicles from impacting hazards 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 to shield rigid objects or hazardous conditions that cannot be removed, relocated, or made breakaway. Approved systems are shown on Figures 720-2 through 4 and are described as follows:

(1) Permanent Installations

- **Crash Cushion Attenuating Terminal (CAT).** The CAT is an end treatment for beam guardrail. It can also be used for concrete barrier if a transition is provided. It is 31.25 ft long and 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. 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. When this system is used with a rigid barrier, a transition is required and must be specified in the contract along with the appropriate connection. (See Chapter 710.)

- **Brakemaster.** The Brakemaster system is an end treatment for beam guardrail. It can also be used for concrete barrier if a transition is provided. It is 31.5 ft long and consists of telescoping w-beam panels mounted on both sides of steel skids. The system uses a brake and cable device for attenuation and redirection. The cable is embedded in a concrete anchor at the end of the system. A concrete foundation is not required for this system but a paved surface is recommended. When this system is used with a rigid barrier, a transition is required and must be specified in the contract along with the appropriate connection. (See Chapter 710.)

- **QuadTrend - 350.** The QuadTrend - 350 is an end treatment for concrete barriers. Its overall length of 20.7 ft allows it to be used at the ends of bridges where a standard beam guardrail installation is not feasible. This system consists of telescoping quadruple corrugated fender panels mounted on steel breakaway posts. Sand-filled boxes attached to the posts dissipate a portion of the energy of the impact. A concrete foundation is required to support the steel posts. An anchored cable installed behind the fender panels directs the vehicle away from the barrier end. A 6H:1V or flatter slope is required behind the barrier to allow for vehicle recovery.

- **QuadGuard.** The QuadGuard is an end treatment for concrete barrier and beam guardrail and is also used to mitigate fixed objects up to 7.5 ft in width. A transition is required when it is used with beam guardrail in a location subject to reverse direction impacts. The length of the QuadGuard varies based on the posted speed of the highway (see Figure 720-1.) The QuadGuard system consists of a series of Hex-Foam cartridges surrounded by a framework of steel diaphragms and quadruple corrugated fender panels. It is installed on a concrete slab. Impact energy from end-on hits is absorbed by the internal shearing of the cartridges and the crushing of the energy absorption material. The fender panels redirect vehicles impacting the attenuator on the side.

- **QuadGuard Elite.** The QuadGuard Elite is an end treatment for concrete barrier and beam guardrail and is also used to mitigate fixed objects up to 7.5 ft in width. The length of the system is 35.5 ft and consists of telescoping quadruple corrugated fender panels mounted on both sides of a series of polyethylene cylinders. The cylinders are...
compressed during a head-on impact and will return to their original shape when the system is reset. The advantage of this system is that it can withstand numerous impacts without requiring extensive repair.

**Reusable Energy Absorbing Crash Terminal (REACT 350).** The REACT 350 is an end treatment for concrete barriers and is also used to mitigate fixed objects up to 9 ft in width. The length of the REACT 350 varies based on the posted speed of the highway. (See Figure 720-1.) The system consists of polyethylene cylinders with varying wall thicknesses, redirecting cables, a steel frame base, and a backup structure. The system is installed on a concrete foundation. 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 and absorb the impact energy, but the system returns to approximately 80 percent of its original length immediately. 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.

**Inertial Barrier.** Inertial barrier is an end treatment for concrete barrier and is also used to mitigate fixed objects. This system consists of an array of plastic containers filled with varying weights of sand. The length of inertial barrier arrays vary based on the posted speed of the highway (see Figure 720-1.) 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.

**(2) Work Zone (Temporary) Installation**

**Construction Zone Guard Rail Energy Absorption Terminal (G-R-E-A-T cz).** The G-R-E-A-T cz is an end treatment for beam guardrail and concrete barrier subject to one way flow. This system consists of a series of Hex-Foam cartridges aligned by a cable and diaphragm system installed on a portable support platform. The perimeter is shielded by lapped thrie beam to redirect vehicles impacting the attenuator on the side. Impact energy from end-on hits is absorbed by internal shearing of the cartridges and crushing of the energy absorption material. The platform is anchored by bolts set in concrete (6 in minimum depth) or by anchor pins. Anchor pins may only be used on 3 in minimum depth asphalt concrete surfaces that have a prepared compacted subbase. This system is easily moved to a new site without heavy equipment.

**Advanced Dynamic Impact Extension Module II (ADIEM II).** The ADIEM II is an end treatment for concrete barrier. Other uses may require a special transition design. The system is 30 ft long and consists of 10 lightweight concrete modules on an inclined base. The energy of an impact is dissipated as the concrete modules are crushed. An inclined base provides a track for placement of the modules and provides redirection for side impacts. At this time the use of the ADIEM II is limited to temporary installations. Existing permanent installations are experimental and are being used to evaluate long-term durability. Existing permanent units may be reset.

**QuadGuard cz.** This system is like the permanent QuadGuard listed in (1) above except that it can be installed on a 6 in minimum depth asphalt concrete surface that has a 6 in minimum depth compacted base.

**Reusable Energy Absorbing Crash Terminal (REACT 350).** This is the same system listed in (1) above except that it can be installed on a 4 in minimum depth asphalt concrete surface that has a 6 in minimum depth compacted base.

**Non-Redirecting Energy Absorbing Terminal (N-E-A-T).** The N-E-A-T system is a is an end treatment for temporary concrete barrier where vehicle speeds are 45 mph or less. The system is 9.7 ft long and consists of aluminum cells encased in an aluminum
shell with steel backup, attachment hardware, and transition panels. The energy of an impact is dissipated as the aluminum cells are crushed.

- **Inertial Barrier.** This is the same system listed in (1) above. It is not suitable where space is limited to less than the widths shown in the Standard Plans.

- **Truck-Mounted Attenuator (TMA).** TMAs are portable systems used in work zones. For more information on these systems, see the Traffic Manual.

**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 Olympia Service Center Design Office.

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

- **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 except that it used thrie beam fender panels.

- **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 used thrie beam fender panels.

- **Low Maintenance Attenuator System (LMA).** The LMA is an end treatment for concrete barrier and beam guardrail and was also used to mitigate fixed objects up to 3 ft in width. The system is similar to the QuadGuard Elite except that it used thrie beam fender panels and rubber cylinders.

- **Hex-Foam Sandwich.** The Hex-Foam Sandwich system is an end treatment for beam guardrail and concrete barrier and was also used to mitigate fixed objects 3 ft 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. Lapped panels on the perimeter serve to redirect vehicles on side impacts.

**720.02 Design Criteria**

The following design criteria apply to all new or reset, permanent and temporary impact attenuators. They also apply to existing systems to be left in place when the Barrier Terminals and Transition Sections column 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 the 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 100 mm or less in height may be retained depending on the practicality of their removal.

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 percent for inertial barriers and Hex-Foam Sandwich units and steeper than 8 percent for the QuadGuard, QuadGuard Elite, ADIEM II, and REACT 350 systems. All other systems must have a 10H:1V or flatter slope between the edge of the traveled way and the near face of the unit.

In general, except the inertial barriers, attenuators are aligned parallel to the roadway.
Whenever possible, inertial barriers are aligned so that an errant vehicle deviating from the roadway by 10 degrees would be on a parallel path with the attenuator alignment. (See the Standard Plans.) Also, inertial barriers do not provide any redirection and are not appropriate where high angle impacts are likely.

Inertial barrier configurations are shown in the Standard Plans. If a situation is encountered where the configurations in the Standard Plans are not appropriate, contact the Olympia Service Center Design Office if further information is desired.

720.03 Selection
When selecting an impact attenuator system, consider the following:

- Posted speed
- Available space (length and width)
- Maintenance costs
- Initial cost

The posted speed is a consideration for the QuadGuard, REACT 350 (narrow model only), G-R-E-A-T cz, and the inertial barrier systems only. Use Figure 720-1 to select the size of the system required for the legal posted speed.

<table>
<thead>
<tr>
<th>Posted Speed (mph)</th>
<th>QuadGuard Bays</th>
<th>REACT 350 Cylinders</th>
<th>G-R-E-A-T cz Bays</th>
<th>Inertial Barriers Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 or less</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>45</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>2</td>
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<td>50</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
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<td>55</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
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<td>60</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>5</td>
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<td>8</td>
<td>9</td>
<td>6</td>
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</tr>
<tr>
<td>70</td>
<td>9</td>
<td>11</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Impact Attenuator Sizes

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 can be specified.

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

When considering maintenance costs, anticipate the average annual hit 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 hit. 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 may 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. No maintenance may 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.

One consideration that must not be overlooked in selecting a system is how dangerous it will be for the workers making repairs. 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. In areas with a high exposure to danger, a system that can be repaired quickly is most desirable.

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, the inappropriate systems are eliminated and the remaining systems are to be specified. When the site conditions vary, it may 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.

**Documentation**

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

- Approvals for use of older systems
- Documentation of reasons for eliminating attenuator options
- Approvals of public interest findings regarding sole source proprietary systems
Impact Attenuator Systems — Permanent Installations

Figure 720-2a
Impact Attenuator Systems — Permanent Installations

Figure 720-2c
Impact Attenuator Systems — Work Zone Installations

Figure 720-3
Impact Attenuator Systems — Older Systems

Figure 720-4a
Impact Attenuator Systems — Older Systems

Figure 720-4b

L.M.A.

Hex-Foam Sandwich
## Initial Cost Categories:

- **A** ($5,000 to $8,000)
- **B** ($9,000 to $14,000)
- **C** ($15,000 to $25,000)
- **D** ($25,000 to $40,000)

### Impact Attenuator Systems

(All dimensions are in feet)

<table>
<thead>
<tr>
<th>System</th>
<th>(Permanent)</th>
<th>(Temporary)</th>
<th>Width</th>
<th>Length</th>
<th>Distance Beyond Length of Need</th>
<th>Initial Cost Category</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT (2)</td>
<td>P</td>
<td>2</td>
<td>31.25</td>
<td>YES</td>
<td>18.8</td>
<td>A</td>
<td>SYRO, Inc.</td>
</tr>
<tr>
<td>Brakemaster (2)</td>
<td>P</td>
<td>2</td>
<td>31.5</td>
<td>YES</td>
<td>15.8</td>
<td>A</td>
<td>Energy Absorption Systems, Inc.</td>
</tr>
<tr>
<td>QuadTrend - 350(6)</td>
<td>P</td>
<td>2</td>
<td>20.7</td>
<td>NO</td>
<td>10.5</td>
<td>A</td>
<td>Energy Absorption Systems, Inc.</td>
</tr>
<tr>
<td>QuadGuard</td>
<td>B</td>
<td>2, 2.5, 3, 5.75, 7.5</td>
<td>12 - 30(4)</td>
<td>NO</td>
<td>3.3</td>
<td>C(5)</td>
<td>Energy Absorption Systems, Inc.</td>
</tr>
<tr>
<td>QuadGuard Elite</td>
<td>P</td>
<td>2, 2.5, 3, 5.75, 7.5</td>
<td>35.5</td>
<td>NO</td>
<td>3.3</td>
<td>D</td>
<td>Energy Absorption Systems, Inc.</td>
</tr>
<tr>
<td>REACT 350</td>
<td>B</td>
<td>3</td>
<td>15.25 - 36.25(4)</td>
<td>NO</td>
<td>4.3</td>
<td>C(5)</td>
<td>Roadway Safety Service, Inc.</td>
</tr>
<tr>
<td>Inertial Barriers</td>
<td>B</td>
<td>7</td>
<td>17 - 30(4)</td>
<td>NO</td>
<td>(2)</td>
<td>A(5)</td>
<td></td>
</tr>
<tr>
<td>ADIEM II (7)</td>
<td>T</td>
<td>2</td>
<td>30</td>
<td>NO</td>
<td>14.1</td>
<td>B</td>
<td>SYRO, Inc.</td>
</tr>
<tr>
<td>GREAT cz (9)</td>
<td>T</td>
<td>2.5</td>
<td>12, 21</td>
<td>NO</td>
<td>(2)</td>
<td>C(5)</td>
<td>Energy Absorption Systems, Inc.</td>
</tr>
</tbody>
</table>

60 mph design, the QuadGuard design would be 21 ft, the REACT 350 would be 31 ft, and the inertial barriers would be 30 ft. Costs indicated are for a typical 60 mph design.

### Impact Attenuator Comparison

*Figure 720-5*

1) Generally for use with double sided beam guardrail. Use as an end treatment for concrete barrier requires a transition.

2) The GREAT cz, inertial barriers, and N-E-A-T may only be used beyond the required barrier length of need.

3) There are 3 manufacturers of inertial barriers:
   - Energy Absorption Systems, Inc.
   - Roadway Safety Service, Inc.
   - TrafFix Devices, Inc.

4) See Figure 720-1 for sizes or configuration type.

5) The length of the QuadGuard, REACT 350, and inertial barriers varies since their design is dependent upon speed. For a typical 60 mph design, the QuadGuard design would be 21 ft, the REACT 350 would be 31 ft, and the inertial barriers would be 30 ft. Costs indicated are for a typical 60 mph design.

6) Generally for use at the ends of bridges where a standard beam guardrail installation 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) Limit to one-way traffic flow.
810.01 General
The purpose of this chapter is to describe the procedures for planning construction work zone traffic control. It is important that a construction work zone traffic control strategy be identified early in project development so that its effect can be considered in the design of a project and used later in developing the traffic control plan for the PS&E.

Primary consideration should be given to worker safety within the work zone, while at the same time, providing for the safe and timely passage of nonconstruction traffic.

810.02 References
Traffic Manual, M 51-02
Standard Plans for Road, Bridge and Municipal Construction, M 21-01
Plans Preparation Manual, M 22-31
Traffic Control Devices Handbook, FHWA
Manual on Uniform Traffic Control Devices for Streets and Highways, M 24-01

810.03 Definitions
construction work zone traffic control (CWZTC) strategy A general scheme by which traffic can be controlled through or around a construction work zone.

traffic control plan Drawing(s) and special provisions developed as part of PS&E showing how traffic will operate and be controlled during construction. The plan includes the locations of the roadway, detour routes, temporary or portable bridges, cross-roads, ramps, pavement markings, signs, signals, and other traffic control devices.

810.04 Construction Work Zone Traffic Control Strategy
The CWZTC strategy may contain, for example, the following:

- The number of lanes or areas of the roadway that can be closed.
- The hours of the day when work can occur.
- The days of the week when work can occur.
- The level of service to be provided to motorists during construction.
- The need for night operations.
- The influence on other streets in the network.
- The general impact of the selected construction work zone traffic control strategy on, for example, the traveling public, the contractor, construction work forces, costs.
- Other special site related conditions (e.g. special events).
- Public and local jurisdiction information plans.

See the Traffic Manual for guidance in preparing the CWZTC strategy.

(1) Use of Law Enforcement in Work Zones
The initial determination for the use of law enforcement should be based on evaluation of the work zone by the Maintenance/Construction Office and the region Traffic Office. The evaluation should consider the type of construction activity, complexity of the traffic control plan, possible speed reduction needs, traffic volumes, nighttime work activity, geometric conditions, associated cost for the use of enforcement (cost benefit analysis), and actual traffic problems observed as the work progresses.

Refer to the Traffic Manual for recommended enhanced enforcement in the work zone.
(2) Work Zone Traffic Control Design Checklist
A checklist has been developed to assist the designer in developing the work zone traffic control strategy. Refer to the Traffic Manual for this checklist.

810.05 Procedures
The following procedures must be used for all projects:

(1) Design Conference
A design conference, also attended by the district traffic engineer, law enforcement officials, and a construction project engineer, must be held early in design report preparation to discuss construction work zone traffic control strategy options and to select and develop those options that appear feasible.

The options developed for the CWZTC strategy should provide adequate safety for motorists and workers, minimize travel time delays and other negative traffic related impacts while providing an acceptable level of service, and consider project constructibility and costs.

(2) Design Report
The design report must contain the following items:

- A brief summary of the construction work zone traffic control strategy as developed during the design conference.
- A description of and the basis for the CWZTC strategy developed during project design.

(3) Contract Preparation
Based on the CWZTC strategy contained in the design report, conduct studies and analyses to evaluate the impacts and verify the feasibility of the strategy, and develop the strategy to be included in the traffic control plan.

The PS&E package must include bid items, special provisions, and traffic control drawings. See the Traffic Manual for guidance in developing the specific traffic control plans. See also the Standard Plans and the Plans Preparation Manual.
820.01 General

Signing is a primary mechanism for regulating, warning, and guiding traffic. Signing must be in place when any section of highway is open to the motoring public. Each highway project has unique and specific signing requirements. For statewide signing uniformity and continuity, it is sometimes necessary to provide signing beyond the project limits. Design characteristics of the facility determine the size and legend for a sign. As the design speed increases, larger sign sizes are necessary to provide adequate message comprehension time. The MUTCD, the Traffic Manual, and the Sign Fabrication Manual contain standard sign dimensions, specific legends, and reflective sheeting types for all new signs. Guide signing provides the motorist with guidance to destinations. This information is always presented in a consistent manner. In some cases, there are specific laws, regulations, and policies governing the content of the messages on these signs. All proposed guide signs for a project require the approval of the region’s Traffic Engineer. The use of nonstandard signs is strongly discouraged and their use requires the approval of the State Traffic Engineer.

The Design Matrices identify the design levels for signing on all preservation and improvement projects. These levels are indicated in the column “Signing” for Interstate main line and the column “Signing, Delineation, and Illumination” for all other routes.

Review and update existing signing within the limits of all preservation and improvement projects as indicated in the matrices. Provide standard signing on projects with either a “B” (basic design level) or “EU” (evaluate upgrade) matrix designation by applying the following criteria to determine the need to replace or modify existing signs:

- Lack of nighttime retroreflectivity.
- Substantial damage, vandalism, or deterioration.
- Age of signs (seven to ten years old).
- A change in sign use policy.
- Improper location.
- Message or destination changes necessary to satisfy commitments to public or local agencies.
- Substandard mounting height.
- Change in jurisdiction, for example a county road becomes a state route.

Address sign support breakaway features when identified in the “Clear Zone” columns of the Matrices. When the “F” (full design level) matrix designation is present, the preceding criteria are still applicable and all existing signing is required to conform to the current policy for reflective sign sheeting requirements. Remove or replace signing not conforming to this policy.

820.02 References

Revised Code of Washington (RCW) 47.36.030, Traffic control devices

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

Traffic Manual, M 51-02, WSDOT
Sign Fabrication Manual, M 55-05, WSDOT
Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
820.03 Design Components

(1) Location

The MUTCD contains the guidelines for positioning signs. Check sign locations to ensure that the motorist’s view of the sign is not obscured by other roadside appurtenances. Also, determine if the proposed sign will obstruct the view of other signs or limit the motorist’s sight distance of the roadway. Reposition existing signs, when necessary, to satisfy these visibility requirements. Where possible, locate signs behind existing traffic barriers, on grade separation structures, or where terrain features will minimize their exposure to errant vehicles.

(2) Longitudinal Placement

The MUTCD and the Traffic Manual provide guidelines for the longitudinal placement of signs that are dependent on the type of sign. Select a location to fit the existing conditions to ensure visibility and adequate response time. In most cases, signs can be shifted longitudinally to enhance safety without compromising their intended purpose.

(3) Lateral Clearance

The MUTCD contains minimum requirements for the lateral placement of signs. These requirements are shown in Figures 820-1a and 820-1b. When possible, position the signs at the maximum practical lateral clearance for safety and reduced maintenance costs. Locate large guide signs and motorist information signs beyond the Design Clear Zone, when limited right of way or other physical constraints are not a factor. See Chapter 700. On steep fill slopes, an errant vehicle is likely to be partially airborne from the slope break near the edge of shoulder to a point 12 ft down the slope. When signs are placed on fill slopes steeper than 6:1, locate the support at least 12 ft beyond the slope break. Use breakaway sign support features, when required, for signs located within the Design Clear Zone and for signs located beyond this zone where there is a possibility they might be struck by an errant vehicle. Breakaway features are not necessary on sign posts located behind traffic barriers. Install longitudinal barrier to shield signs without breakaway features within the Design Clear Zone when no other options are available.

Sign bridges and cantilever sign structures have limited span lengths. Locate the vertical components of these structures as far from the traveled way as possible and, where appropriate, install traffic barriers or land forms. See Chapter 710.

Do not locate sign posts in the bottom of a ditch or where the posts will straddle the ditch. The preferred location is beyond the ditch or on the ditch backslope. In high fill areas, where conditions require placement of a sign behind a traffic barrier, consider adding embankment material to reduce the length of the sign supports.

(4) Sign Heights

For ground-mounted signs installed at the side of the road, provide a mounting height of at least 7 ft, measured from the bottom of the sign to the edge of traveled way. Supplemental plaques, when used, are mounted directly below the primary sign. At these locations, the minimum mounting height of the plaque is 5 ft.

Do not attach supplemental guide signs to the posts below the hinge mechanism or saw cut notch on multiple post installations. The location of these hinges or saw cuts on the sign supports are shown in the Standard Plans.

A minimum 7 ft vertical height from the bottom of the sign to the ground directly below the sign is necessary for the breakaway features of the sign support to function properly when struck by a vehicle. The minimum mounting height for new signs located behind longitudinal barriers is 7 ft, measured from the bottom of the sign to the edge of traveled way. A lower mounting height of 5 ft may be used when replacing a sign panel on an existing sign assembly located behind longitudinal barrier.
Signs used to reserve parking for people with disabilities are installed at each designated parking stall and are mounted between 3 ft and 7 ft above the surface at the sign location. Figures 820-1a and 820-1b show typical sign installations.

(5) Foundations
Foundation details for wood and steel ground mounted sign supports are shown in the Standard Plans. That manual also contains foundation designs for truss-type sign bridges and cantilever sign structures. Three designs, Types 1, 2, and 3, are shown for each structure.

An investigation of the foundation material is necessary to determine the appropriate foundation design. The Type 1 foundation design uses a large concrete shaft and is the preferred installation when the lateral bearing pressure of the soil is 2,500 psf or greater. The Type 2 foundation has a large rectangular footing design and is an alternate to the Type 1 foundation when the concrete shaft is not suitable. The Type 3 foundation is used in poorer soil conditions where the lateral bearing pressure of the soil is between 1,500 psf and 2,500 psf. Use the data obtained from the geotechnical report to select the foundation type.

If a nonstandard foundation or monotube structure design is planned, forward the report to the Bridge and Structures Office for their use in developing a suitable foundation design. See Chapter 510.

(6) Sign Posts
Ground mounted signs are installed on either wood posts, laminated wood box posts, or steel posts. The size and number of posts required for a sign installation are based on the height and surface area of the sign, or signs, being supported. Use the information in Figures 820-2, 820-3, and 820-4 to determine the posts required for each installation. Use steel posts with breakaway supports that are multidirectional if the support is likely to be hit from more than one direction. Design features of breakaway supports are shown in the Standard Plans. Steel posts with Type 2A and 2B bases have multidirectional breakaway features.

820.04 Overhead Installation
Conditions justifying the use of overhead sign installations are noted in the MUTCD. Where possible, mount overhead signs on grade separation structures rather than sign bridges or cantilever supports.

Details for the construction of truss-type sign bridges and cantilever sign supports are shown in the Standard Plans.

The Bridge and Structures Office designs structure mounted sign mountings, monotube sign bridges, and monotube cantilever sign supports. For overhead sign installation designs, provide sign dimensions, horizontal location in relation to the roadway, and the location of the lighting fixtures, to facilitate design of the mounting components by the Bridge and Structures Office.

(1) Illumination
In urban areas, all overhead signs on multilane highways are illuminated. In rural areas, all overhead regulatory and warning signs including guide signs with “Exit Only” panels on both multilane and conventional highways are illuminated. All other overhead signs are only illuminated when one of the following conditions is present:

- Sign visibility is less than 800 ft due to intervening sight obstructions such as highway structures or roadside features
- Ambient light from a non-highway light source interferes with the sign’s legibility
- The sign assembly includes a flashing beacon

Sign illumination is provided with sign lighting fixtures mounted directly below the sign. The light source of the fixture is a 175 watt mercury vapor lamp. Provide one sign light for a sign with a width of 16 ft or less. For wider signs, provide two or more sign lights with a spacing not exceeding 16 ft. If two or more closely spaced signs are in the same vertical plane on the structure, consider the signs as one unit and use a uniform light fixture spacing for the entire width.

Voltage drops can be significant when the electrical service is not nearby. See Chapter 840 for guidance in calculating electrical line loss.
In areas where an electrical power source is more than ½ mile away, utility company installation costs can be prohibitive. Reconsider the benefit of an overhead sign installation at these locations.

(2) Vertical Clearance
The minimum vertical clearance from the roadway surface to the lowest point of an overhead sign assembly is $17 \text{ ft-6 in}$. The maximum clearance is $21 \text{ ft}$.

(3) Horizontal Placement
Consider roadway geometrics and anticipated traffic characteristics in order to locate signs above the lane, or lanes, to which they apply. Install advance guide signs and exit direction signs that require an EXIT ONLY and “down arrow” panel directly above the drop lanes. To reduce driver confusion as to which lane is being dropped, avoid locating a sign with an EXIT ONLY panel on a horizontal curve.

(4) Service Walkways
Walkways are provided on structure-mounted signs, truss-type sign bridges, and truss-type cantilever sign supports where the roadway and traffic conditions prohibit normal sign maintenance activities. Normally, monotube sign bridges and cantilever sign supports do not have service walkways.

Vandalism of signs, particularly in the form of graffiti, can be a major problem in some areas. Vandals sometimes use the service walkways. Maintenance costs in cleaning or replacing vandalized signs at these locations can exceed the benefit of providing the service walkway.

820.05 Mileposts
Milepost markers are a part of a statewide system for all state highways and are installed in accordance with the Directive D 32-20, State Route Mileposts.

820.06 Guide Sign Plan
A guide sign plan is used by the region to identify existing and proposed guide signing on state highways. The plan provides an easily understood graphic representation of the signing and allows assessment of the continuity in signing to motorist destinations, activities, and services. It is also used to identify deficiencies or poorly defined routes of travel. A guide sign plan for safety and mobility improvement projects is desirable. When proposed highway work affects signing to a city or town, the guide sign plan can be furnished to the official governing body for review and consideration. The guide sign plan is reviewed and approved by the region’s Traffic Engineer.

820.07 Documentation
Include the following items in the project file:

- An inventory of all existing signing within the project limits
- Approval of proposed guide signs
- Approval of non-standard signs
- Soils investigations for all sign bridge and cantilever sign supports
**Sign Support Locations**

*Figure 820-1a*

1. 7' min vertical clearance for sign supports with breakaway features
Sign Support Locations

Figure 820-1b

**Notes**

1. 7' min for new sign installations
2. 5' min for existing sign installations
3. 7' min vertical clearance for sign support with breakaway features

---

**Sign Installation Behind Traffic Barrier**

- W
- 2' min
- See note 2

**Multiple Sign Post Installation in Ditch Section**

- W
- 12' min
- See note 2

**Guide or Directional Sign with Secondary Sign Installation on Expressways and Freeways**

- W
- 12' min
- 6' min
- 5' min
- 8' min
- 0 to 3'
- See note 2

**Multiple Sign Post Installation in Fill Section**

- W
- 6.1 or flatter slope
- 7' min
- 7' min
For the purpose of post selection, X and Y are as follows:

- Single sign, or back-to-back signs, X and Y are the overall dimensions of the sign.
- Multiple sign installations, X and Y are the dimensions of a rectangle enclosing all signs.
- Z is the height from ground line to mid-height of sign at longest post.
- \( H1 + H2 \), etc., equals overall post length.
- D is the required post embedment depth.
- V is the vertical clearance from edge of traveled way.

<table>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>4x4</td>
<td>60*</td>
<td>135</td>
<td>215</td>
<td>295</td>
<td>3 ft</td>
</tr>
<tr>
<td>4x6</td>
<td>175*</td>
<td>355</td>
<td>530</td>
<td>705</td>
<td>4 ft</td>
</tr>
<tr>
<td>6x6</td>
<td>210</td>
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<td>635</td>
<td>845</td>
<td>4 ft</td>
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<tr>
<td>6x8</td>
<td>300</td>
<td>850</td>
<td>1280</td>
<td>1700</td>
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<tr>
<td>6x10</td>
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<td>8x10</td>
<td>575</td>
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<td>2410</td>
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<td>8x12</td>
<td>775</td>
<td>2310</td>
<td>3465</td>
<td>4620</td>
<td>6 ft</td>
</tr>
</tbody>
</table>

*Single post application utilizing Western Red Cedar has \((X)(Y)(Z)\) allowable of 50 and 155 respectively.

**Values shown are the maximum permitted. If the quantity \((X)(Y)(Z)\) exceeds the limit for 8X12 posts, use steel post installations.

When sign is to be located in the clear zone or outside of the clear zone, but in an area where it is likely to be struck by an errant vehicle, the following configurations are not permitted:
1. Timber posts larger than 6X8.
2. Signs less than 12 ft wide and three 6X6 or larger posts.
3. Signs less than 17 ft wide and four 6X6 or larger posts.

Use steel or laminated wood posts in these situations.

**Design Example**

**Given:** A 36 in wide, 42 in high sign with a 18 in wide, 24 in high sign mounted 3 in below. 8 ft shoulder with 2% slope and 6H:1V embankment. \( W = 15 \) ft. \( V = 5 \) ft.

**Solution:** Use single post. \( X = 3 \) ft, \( Y = 5.75 \) ft, \( Z = 5.75/2 + (1.02x8) + 5.75 = 9.21 \) ft. From table, select smallest post having \((X)(Y)(Z)\) of 159 ft^3 or more. Use 4X6 post. \( H = Z + Y/2 + D = 9.46 + 6.25/2 + 4.0 = 16.6 \) ft. Use 6x6 when using Western Red Cedar.

**Design Example**

**Given:** A 10 ft wide, 4 ft high sign. 10 ft shoulder with 2% slope and 6H:1V embankment. \( W = 35 \) ft. \( V = 7 \) ft. Assume sign is inside of clear zone.

**Solution:** Try two posts. \( X = 10 \) ft, \( Y = 4 \) ft, \( Z = 4/2 + 7 + (0.02x10) + (25 + 0.6x10)/6 = 14.37 \) ft. From table, select smallest post having \((X)(Y)(Z)\) of 575 ft^3 or more. Two 6X6 posts are not sufficient, use 6X8 posts because three 6X6 posts would require a traffic barrier.

\( H2 = 14.37 + 2 + 4 = 20.4 \) ft

\( H1 = 20.4 - (0.6x10)/6 = 19.8 \) ft

All dimensions are in ft unless otherwise noted.

**Wood Posts**

*Figure 820-2*
For the purpose of post selection, X and Y are as follows:

- Single sign, or back-to-back signs, X and Y are the overall dimensions of the sign.
- Multiple sign installations, X and Y are the dimensions of a rectangle enclosing all signs.
- Z is the height from the base connection (2 1/2 in above the post foundation) to mid-height of sign at the longest post.
- H1, H2, etc., equals overall post length (base connection to top of sign).
- D is the required post embedment depth (see standard plans).
- V is the vertical clearance from the edge of traveled way.

**Single Post Signs**

For a maximum 20 ft² sign, use 4 in standard pipe for Z less than 18 ft 6 in or 5 in standard pipe for Z greater than 18 ft 6 in.

For a maximum 45 ft² sign, use 5 in standard pipe for Z less than 15 ft 6 in or 6 in standard pipe for Z greater than 15 ft 6 in.

**Two and Three post signs**

<table>
<thead>
<tr>
<th>Post Selection</th>
<th>Post Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X)(Y)(Z) in ft³</td>
<td>*AASHTO M183</td>
</tr>
<tr>
<td>1570</td>
<td>W6x9</td>
</tr>
<tr>
<td>2355</td>
<td>W6x12</td>
</tr>
<tr>
<td>2810</td>
<td>W6x12</td>
</tr>
<tr>
<td>4220</td>
<td>W6x16</td>
</tr>
<tr>
<td>4940</td>
<td>W8x18</td>
</tr>
<tr>
<td>7410</td>
<td>W8x21</td>
</tr>
<tr>
<td>7580</td>
<td>W10x22</td>
</tr>
<tr>
<td>11370</td>
<td>W10x26</td>
</tr>
</tbody>
</table>

*Value shown are the maximum permitted.

**Steel Posts**

* *AASHTO M222 or M223 may be used as an acceptable alternative to AASHTO M 183 at the sizes listed.

**Design Example**

*Given:* 22 ft wide, 12 ft high sign. 10 ft shoulder with 2% slope and a 3H:1V embankment slope. W = 32 ft.

*Solution:* Use three posts. X = 22 ft, Y = 12 ft, V = 7 ft, Z = 12/2 + 7 + (0.02x10) + (22 + 0.70x22)/3 - 0.21 = 25.46 ft. (X)(Y)(Z) = 22x12x25.46 = 6721 ft³. From table, select smallest post having (X)(Y)(Z) of 6721 or more. Use W8x18 (AASHTO M222 or M223) or W8x21 (AASHTO M183) posts.

H3 = 25.46 + 12/2 = 31.46 ft = 31 ft 5 1/2 in

H2 = 31.46 - (0.35x22)/3 = 28.89 ft = 28 ft 10 5/8 in

H1 = 31.46 - (0.70x22)/3 = 26.33 ft = 26 ft 4 in

For any sign installation located within the clear zone distance of the lane edge, the total weight of all the posts in the 7 ft wide path shall not exceed a combined post weight of 36 lbs/ft. If the proposed sign configuration does not meet this criteria, relocate, resize or provide additional protection for the proposed installation.

Use the following table to determine post weights.

<table>
<thead>
<tr>
<th>Beam size</th>
<th>Weight lbs/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>W6x9</td>
<td>9</td>
</tr>
<tr>
<td>W6x12</td>
<td>12</td>
</tr>
<tr>
<td>W6x16</td>
<td>16</td>
</tr>
<tr>
<td>W8x18</td>
<td>18</td>
</tr>
<tr>
<td>W8x21</td>
<td>21</td>
</tr>
<tr>
<td>W10x22</td>
<td>22</td>
</tr>
<tr>
<td>W10x26</td>
<td>26</td>
</tr>
</tbody>
</table>
For the purpose of post selection, X and Y are as follows:

Single sign, or back-to-back signs. X and Y are the overall dimensions for the sign.

Multiple sign installations, X and Y are the dimensions of a rectangle enclosing all signs.

Z is the height from ground line to mid-height of sign at the longest post.

H₁ and H₂ equal overall post length.

D is the required post embedment depth.

V is the vertical clearance from edge of traveled way.

<table>
<thead>
<tr>
<th>Box Post Type</th>
<th>Z (ft)</th>
<th>(X)(Y)(Z) ft³</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>15 &lt; Z ≤ 30</td>
<td>1329</td>
</tr>
<tr>
<td>M</td>
<td>Z &lt; 15</td>
<td>1661</td>
</tr>
<tr>
<td>L</td>
<td>15 &lt; Z ≤ 30</td>
<td>3502</td>
</tr>
<tr>
<td>L</td>
<td>Z &lt; 15</td>
<td>4378</td>
</tr>
</tbody>
</table>

Design Example
Given: 16 ft wide, 6 ft high sign. 10 ft shoulder with 2% slope and a 6H:1V embankment. W = 25 ft. V = 7 ft.
Solution: Use two posts. X = 16 ft, Y = 6 ft.
For two posts: Z = 6/2 + 7 + (0.02x10) + (15 + 0.6x16)/6 = 14.3 ft.
(X)(Y)(Z) = 16x6x14.3 = 1,373 ft³
From table, select smallest post having (X)(Y)(Z) of 1,373 or more and meets the “Z” requirements.
Use two M posts
H₂ = Z + Y/2 + D = 14.3 + 3.0 + 6.0 = 23.3 ft.
H₁ = 23.3 - (0.6x16)/6 = 21.7 ft.

Design Example
Given: 18 ft wide, 8 ft high sign, 10 ft shoulder with 2% slope and a 6H:1V embankment. W = 25 ft, V = 7 ft.
Solution: Use two posts. X = 18 ft, Y = 8 ft.
For two posts: Z = 8/2 + 7 + (0.02x10) + (15 + 0.6x18)/6 = 15.5 ft.
(X)(Y)(Z) = 18x8x15.5 = 2,232 ft³.
From table, select smallest post having (X)(Y)(Z) of 2,232 or more and meets the “Z” requirements.
Use two L posts.
H₂ = Z + Y/2 + D = 15.5 + 4.0 + 9.0 = 28.5 ft.
H₁ = 28.5 - (0.6x18)/6 = 26.7 ft.

All dimensions are in feet unless otherwise noted.
830.01 General
Delineation is the marking of highways by pavement marking, raised pavement markers, guideposts, and other devices to guide traffic and encourage safe operation. WSDOT uses the latest edition of FHWA's *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)* as a guide for design, location, and application of delineation.

830.02 Pavement Marking
The purpose of pavement marking is to warn, guide, or regulate traffic. Pavement markings are classified as either longitudinal or transverse.

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

Longitudinal pavement markings are:
- Barrier stripe
- Double yellow center stripe
- Skip center stripe
- No-pass stripe
- Edge stripe
- Lane stripe
- Gore stripe
- Two-way left turn stripe
- Reversible lane stripe

• Drop lane stripe
• Dotted extension stripe

Transverse pavement markings define pedestrian crossings and vehicle stopping points at intersections. Arrows, letters, and symbols warn of approaching conditions, vehicle maneuvers, or lane usage.

Typical transverse pavement markings are:
- Crosswalk stripe
- Stop bar
- Traffic arrow
- Traffic letters
- Handicapped parking stall symbol
- Preferential lane symbol
- Railroad crossing symbol
- Cycle detector symbol

Longitudinal pavement markings typically consist of yellow or white reflectorized traffic paint. Plastic pavement markings, because of their durability, should be considered for roadway sections subject to abnormally heavy wear.

Transverse pavement markings are usually white, extruded plastic. Asphalt pavement placed over plastic markings will not adhere properly and will eventually spall off. Consideration should be given to installing painted transverse markings if the roadway will be resurfaced in the near future.

Plastic markings, when wet, provide poor traction for pedestrians and bicycles. Foot paths and bike paths should, therefore, have painted transverse pavement markings.

Plastic should be used for parallel crosswalk stripes. These stripes define the limits of the crosswalk and are not a hazard to pedestrians.
If a cross-hatched or longitudinal bar crosswalk is desired, it should be constructed with plastic markings to withstand wear from vehicular traffic. It should also have a higher concentration of glass beads embedded in the plastic to provide better traction for pedestrians.

Descriptions of these pavement markings are contained in the Standard Specifications for Road, Bridge, and Municipal Construction.

Guidelines for the application of various pavement markings are provided in Chapter 910 for intersections and channelization, Chapter 940 for interchanges, and the Standard Plans for Road, Bridge, and Municipal Construction.

830.03 Raised Pavement Markers (RPMs)

(1) General

RPMs are small delineation devices, usually constructed from plastic, which are glued to the roadway surface. They are used as a supplement to or a substitute for pavement markings.

RPMs, because of their high visibility, provide an additional element of safety. Refer to the Standard Plans for Road, Bridge, and Municipal Construction for RPM types, spacing, and other details.

Type 1 RPMs are circular in shape and are available in yellow or white. They are used primarily as a substitute for paint stripes.

Type 2 RPMs are square in shape and have one or two reflective faces. They are available in various combinations of yellow, white, and red. They can be used to supplement a paint stripe. They can also be used with Type 1 RPMs as a substitute for a paint stripe.

Type 3 RPMs are elongated rectangular markers and may be used where the District Traffic Engineer determines that additional emphasis is necessary. Islands, median, pedestrian, bicyclist, and vehicle separations, and other wide line applications may require these RPMs. Type 3 RPMs can adversely affect steering control of motorcycles and bicycles and should not be placed directly in their path.

The general use of Type 2 RPMs on right edge lines is strongly discouraged. See the Traffic Manual for approved right edge applications.

The use of RPMs, other than as specified below, must be approved by the State Traffic Engineer on a project-by-project basis.

(2) Multilane

RPMs are used on all multilane highways west of the Cascade Mountains (west of a hypothetical line extending more or less north and south through North Bend, Washington). The State Traffic Engineer may approve their use on multilane highways east of the Cascade Mountains. RPMs, however, are not normally used in areas where snow and ice removal operations will damage the markers. Snow-plowable markers, such as recessed markers, may be considered for these areas.

Type 2 RPMs may be used in conjunction with painted edge stripes on the left.

(3) Two Lane

Type 2 RPMs are installed as positioning guides to painted center lines of two lane highways west of the Cascade Mountains. Highways with very low traffic volumes may not justify center line RPMs, but their use is recommended.

Type 1 and 2 RPMs may be substituted for painted center line on two lane highways where environmental or unique conditions warrant. Type 2 RPMs may be used to supplement painted edge stripes where very unique conditions warrant. Approval by the State Traffic Engineer is required.

(4) Other

RPMs may be used to supplement, or be substituted for pavement markings for width transitions, channelizations, approaches to islands or obstructions, traffic islands, and arrows (see Chapter 910). The color of the RPM shall be consistent with the color of the pavement marking it is supplementing or replacing.

Where RPMs are used as a substitute, their spacing must simulate the appropriate pavement marking stripe. The spacing formulas for substitution are contained in the Standard Plans.
830.04 Guideposts

(1) General

Guideposts are classified as 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 snow conditions warrant, and at intersections without illumination. The types of guideposts and their application are as follows:

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

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

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

(d) Type WR and YR. Guideposts with red reflective sheeting, on the back side of the post, used at locations where traffic could enter and travel in the wrong direction on a one-way facility. These guideposts should be installed for a distance of approximately 500 feet from the point where a wrong-way driver could enter the one-way roadway. Red reflectors should not be placed in any location that would allow a driver traveling in the proper direction to see them and become confused.

(2) Placement and Spacing

Guideposts are placed on roadways as shown in Figure 830-1. Use of guideposts on tangent sections or on the inside of horizontal curves may be considered for locations that demonstrate need.

<table>
<thead>
<tr>
<th>Type of Highway</th>
<th>Spacing (FL)</th>
<th>Guidepost Type</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided Highways with RPM Delineation</td>
<td>300 max. on curves</td>
<td>W</td>
<td>Inside and outside of horizontal curves (see Standard Plans).</td>
</tr>
<tr>
<td>Divided Highways without RPM Delineation</td>
<td>528 max. on tangent</td>
<td>W</td>
<td>Right side of roadways; and inside and outside of horizontal curves (see Standard Plans).</td>
</tr>
<tr>
<td>All other State Highways</td>
<td>528 max. on tangent</td>
<td>WW</td>
<td>Outside of horizontal curves (see Standard Plans). Placement on a tangent or inside of a curve is optional.</td>
</tr>
<tr>
<td>Lane Reductions</td>
<td>100 max.</td>
<td>W</td>
<td>See Standard Plans.</td>
</tr>
<tr>
<td>Median Crossovers</td>
<td>100 max.</td>
<td>YR</td>
<td>See Standard Plans.</td>
</tr>
<tr>
<td>Bridge Approaches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersection on Divided Highways</td>
<td>100 max.</td>
<td>W</td>
<td>See Standard Plans.</td>
</tr>
</tbody>
</table>

Guideposts are placed not less than 2 nor more than 8 feet outside the outer edge of the shoulder. Guideposts should be placed at a constant distance from the edge of the roadway. When an obstruction intrudes into this space, the guideposts should be placed to smoothly transition to the inside of the obstruction.

For further information on guideposts see the Standard Plans for Road, Bridge, and Municipal Construction.
830.05  Barrier Delineation

Barrier delineation is used in areas with guardrail or concrete barrier where Type W or Y guideposts are required by other roadway conditions.

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

Concrete barrier is delineated by placing reflective devices on the face of the barrier about 6 inches down from the top. Reflective devices may be mounted on the top of the barrier at locations where mud or snow accumulate against the face of the barrier. Reflectors spacing is the same as for guideposts.

830.06  Wildlife Warning Reflectors

(1) Reflector System

Collisions between automobiles and deer produce a substantial economic cost through damage to vehicles, human injury, fatality, and loss of wildlife resource. A wildlife warning reflector system has been developed to reduce this accident potential.

The system consists of a series of reflectors mounted along the roadway. During the hours of darkness, light from the headlights of an approaching vehicle is reflected away from the roadway by the reflectors. This reflected light creates an "optical fence" which causes the deer to remain motionless until the vehicle has passed.

The headquarters Design Office biologist maintains a history of vehicle-deer collisions on state highways and will furnish the district with prospective "optical fence" locations. The headquarters biologist is available to assist with a cost-benefit analysis of proposed reflector installations. Reflectors may be warranted if the deerkill for any one mile section exceeds five kills per year. Special circumstances, such as a high use deer crossing, may also require short sections of this reflector system.

(2) Reflector Placement

Spacing of the wildlife reflectors along the shoulder edges depends upon the geometric configuration of the highway.

For straight and level roads and horizontal curves greater than 1,000 feet in radius, the reflectors should be spaced every 70 feet along both sides of the pavement shoulders.

For vertical curves up to 4,500 feet in length and horizontal curves of 1,000 feet radius or less, the spacing shown in the charts in Figure 830-2 should be used. The chart in this figure which produces the smallest spacing should be used when a horizontal curve and a vertical curve occur at the same location.

On two-lane and three-lane highways, the reflectors should be positioned on both sides of the roadway opposite each other. On horizontal curves, the reflector spacing should be on the outside of the curve. The reflectors on the inside of the curve should be positioned radially to the outside reflectors.

Lateral placement will preferably be 2 feet from the edge of the shoulder, but not more than 10 feet from the edge of the near lane.

In those areas with closely spaced trees and undergrowth adjacent to the roadway, special design considerations may be required. The headquarters biologist should be contacted for assistance.

The height of the reflector should be at the same elevation as the average vehicle headlight height. Where possible, the bottom of the reflector should be 2 feet above the roadway crown.

830.07  Procedure

Delineation is to be addressed in the design report and included in the PS&E in accordance with Chapter 330 and the Plans Preparation Manual respectively.
SPACING OF WILDLIFE REFLECTORS ON HORIZONTAL CURVES

- **Spacing on Inside Curve:**
  - Radii up to 90 m: One reflector for every second reflector on outer curve.
  - Radii over 90 m: One reflector for each reflector on outer curve.

- **Spacing on Outside Curve:**

```
Spacing (meters)  
-------------------------------
  0  6  12  18  24
-------------------------------
Horizontal Curve (meters)  
30  60  90  120  150  180  210  240  270  300
```

SPACING OF WILDLIFE REFLECTORS ON VERTICAL CURVES

```
Spacing (meters)  
-------------------------------
  0  6  12  18
-------------------------------
Vertical Curve (meters)  
0  150  300  450  600  750  900  1050  1200  1350
```

Spacing of Wildlife Reflectors

*Figure 830-2 (Metric)*
Delineation
Spacing of Wildlife Reflectors

Figure 830-2
840
Illumination

840.01 General
Transportation facility illumination provides visual perception of conditions or features that require additional driver or pedestrian alertness. This is accomplished through the use of materials and techniques that result in optimum energy efficient illumination designs.

WSDOT is responsible for illumination on state highways with access control regardless of location and for illumination of highways without access control located outside of the corporate limits of any city. Cities are responsible for illumination of state highways without access control located within their corporate limits. In cities with a population under 15,000 where the state is responsible for signalization, the state may assume responsibility for illumination installed on signal standards in the interest of reducing intersection clutter.

Expanded definitions, design criteria, and example applications are shown in the Traffic Manual.

840.02 References
- RCW 47.24.020.

840.03 Definitions

Basic Illumination The minimal amount of illumination to be provided at certain transportation facilities.

Major Parking Lots Major parking lots for park and ride lots, pool-it lots, and ferry terminal facilities are those with nighttime usage exceeding fifty vehicles during the nighttime peak hour.

Security Lighting The techniques of providing low level lighting for public safety or theft reduction. Security lighting is not subject to any lighting uniformity requirements.

Walkway The connection between two areas over which the user is required to travel in order to utilize available services. Typical examples are as follows:
- Walkways between parking areas and rest room buildings at rest areas.
- Walkways between drop-off or pick-up points and bus loading areas at flyer stops.
- Walkways between parking areas and bus loading areas.
- Nighttime The period of time from one-half hour after sunset to one-half hour before sunrise and any other time when persons or object may not be clearly discernible at a distance of five hundred feet (RCW 46.04.200 Hours of Darkness).

840.04 Approval Requirements

(1) General
For basic illumination, see 840.04(2), and for applications, see Figures 840-1, 2, and 3.

Proposals to provide less than or more than the amount of lighting required for basic illumination will require the approval of the State Traffic Engineer.

For illumination of other highway facilities, see 840.04(3).

When the State Traffic Engineer’s approval is required, justification should be included in the design report or the design report supplement. See Chapter 330. Illumination plans and substantiating data will not be required in the design report but must be retained by the district to be provided to the State Traffic Engineer if requested.

(2) Basic Illumination
Basic illumination is required for the following facilities:
- Freeway ramp gore areas.
- Ramp terminals.
- Channelized intersections.
- Signalized intersections.
- Railroad crossings with gates or signals provided there is nighttime train traffic.
- Loading areas at flyer stops.
- Major parking lots.
- Rest areas.
- Scale platforms at weigh stations.

(3) Illumination of Other Highway Facilities
Illumination at the locations listed below is divided into two categories depending on whether approval by the State Traffic Engineer is required.

Approval by the State Traffic Engineer is required for illuminating the following facilities:
- All highways with or without access control.
- Unsignalized or unchannelized intersections.
- Tunnels, underpasses, and lids.
- Bridges.
Illumination of the following facilities will not require the State Traffic Engineer’s approval:

- Construction zones.
- Detours.
- Railroad crossings without gates or signals.
- Walkways.
- Bicycle trails.
- Minor parking lots.
- Pavement transitions.

(4) Nonstandard Features

Approval by the State Traffic Engineer is required for any proposal that incorporates lighting equipment or features other than those identified as standard in the Traffic Manual.

840.05 WARRANTS

(1) General

Proposals to install additional lighting at basic illumination locations and to illuminate other locations requires satisfying the warranting conditions listed below. When volumes are used to determine the level of service, the counts should be taken during the nighttime peak hour.

Peaking characteristics in urban areas are related to clock time. Traffic counts taken during daylight hours after 4:30 p.m. and before 7:30 a.m. may be used to satisfy nighttime volume warrants providing seasonal adjustment factors have been applied to demonstrate warrant satisfaction for the applicable portions of the months of November, December, and January.

When accidents are used to warrant illumination, the ratio of nighttime to daytime accident rates should be at least 1.5 times higher than the average for similar locations, and a study should indicate that illumination will result in a reduction in nighttime accidents. When comparing similar locations, volumes, speed, land use, and access control should be similar.

(2) Highways With Access Control

All roadways within the limits of access control are covered in this category and include mainline, ramps, and crossroads.

(a) Mainline. Illumination is warranted when the nighttime peak hour level of service is D or below and any two of the following conditions occur:

- Three or more successive interchanges are located within an average spacing of 1 1/2 miles or less.
- The segment is in an urban area.
- The nighttime accident warrant is satisfied.

(b) Ramps. Illumination is warranted when any of the following conditions occur:

- Nighttime peak hour level of service is D or below.
- Complex ramp alignment and grade.
- There are routine queues of five or more vehicles per lane during darkness due to traffic control features at the ramp terminal.
- The exit advisory speed is more than 20 mph below the posted mainline speed.
- The nighttime accident warrant is satisfied.

(c) Crossroads. Illumination is warranted if any of the following conditions occur:

- Nighttime peak hour level of service is D or below.
- The nighttime accident warrant is satisfied.

(3) Highways Without Access Control

Illumination is warranted if the segment is classified as commercial and the nighttime level of service is D or the nighttime accident warrant is satisfied.

(4) Intersections

Illumination of unsignalized and unchannelized intersections is warranted if channelization warrants or the nighttime accident warrant are satisfied.

(5) Tunnels, Underpasses, or Lids

Daytime illumination is warranted if portal conditions result in a condition where brightness reduction is greater than 15 times and the length to vertical clearance ratio is ten to one or greater.

(6) Construction Zones and Detours

Illumination may be warranted if construction activities take place on the roadway at night.

(7) Detours

Illumination is warranted if detour alignment and grade are unusual or result in unexpected maneuvers.

(8) Minor Parking Lots

Security lighting is warranted if vandalism or security problems have developed or are anticipated.

(9) Bridges

Warrants for illuminating bridges are the same as those for highways with or without access control, whichever is applicable.

(10) Walkways and Bicycle Trails

Security lighting is warranted if security problems have developed or are anticipated.

(11) Railroad Crossing Without Gates or Signals

Illumination of these facilities is warranted if there are potential nighttime accidents. The extent of nighttime
train activity should be taken into consideration. Also, if there is the probability that railroad cars may be stopped on the crossing during the nighttime, lighting should be considered.

**840.06 DESIGN REPORT**

The design report shall note the following:
- The facilities where basic illumination is proposed.
- Justification for any proposal to install less than or more than the lighting required for basic illumination.
- Justification for any proposal to install illumination at other highway facilities.
- The status of existing illumination before, during, and after construction.
TYPICAL DIAMOND INTERCHANGE BASIC ILLUMINATION
(Shown for single lane off connections and two lane crossroad without channelization)

NOTE:
See Traffic Manual for luminaire spacing

SINGLE LANE OFF CONNECTION
(Standards can be shifted up to 30 m from gore point)

DOUBLE LANE OFF CONNECTION

Legend
♀ Standard luminaire and light pole.

BASIC ILLUMINATION APPLICATIONS
Figure 840-1
(Metric)
STANDARD ON CONNECTIONS

AUXILIARY LANE STARTING AT ON CONNECTION
(Required only if significant weaving problem exists)

DOUBLE LANE ON CONNECTION

Legend

Standard luminaire
and light pole.

NOTE:
See Traffic Manual
for luminaire spacing.

BASIC ILLUMINATION APPLICATIONS
Figure 840-2
CURBED LEFT TURN CHANNELIZATION

PAINTED LEFT TURN CHANNELIZATION

FOUR-WAY

TEE

TEE OR RAMP TERMINAL

INTERSECTIONS

RAILROAD CROSSING

Legend

.standard luminaire
.and light pole.

NOTE:
See Traffic Manual
for luminaire spacing

BASIC ILLUMINATION APPLICATIONS
Figure 840-3
TYPICAL DIAMOND INTERCHANGE BASIC ILLUMINATION
(Shown for single lane off connections and two lane crossroad without channelization)

NOTE:
See Traffic Manual for luminaire spacing

SINGLE LANE OFF CONNECTION
(Standards can be shifted up to 100' from gore point)

Legend

Standard luminaire and light pole.

DOUBLE LANE OFF CONNECTION

BASIC ILLUMINATION APPLICATIONS
Figure 840-1
850
Traffic Control Signals

850.01 General
850.02 Policy
850.03 Approval Requirements
850.04 Signal Design
850.05 Contract Preparation

850.01 GENERAL

(1) Definitions

Traffic control signals are devices that warn or direct traffic to take specific action. Traffic control signals include the following types:

Conventional Traffic Signal. A permanent or temporary installation providing alternating right of way assignments for conflicting traffic movements.

Emergency Vehicle Signal. A special adaptation of a conventional traffic signal specifically installed to allow for the safe movement of authorized emergency vehicles. When not providing for the movement of emergency vehicles the signal shall either flash continuously consistent with the requirements for a conventional traffic signal or display continuous green (allowed at non-intersection locations only). At no time shall the system simply be de-energized.

School Signal. A special adaptation of a conventional traffic signal installed at established school crossings on the basis of a need to create adequate gaps in the vehicular stream for pedestrian crossings. When not operating as a school signal the system shall operate consistent with the requirements for an emergency vehicle signal during non-emergency intervals. At no time shall the system simply be de-energized.

Intersection Control Beacon (Flashing Beacon). A secondary control device supplementing "intersection" or "stop" signs. The display requirements for an intersection control beacon differ from those for a conventional traffic signal in that a minimum of one rather than two displays per approach is required. An intersection control beacon is used when high accident rates indicate a special hazard or where traffic or physical conditions do not justify conventional traffic signals. Intersection control beacons are used only at an intersection to control two or more directions of travel.

Movable Bridge Signals (Drawbridge Signal). A special type of signal, the purpose of which is to notify traffic to stop because of a road closure, rather than alternately assigning right of way to conflicting traffic movements.

Lane Control Signals. Special overhead signals having indications to permit or prohibit the use of specific lanes or to indicate the impending prohibition of use. Lane control signals are most often used for reversible lane control.

Hazard Identification Beacon. A hazard identification beacon is used to supplement an appropriate warning or regulation sign or marker. Display consists of circular flashing yellow. Use with "stop", "yield" or "do not enter" signs is not allowed.

Ramp Meter Signal. A special type of signal used to control the flow rate onto a freeway.

Speed Limit Sign Beacon. A speed limit sign beacon is used with a fixed or variable speed limit sign.

Stop Sign Beacon. A stop sign beacon is mounted above a stop sign.

(2) Compliance

The design, construction and operation of traffic control signals installed on state highways shall conform to the requirements contained in the following articles:

M 24-01 Manual on Uniform Traffic Control Devices for Streets and Highways as modified and adopted by WSDOT (MUTCD).

Revised Code of Washington (RCW):
- Chapter 35.77
- Chapter 46.61
- Chapter 47.24
- Chapter 47.36


Department Directives:

M 21-01 Standard Plans for Road, Bridge and Municipal Construction.

M 41-10 Standard Specifications for Road, Bridge and Municipal Construction.

M 22-87 Utilities Manual.
850.02 POLICY

(1) Legal Basis

Policies regarding the installation and operation of traffic signals are based on Washington State laws, including the following:

RCW 46.61.085  Traffic control signals or devices upon city streets forming part of state highways — Approval by Department of Transportation.

RCW 47.24.020  Jurisdiction, control of such streets. 47.24.020(6) and (13)

RCW 47.36.020.  Traffic control signals.

RCW 47.36.060.  Traffic devices on county roads and city streets.

(2) Valid Permit

As noted in the RCW's, the design and location of all traffic signals located on city streets forming parts of state highways must be approved by the department. By policy, approval is also required for all other traffic signals located on state highways. A valid traffic signal permit issued by the State Traffic Engineer constitutes this approval. As stipulated on the permit application, a sketch indicating the proposed operation must accompany the application. The validity and integrity of the permit is maintained by the submittal of reports of the actual construction of the signal and subsequent equipment or operational changes that occur thereafter. Permits are required for the following types of signals:

- Conventional Traffic Signals
- Emergency Vehicle Signals
- Intersection Control Beacons
- School Signals
- Reversible Lane Control Signals
- Movable Bridge Signals (Drawbridge Signals)
- Ramp Meter Signals
- Hazard Identification Beacons if installed overhead at an intersection are considered a type of intersection control beacon and will require a permit.
- Temporary or portable signals.

Emergency vehicle signals require annual permit renewal. The renewal is extended by a letter to the permit holder from the District Administrator with a copy to the State Traffic Engineer.

Hazard identification beacons, not installed overhead at an intersection, speed limit sign beacons, stop sign beacons and lane assignment signals at toll facilities do not require traffic signal permits.

When it is necessary to change the type of signal already installed at an existing intersection under valid permit, a new permit application will be required if the level of control is increased. For example, if it is necessary to change an intersection control beacon to a conventional traffic signal, a new permit application is required. If the change results in a reduction in level of control, submit "Report of Change" Form 242-014 to the State Traffic Engineer.

(3) Responsibility for Finance, Construction, Maintenance and Operation

Responsibility for the finance, construction, maintenance and operation of traffic signals has been defined by legislative action and commission resolutions. Figure 850-1 indicates various signal categories and agency responsibilities. The following rules are also applicable.

(a) The Washington State Department of Transportation reserves the right to discharge any of its responsibilities through agreements with a third party. All such agreements shall be reviewed annually by all parties to determine the need for renegotiation.

(b) At those locations where the Department of Transportation has jurisdiction but where funding schedules and priorities do not provide for the timely construction of a traffic signal which another governmental jurisdiction desires and is willing to finance, the department may permit a traffic signal to be constructed subject to the following:

- Any signal installation so proposed shall conform to all pertinent requirements of the manuals, policies and directives identified herein.
- A traffic signal permit application shall be submitted to and authorized by the Department of Transportation.
- Detailed signal contract plans shall be submitted by the governmental jurisdiction to the District Administrator for forwarding to the State Traffic Engineer. The plans shall be submitted for review and approval prior to any plans being advertised for construction.
- Final inspection of the project by the district involved will be required.
- Subject to a formal letter of agreement, and after final inspection affirms that the installation is consistent with current design standards, the department may assume ownership, operational authority and responsibility.

(c) Work performed under the heading "Responsibility to Maintain" is inclusive of only the physical maintenance of the equipment installed at the time of original installation and any other equipment installed at a later date due to changes in standards. When it is necessary to materially upgrade components by the addition of new signal heads, detectors, modernized signal controllers, etc., the cost associated with this work shall be proportioned in accordance with guidelines listed in Figure 850-1.
In such cases where existing signal equipment is removed, the salvage value of the removed equipment or the actual removed equipment will be distributed in accordance with guidelines listed in Figure 850-1.

(d) The responsibility to finance the construction of conventional traffic signals, school signals, and intersection control beacons at intersections of county roads and state highways shall be consistent with Washington Administrative Code 468-18-040.

(e) Any conventional traffic signal, school signal or intersection control beacon required at the freeway ramp terminal of a state highway shall be entirely the state’s responsibility if the installation is located on state right of way.

(f) The responsibility to finance, install, operate and maintain the components necessary to provide emergency vehicle pre-emption sequences and/or railroad pre-emption sequences at conventional traffic signal installations under state jurisdiction shall be as follows:

1. The state will be responsible for all costs of pre-emption equipment, associated wiring, etc., necessary to provide railroad pre-emption where warranted by the MUTCD.

2. The state will be responsible for all costs of pre-emption equipment, associated wiring, etc., that are installed permanently at the intersection necessary to provide emergency vehicle pre-emption on new signal projects or signal rebuild projects that are within an operating pre-emption system.

3. All costs of equipment, associated wiring, etc., necessary to provide emergency vehicle pre-emption at existing signal installations will be the responsibility of others.

(g) During any emergency vehicle pre-emption operation, a minimum of two displays per approach shall be provided. Emergency pre-emption of an intersection control beacon with a singular display on an approach is prohibited.

(h) At signals inside cities with population under 15,000 where the state has responsibility for signals, the state will assume responsibility for constructing, operating and maintaining luminaires mounted on Type III or V Signal Standards. Any additional illumination will be the city’s responsibility. Outside city limits or within access control, the state is responsible for intersection illumination (see Chapter 840).

850.03 APPROVAL REQUIREMENTS

(1) General

For new signal proposals, approval by headquarters will be required for the permit, the preliminary signal plan, and design reports not approved by the districts. For signal rebuilds, approval by headquarters will be required for the preliminary signal plans and design reports not approved by the districts.

The preliminary signal plan will not be approved until both the permit and design report are approved. It is preferred that these two be approved prior to the submittal of the preliminary signal plan.

(2) Permit

Items to be included with the permit application are noted on Form 242-014. The warrant analysis shall note the extent to which each warrant is met. The vehicular volume count information shall include turning movement counts and specifically note the right turn volumes. Show lane configuration, turning radii, and corner radii on the intersection sketch.

All applications shall be submitted to the State Traffic Engineer for approval.

If signalization projects are proposed by another agency, the application will be submitted to the local District Administrator, who will review the application, make a recommendation and then forward the application to the State Traffic Engineer.

Based on the calendar action of the State Maintenance Engineer, the State Traffic Engineer will either authorize the permit or will notify the District Administrator of rejection.

The permit is updated by filing “Report of Installation” and “Report of Change,” both contained on Form 242-014. The turn-on date should be reported on the “Report of Installation” and any change in the type of signal or the control method should be reported on the “Report of Change.”

Permits for emergency vehicle signals require annual renewal. The installations shall be reviewed by the District Administrator for compliance with state standards. Renewal is by letter from the District Administrator to the agency.

The signal permit should be approved before the design report is submitted for approval, or approved by the district. The design report will not be approved until the signal permit is approved.

(3) Design Report

(See Chapter 330)

(a) New Installations. The design report should include the following items:

• A statement of the problem that is being addressed by the installation of a signal.

• A discussion of what alternatives were considered, including cost estimates.
• A comparison of queue, delay and safety for all alternatives considered.

(b) Signal Rebuilds. The design report should identify the specific reasons for the signal rebuild. The report should also include a warrant analysis to show that the signal is still required under both existing and proposed lane configurations.

(c) Intersections. If channelization or other intersection revisions are proposed, see Chapter 330.

(4) Preliminary Signal Plan

The preliminary signal plan is submitted to the State Traffic Engineer for approval after the permit and design report are approved. If the design report was approved by the District Administrator, include a discussion of the items in (3), above. The State Traffic Engineer will notify the District Administrator of the approval or disapproval of the plan.

(a) If the district is preparing the plans, specifications and estimates for the project, the preliminary signal plan (1 inch = 20 feet) shall include the following items:

• Turning radii, left turn and corner.
• Stop bar locations.
• Detector locations.
• Signal standard type and locations.
• Signal displays.
• Phase diagram, including pedestrian movements.
• Illumination treatment.

(b) If headquarters is preparing the plans, specifications, and estimates for the project, the preliminary signal plan (1 inch = 20 feet) shall include the following items:

• Existing utilities, underground and overhead.
• Existing and proposed intersection layout including proposed crosswalk locations, turning radii, stop bar locations and corner radii.
• Existing and proposed illumination treatment.
• Signal standard type and locations.
• Signal displays.
• Phase diagram including pedestrian movements.
• Turning movement counts, peak hour for isolated intersections, a.m., midday, and p.m. peaks if there is another intersection within 500 feet.
• Speed study indicating 90th and 10th percentile speeds for all approaches.
• Detector locations.
• Emergency vehicle pre-emption requirements.
• Service location and power hookup requirements.

The submittal shall designate a contact person, charge numbers, and schedules. After the plans, specifications, and estimate have been prepared, the entire package will be transmitted to the district for incorporation into the total project plans.

850.04 SIGNAL DESIGN

(1) General

The quality of a signal installation is a result of the knowledge, experience and decision-making ability of the designer. Throughout the development stages, the designer is required to make numerous decisions, often involving a compromise in one or more of the basic values of safety, driver comfort, efficiency, fuel consumption, maintainability and cost. Information contained herein and in previously mentioned references is intended to assist the designer in this decision-making process.

The goal of any signal design is to assign right of way in the most efficient manner possible, consistent with traffic volumes, geometrics and safety. Until recently, the predictive techniques available to the designer for evaluating the efficiency of alternate designs have been either too tedious or too inaccurate for practical use. The designer should always bear in mind that all predictive techniques are based on assumptions related to arrival rate distribution and driver behavior patterns that will vary depending on a number of factors. Techniques presented herein are most applicable for comparison of alternative designs for signals at isolated intersections. Variations in results may be significant when techniques are applied to multi-signal systems, although these techniques are still valuable for comparing the relative merits of alternative designs at individual intersections within the multi-signal system.

(2) Phase Analysis

After all advanced engineering data has been collected, and after field conditions have been observed, the next step is to conduct a phase analysis. The goal of a phase analysis is to develop a timing pattern that will:

• Minimize total delay to all vehicles and pedestrians.
• Minimize delay to any single group of vehicles or pedestrians.
• Minimize accident potential and severity.
• Provide an adequate level of service on all approaches.

As a general rule, although there are exceptions, the fewer the phases, the more efficient the operation. The number of phases required for safe, efficient operation is related to intersection geometrics, traffic volumes, the composition of the traffic flow, turn demands and the level of driver comfort desired. Often, the most crucial decision encountered while conducting a phase analysis is whether or not to include protected left turn phasing. The volume output of an unprotected left turn movement is a function of the acceptable gap frequency of the opposing movement. In some cases, protected phasing can be justified.
purely on this basis. In most cases, protected phasing may be justified based on a comparison of the delay for situations both with and without protected phasing. In borderline cases, the decision resolves to a comparison of the benefits of increased efficiency versus the level of driver comfort desired. As a general rule, protected left turn phasing should be considered if peak hour left turn volume exceeds 50 and the product of the turning and opposing through volume exceeds 50,000 for a single lane opposing movement and 100,000 for a double lane opposing movement. In addition, whenever left turn demand exceeds 300 vehicles per hour, installation of double left turns should be considered.

Delay is one of the more important measures of effectiveness available to the designer for evaluating the effectiveness of alternative phase strategies. Total delay is defined as the time required for all vehicles approaching an intersection during the study period to traverse the zone of influence, minus the time required to traverse the same distance if no signal existed. Other significant measures of effectiveness include the following:

- Average queue lengths.
- Maximum queue lengths.
- Volume output.
- Total number of stops required.
- Fuel consumption.
- Number of vehicles caught in the dilemma zone.

Delay at traffic signals is related to the type of control equipment, phasing, time settings on the control equipment, the detection system and the arrival pattern. One method of evaluating alternative phase strategies is to compare levels of service. A capacity analysis will yield level of service factors. The "Webster" analysis technique offers a rational determination of the optimum cycle to minimize delay. The optimum cycle calculation with associated split determinations, when used with capacity analysis, offers a realistic common denominator for comparing alternative phasings.

The following example illustrates the "Webster" technique.

**Example Optimum Cycle and Split Calculation:**
Calculate the optimum cycle and splits that will provide minimum delay for the intersection indicated in Figure 850-2, assuming the following:

- 5 phase operation.
- 7 second minimum green (G) time.
- 4 second amber (A) time.
- Minimum flashing don't walk (FDW) time is equal to the time required to walk from the curb to the center of the farthest lane at a rate of 4 feet per second.
- 20 foot average vehicle length.
- 2.1 second average saturation flow headway.
- Random arrival pattern.

(a) **Formulas**

- **Webster Optimum Cycle Formula**

\[
C_0 = \frac{(1.5L + 5)}{(1 - Y)}
\]

- **Optimum cycle to minimize delay.**

- **Y** = The total of the ratios of critical movements to saturation flows.

- **L** = Total lost time per cycle, including the time lost during queue startup, in addition to the time lost while the last vehicle in the queue travels from the stop bar to a point safely beyond the traveled way of the next conflicting movement.

- **Australian Left Turn Factor Formula**

\[
EL = \frac{1.5}{\ln(SG) - \frac{fOC}{(GnS-Q)}} + \frac{4.5}{G}
\]

- **EL** = Factor for converting unprotected left turning vehicles to equivalent passenger car units, (pcu).

- **S** = Saturation flow in vehicles per hour per lane, (vphl).

- **C** = Cycle length in seconds.

- **n** = Number of opposing lanes.

- **G** = Effective green time in seconds.

- **Q** = Opposing straight through and right turning traffic in passenger car units (pcu) per hour.

- **f** = A function of the opposing flow (Q) that varies as follows

\[
\begin{align*}
Q & \quad f \\
0 & \quad 1.00 \\
200 & \quad 0.81 \\
400 & \quad 0.65 \\
600 & \quad 0.54 \\
800 & \quad 0.45
\end{align*}
\]

(b) **Minimum Cycle Calculation.** The minimum cycle length, assuming considerable pedestrian activity, will be controlled by the minimum times set for phase 1 + phase 2 + phase 4 or by phase 5 + phase 6 + phase 4.
phase 2 = 7 sec. W + 52/4 sec. FDW = 20 sec.
phase 4 = 7 sec. W + 64/4 sec. FDW = 25 sec.
Total = 56 sec.

The total for phase 5 + phase 6 + phase 4 is the same, since phase 5 G + A are equal to phase 1 G + A and phase 2 FDW time is equal to phase 6 FDW time.

(c) Optimum Cycle Calculation.

- Convert street volumes to equivalent passenger car units (pcu). Ideally, conversion factors should be developed from field measurements. Flow characteristics may vary significantly depending on local intersection conditions. For this example the following factors have been assumed:
  - Straight through passenger car = 1.0 pcu.
  - Left turning passenger car during protected phase = 1.1 pcu.
  - Right turning passenger car with turning radius 25 feet minimum and adequate lane width = 1.1 pcu.
  - Right turning passenger car with turning radius less than 25 feet or with narrow lane width = 1.3 pcu.
  - Truck or bus = 1.5 pcu.

Left turning passenger cars during a permissive phase are equal to the value obtained from the "Australian" formula. For this example an S value of 1714, a 90 second cycle and a 30 second effective green time for phase 4 have been assumed, resulting in a factor of 2.54 pcu for the north approach and 2.68 for the south approach.

Applying these factors to the traffic volumes results in the following equivalent passenger car volumes:

<table>
<thead>
<tr>
<th>Approach</th>
<th>Left</th>
<th>Straight</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>231</td>
<td>945</td>
<td>116</td>
</tr>
<tr>
<td>East</td>
<td>173</td>
<td>525</td>
<td>173</td>
</tr>
<tr>
<td>North</td>
<td>260</td>
<td>308</td>
<td>113</td>
</tr>
<tr>
<td>South</td>
<td>412</td>
<td>256</td>
<td>133</td>
</tr>
</tbody>
</table>

Applying the approach volumes to the intersection lane configuration results in the following hourly volumes:

<table>
<thead>
<tr>
<th>Approach</th>
<th>Lane</th>
<th>Phase</th>
<th>Movement</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>A</td>
<td>1</td>
<td>1</td>
<td>231</td>
</tr>
<tr>
<td>West</td>
<td>B</td>
<td>6</td>
<td>6</td>
<td>530</td>
</tr>
<tr>
<td>West</td>
<td>C</td>
<td>6</td>
<td>6</td>
<td>530</td>
</tr>
<tr>
<td>South</td>
<td>D</td>
<td>4</td>
<td>4</td>
<td>412</td>
</tr>
<tr>
<td>South</td>
<td>E</td>
<td>4</td>
<td>4</td>
<td>389</td>
</tr>
<tr>
<td>East</td>
<td>F</td>
<td>5</td>
<td>5</td>
<td>173</td>
</tr>
<tr>
<td>East</td>
<td>G</td>
<td>2</td>
<td>2</td>
<td>349</td>
</tr>
<tr>
<td>East</td>
<td>H</td>
<td>2</td>
<td>2</td>
<td>349</td>
</tr>
<tr>
<td>North</td>
<td>I</td>
<td>4</td>
<td>8</td>
<td>340</td>
</tr>
<tr>
<td>North</td>
<td>J</td>
<td>4</td>
<td>8</td>
<td>341</td>
</tr>
</tbody>
</table>

The cycle length will be controlled by the critical lane volumes for the phase combination of phases (1 + 2 + 4) or phases (5 + 6 + 4).

| Phase 1 lane A | 231 |
| Phase 2 lane G or H | 349 |
| Phase 4 lane D | 412 |
| Total | 992 |

| Phase 5 lane F | 173 |
| Phase 6 lane B or C | 530 |
| Phase 4 lane D | 412 |
| Total | 1115 |

Phases (5 + 6 + 4) will control the cycle length. The ratio of critical flows to saturation flow can now be calculated.

\[
Y = \frac{\text{Total critical flows}}{S}
\]

\[
S = \frac{3600 \text{ sec. per hour}}{2.1 \text{ sec. per vehicle}}
\]

\[
Y = \frac{(1115)}{1174} = 0.651
\]

Lost time per cycle can now be calculated. Lost time consists of the time lost during queue startup and time lost during phase termination. Startup losses vary with the queue length as follows:

<table>
<thead>
<tr>
<th>Queue (pcu)</th>
<th>Startup loss (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.7</td>
</tr>
<tr>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>4</td>
<td>3.6</td>
</tr>
<tr>
<td>5</td>
<td>3.7</td>
</tr>
<tr>
<td>6</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Assuming a 90 second cycle, splits proportional to critical lane volumes and a uniform arrival rate, average queue length can be calculated.

Average arrival rates (g)

- Phase 5 = 173 vph = 0.048 vph
- Phase 6 = 530 vph = 0.147 vph
- Phase 4 = 412 vph = 0.114 vph

Red (R) times

- Phase 5 = (1115-173)/1115 x 90 = 76 sec.
- Phase 6 = (1115-530)/1115 x 90 = 47 sec.
- Phase 4 = (1115-412)/1115 x 90 = 57 sec.

Average queue length, (g)(R)

- Phase 5 = 0.048 x 76 = 3.6 vehicles
- Phase 6 = 0.147 x 47 = 6.9 vehicles
- Phase 4 = 0.114 x 57 = 6.5 vehicles
Based on average queue length, the following startup losses are determined:

- Phase 5 = 3.5 seconds
- Phase 6 = 3.7 seconds
- Phase 4 = 3.7 seconds

Phase termination losses include the time consumed while the last vehicle in the queue travels from the stop bar to a point safely beyond the traveled way of the next conflicting movement. It has been assumed that these vehicles are traveling at the approach speed, except the left turning Phase 5 vehicle where a 15 mph speed has been assumed.

- Phase 5 = (50' + 20') / 22' per sec. = 3.2 sec.
- Phase 6 = (60' + 20') / 44' per sec. = 1.8 sec.
- Phase 4 = (75' + 20') / 29' per sec. = 3.3 sec.

Combined startup and termination losses are as follows:

- Phase 5 = 3.5 sec. + 3.2 sec. = 6.7 sec.
- Phase 6 = 3.7 sec. + 1.8 sec. = 5.5 sec.
- Phase 4 = 3.7 sec. + 3.3 sec. = 7.0 sec.
- Total = 19.2 sec. = L

The optimum cycle to minimize delay can now be calculated.

$$ Co = \frac{(1.5L + 5)}{(1-Y)} $$

$$ Co = \frac{(1.5 \times 19.2 + 5)}{(1-0.651)} $$

$$ Co = 97 \text{ seconds} $$

Splits are as follows:

- Phase 5 = 173/1115 x 97 = 15 sec. (G+A)
- Phase 6 = 530/1115 x 97 = 46 sec. (G+A)
- Phase 4 = 412/1115 x 97 = 36 sec. (G+A)

Based on a 97 second cycle and a G of 29 sec. (36 sec. - 7 sec. losses) for Phase 4 a new equivalent car factor for the south approach of 2.8 pcu results in a critical volume for lane D of 431 vph. Adjusting the calculations for this volume results in an optimum cycle of 100 seconds. Final splits are:

- Phase 1 = 25 sec. Phase 5 = 15 sec.
- Phase 2 = 37 sec. Phase 6 = 47 sec.
- Phase 4 = 38 sec. Phase 4 = 38 sec.

Based on these splits and cycle length, volume to capacity ratio and level of service can be determined as follows:

$$ V/CP = \frac{Y}{1-L/Co} $$

$$ V/CP = \frac{0.651}{1-19.2/97} $$

$$ V/CP = 0.81 $$

Level of service is selected from the following table:

<table>
<thead>
<tr>
<th>V/CP</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60</td>
<td>A</td>
</tr>
<tr>
<td>0.70</td>
<td>B</td>
</tr>
<tr>
<td>0.80</td>
<td>C</td>
</tr>
<tr>
<td>0.90</td>
<td>D</td>
</tr>
<tr>
<td>0.91</td>
<td>E</td>
</tr>
</tbody>
</table>

For these conditions, level of service is D.

Optimum cycle length also relates to level of service although the correlation is not nearly as accurate as that provided by “Y”. As a general rule, if the optimum cycle calculation yields a cycle length in excess of 75 seconds for two critical phases, 100 seconds for three critical phases, or 140 seconds for four critical phases, the intersection warrants more study and measures to increase capacity should be considered.

Assuming the example intersection as the base condition, other alternatives have been investigated in an effort to increase capacity. Each case is identified as follows:

- Case 1 - Example intersection, 5 phase operation.
- Case 2 - Example intersection, 5 phase operation, add right turn lane on west approach.
- Case 3 - Example intersection, 6 phase split side street operation.
- Case 4 - Example intersection, 6 phase split side street operation, add right turn lane on west approach.
- Case 5 - Example intersection, 6 phase split side street operation, add right turn lane on west approach, widen side streets to provide left turn lane and two through lanes.
- Case 6 - Example intersection, 8 phase operation, add right turn lane on west approach, widen cross streets to provide left turn lane and two through lanes.

Results of each investigation are as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>3</td>
<td>56</td>
<td>19.2</td>
<td>97</td>
<td>0.65</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>59</td>
<td>19.2</td>
<td>89</td>
<td>0.62</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>4</td>
<td>81</td>
<td>26.1</td>
<td>164</td>
<td>0.73</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>4</td>
<td>84</td>
<td>26.2</td>
<td>143</td>
<td>0.69</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>4</td>
<td>87</td>
<td>26.3</td>
<td>114</td>
<td>0.61</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>4</td>
<td>73</td>
<td>26.2</td>
<td>111</td>
<td>0.60</td>
<td>C</td>
</tr>
</tbody>
</table>

Cases 2, 5 and 6 should be considered for improving intersection efficiency. Cases 3 and 4 should be rejected as viable alternatives.
(d) Queue. Queue lengths should be determined for all turn movements to ensure that adequate storage is available. A program is available through the State Traffic Engineer for computing average queue lengths. The program is based on Webster's methodology and uses an IBM PC. A program is also available for the TI-59 calculator. Average queue lengths should be adjusted to a 95% confidence level using the Poisson curve shown on Figure 3, page 558, Traffic System Analysis for Engineers and Planners, Martin Wohl and Brian V. Martin, McGraw-Hall, 1967.

Inputting a cycle length of 98 seconds, a three second amber time, a 3.7 second queue start up delay, a 3.2 second last car delay and an approach rate of 231 vehicles per hour for phase 1 yields an average queue of 5 vehicles and a 95% confidence level queue of 8 vehicles or 200 foot storage requirement.

(3) Control equipment selection

After the phase analysis has been completed, the next step is to select control equipment. In most cases traffic actuated equipment is justified.

Actuated controllers are structured for either single timing ring or dual timing ring operation. See Figure 850-3.

Under fully loaded conditions the phases in any ring will time sequentially. Dual ring controllers offer the advantage of independent timing on non-conflicting movements.

At some intersections the required traffic patterns can be provided by different controller configurations or by utilizing different overlaps. An overlap is a control feature that can be used to provide a green display to an identified movement when any one of the phases included in the overlap is active. The NEMA Standard 4 phase and 8 phase controllers each provide 4 overlaps. Up to 4 phases can be included in an overlap on a 4 phase controller and up to 8 phases can be included in an overlap on an 8 phase controller, although this would result in a continuous display that should be accomplished by other means. Overlaps are identified by letter, A, B, C and D. It is the designer's responsibility to designate which phases are associated with each overlap. Figure 850-4 illustrates a tee intersection phase strategy that could be accomplished by three different methods. Controller I is a 4 phase frame, 4 phases and three overlaps. Controller II replaces Controller I overlap C with an independently timed phase. Controller II provides the flexibility and efficiency of dual ring independent timing. Controller III offers independent timing for movement 8 although it is doubtful if any efficiency can be gained since this movement receives green in any application except when movements 2 and 6 time.

(4) Detection Systems

The detection system at an actuated traffic signal installation provides the control unit with information regarding the presence or movement of vehicles. Detection performs three basic functions: queue clearance, the calling of phases, and the termination of phases. Depending on the specific intersection characteristics, any one of these functions may take priority and a compromise must be reached that will weigh the merits of each function.

Queue clearance is the clearing of all vehicles that are waiting on an approach by continuous detection from the stop bar to a point between 30 feet and 50 feet from the stop bar. The detection zone must be long enough to insure that any gaps that may develop in the queue as it clears the intersection will not occur over the detection zone.

In some instances the calling and termination of phases will take priority over queue clearance. The call function is best served by detection that is placed such that the first vehicle waiting for green will be detected. During heavy traffic conditions this will occur at the stop bar and detection located for queue clearance will serve adequately. Under light traffic conditions, detection located well in advance of the stop bar will do a better job of calling the phase. With enough distance between the stop bar and the calling detector, a driver can receive a green indication before deceleration is required. The stop bar to detector distance in this situation is based on approach speed and side street clearance time.

The phase termination function assumes critical importance on high speed approaches, usually in excess of 35 mph. The exact detector location is often a compromise involving the values of safety and efficiency. A motorist approaching a signal during phase termination is forced to choose between two equally unattractive courses of action: proceed and risk collision at the intersection, or decelerate and risk rear end collision. This "indecision" or "dilemma" zone is normally assumed to occur between those distances from stop bar, that would require deceleration rates between 8 ft/sec² and 12 ft/sec². Elimination of this "dilemma" zone requires detector placement in advance of this zone. Complete elimination of the "dilemma" zone could result in inefficient operation. In order to minimize phase termination delay, and thereby increase efficiency, green time should end as soon as the last vehicle can safely proceed through the intersection. This is usually taken to be when the last car reaches the stop bar, thus requiring detector location from the stop bar equal in travel time to the gap set on the phase module for that approach. As a general rule, assuming normal surface conditions and flat grade, a deceleration rate of 10 ft/sec² and one second perception reaction time may be assumed. For a 40 mph approach, the detector location would be S=V²/2a + V or 58.72/2X10 + 58.7 = 231 feet from stop bar.

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In those instances where phase termination is being accomplished with advance detection but where stop bar detection is required because access to the approach is allowed between the advance detection location and stop bar, equipment should be provided to drop stop bar detection out of the controller input circuitry after queue clearance.

At locations where turn on red is heavy, the detection equipment for this movement should be provided with delay timers to prevent unnecessary call and extension.

After detector locations and type of control have been determined, the actual design of the detection system can begin. The detection provided on any approach should be sensitive enough to detect all classes of motor vehicles, including motorcycles. In addition, bicycle detection should be provided unless bicycles are prohibited on the approach or the control for the approach is planned to be operated in the recall mode.

In most cases, detection can best be accomplished with induction loops; however, at certain locations where significant amounts of horizontal steel exist, induction loops may not provide satisfactory operation and other types of detection such as magnetometers should be considered.

(5) Pedestrian considerations

The needs of the pedestrian shall be considered at all traffic signal installations where pedestrian activity might be expected. The pedestrian has the legal right to cross the roadway within any marked or unmarked crosswalk during the display of a vehicular green indication unless one or more of the following conditions exist:

- The vehicular green indicator consists of a sole green arrow controlling a vehicular movement in conflict with the pedestrian movement.
- The pedestrian has been otherwise directed by a pedestrian signal.
- Pedestrian crossing has been specifically prohibited by appropriate signing.

Pedestrian detection shall be provided for pedestrian movements when the associated vehicular movement is controlled by actuated equipment, unless pedestrian crossings have been prohibited.

Pedestrian signals shall be provided when one or more of the following conditions exist:

- Pedestrian warrants are satisfied.
- Potential pedestrian-vehicle conflicts exist due to split phase signal controls.
- Vehicular displays controlling pedestrian movements are not adequately visible to the pedestrian.

When pedestrian signals are not installed and vehicular signals provide sole pedestrian control, the displays should be carefully evaluated to insure that the control indications, especially if louvered or optically programmed, are adequately visible to the pedestrian. All conventional vehicular signal heads that also function as pedestrian controls should be provided with cadet visors.

In consideration of the physically handicapped, curb ramps are now required on or near crosswalks at intersections. The law specifically requires location and construction of ramps to allow reasonable access to the crosswalk for physically handicapped persons without uniquely endangering blind persons. The law also requires that any ramp constructed at one end of a crosswalk shall be matched by a ramp at the other end of the crosswalk unless there is no curb or sidewalk at the other end. See WAC 236-60 and Chapter 1020.

Special attention should be directed to the location of pedestrian related facilities. Basic considerations include the following:

- Crosswalks should be located to minimize walk time and to minimize potential pedestrian-vehicular conflicts. In some cases, the complete elimination of an excessively long or high-potential-conflict crosswalk should be considered in the interest of safety and operating efficiency.
- Pedestrian detector locations should provide convenient access to pedestrians, including the handicapped. As a general rule, the pedestrian should not be required to deviate more than 5 feet from the normal path of travel in order to actuate the detector.
- The purpose and use of pedestrian detectors should be clearly identified.
- A detector should clearly identify which crosswalk it operates with.
- Pedestrian signals should be located in the line of the pedestrian's vision which pertains to the crosswalk being used.
- Pedestrian signal heads shall be positioned to provide maximum visibility at the beginning of the controlled crossings.

(6) Signal Displays

Signal displays are the devices used to relay right of way assignments and warnings from the control mechanism to the motorist and pedestrian. The most important objective to be considered when selecting display configurations and locations is the need to convey to the motorist and pedestrian in a clear and concise manner the nature of the right of way assignment. It is essential that display applications which imply false security be avoided. Typical display applications and time interval block are shown in Figures 850-5a and 5b. The time interval block diagrams include all intervals where any movement on the approach receives a green indication. In addition to the display requirements of the MUTCD, the following shall also apply:
• Vertical display configurations shall be used unless there are height restrictions.
• Conventional vehicle displays that control both vehicles and pedestrians shall be installed with cadet visors.
• Conventional vehicle displays that control only vehicle movements will normally be provided with tunnel visors.
• The special provisions or plans should specifically address the responsibility for programming and adjusting all optically programmed heads.
• If one section of a display warrants a 12 inch size, all sections should be 12 inches.

(7) Signal Supports

Permanent traffic signal supports will consist of either metal mast arm supports or metal cable-strain pole supports. Timber strain poles are allowed only on temporary systems. Cable-strain pole supports should be considered if any of the following conditions exist.
• Where installation of aerial wiring will have an insignificant effect on the overall visual appearance of the intersection.
• Where it is difficult or impossible to obtain optimum signal display locations using conventional mast arm supports.

See Figures 850-6a and 6b to select strain pole class.

In the placement of signal supports, give primary consideration to ensuring proper visibility of signal faces. However, in the interest of safety, place signal supports and controller cabinets as far as practicable from the edge of the traveled way without adversely affecting signal visibility. (See the MUTCD for guidance in locating signal supports.)

Initial layouts for supports for vehicle display systems, pedestrian detection systems and pedestrian display systems should be accomplished independently to determine the optimal location of supports. If conditions allow and optimal locations are not compromised, pedestrian displays and pedestrian detectors can be installed on the vehicular display support.

If soil conditions are questionable, undertake an in-depth soils investigation.

(8) Controller Cabinets

The selection of the controller cabinet location must be made in the early stages of plan development. The cabinet location should not restrict the lateral visibility of vehicular traffic. Ideally, the cabinet location should provide easy access for maintenance operations. The cabinet should be oriented to allow simultaneous reviewing of the controller and signal displays. Other considerations include the location of the power source and possible future widening.

(9) Miscellaneous Consideration

(a) Underground Raceway Layout. Cost, flexibility, ease of construction and ease of maintenance should be considered when laying out an underground raceway system. Cross-roadway runs should be minimized whenever possible. Cross-roadway runs should be located so that adequate room is available on both sides of the roadway for the required jacking or drilling operations.

(b) Junction Boxes. Junction boxes should be provided at each end of cross-roadway runs, where conduit changes size, where detection circuit splices are required and at other locations that will facilitate ease of construction or maintenance. A signal standard or strain pole base should not be used as a junction box. Design capacities for various size junction boxes are shown in the standard plans.

(c) Conduit. All underground raceways for a traffic signal installation shall be galvanized steel conduit. With the exception of the 1/2 inch conduit for the service ground conductor, the minimum size conduit for off-roadway runs is 1 inch. The minimum size conduit for cross-roadway runs is 1 1/4 inches. All conduits should be sized to provide 26 percent maximum conductor fill. See Figure 850-7.

850.05 CONTRACT PREPARATION

(1) Plans

Typical traffic signal plans are prepared to a scale of 1 inch = 10 feet or 1 inch = 20 feet. Elements that should be contained in the plans include the following:

(a) Existing Intersection Plan. This plan depicts existing features including all known above ground and below ground appurtenances such as channelization, utilities, illumination systems, signal systems, drainage, items requiring removal, etc. In many cases the existing intersection plans can be combined with the signal plan.

(b) Signal Plan. The signal plan identifies and locates all elements that are to be installed or modified. See Figure 850-8.

(c) Legend. The legend identifies with symbols all elements shown on the existing intersection plan and the signal plan that are not identified by separate note. See Figure 850-8.

(d) Signal Display Identification. The signal display identification consists of a schematic representation of each different type of vehicular and pedestrian signal display to be installed or modified on the project. Included with the signal display identification or in the special provisions are type, size, mounting, door, visor, backplate, and programming requirements. Backplates are required on all signals.
Signal head numbering consistent with Figure 850-9 is recommended.

(e) **Phase Sequence Diagram.** Typical phase sequence diagrams are indicated in Figure 850-10a through 10d. Individual movements are identified within each phase block consistent with Figure 850-9.

(f) **Signal Sequence Chart.** A signal sequence chart will be required for non-standard phasing or when overlaps are utilized. Standard applications will not require a sequence chart. A signal sequence chart for the example signal plan presented in Figure 850-8 is shown in Figure 850-11. The signal sequence chart identifies all displays and switching sequences for 100 percent of the time, including normal, pre-empt, and flash operation. The chart should indicate all displays, including arrow displays. The only exception to this rule is when a green arrow is electrically paralleled to a green ball display, only the green ball need be shown on the signal sequence chart. If state furnished controls are to be provided, a signal sequence chart will not be required as part of the contract.

(g) **Wiring Schedule.** The wiring schedule identifies all raceways for size, type of wiring, and number of individual conductors and cables. See Figure 850-8.

(h) **Wiring Schematic.** The wiring schematic relates circuitry to the physical components of the system. See Figure 850-12. Each conductor should be identified by a number code or a combination number-color code. Circuit numbering should correspond with the movement designations shown in Figure 850-9. All terminations should be identified and provision should be made for all spare wiring identified in the wiring schedule.

(i) **Signal Standard Detail Chart.** The signal standard detail chart identifies mounting heights and orientations for all pole mounted appurtenances; in addition, all offset distances to mast arm mounted appurtenances are identified. The chart also identifies projected windload areas for all mast arm mounted appurtenances. Windload areas for 12-inch vehicle signal heads are computed as follows: single section, 4.4 square feet; add 2.4 square feet for each additional section. See Figure 850-13.

(j) **Construction Notes.** The construction notes should provide all signal standard, controller cabinet and service locations and should reference any necessary details required for proper construction of the appurtenance. See Figure 850-8.

(2) **Special Provisions**

Special provisions should include specifications covering materials, equipment, operational requirements or installation procedures that are not adequately covered in the plans or standard specifications.

(3) **Estimate**

The cost estimate should be based on an itemized estimate of both material and labor costs. Since both material and labor charges are variable, it is essential that these prices be verified prior to estimate preparation.
### Responsibility for Various Types of Facilities on State Highways

<table>
<thead>
<tr>
<th>Area</th>
<th>Responsibility</th>
<th>Emergency Vehicle Signals</th>
<th>Traffic Signals, School Signals &amp; Intersection Control Beacons</th>
<th>Reversible Lane Signals, Moveable Bridge Signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cities less than 15,000 Population</td>
<td>Finance Construct Maintain Operate</td>
<td>ESA (1)</td>
<td>STATE</td>
<td>STATE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>STATE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>STATE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>STATE</td>
</tr>
<tr>
<td>Cities greater than 15,000 Population</td>
<td>Finance Construct Maintain Operate</td>
<td>ESA (1)</td>
<td>CITY (2)</td>
<td>CITY (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>CITY (2)</td>
<td>CITY (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>CITY (2)</td>
<td>CITY (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>CITY (2)</td>
<td>CITY (2)</td>
</tr>
<tr>
<td>Beyond Corporate Limits</td>
<td>Finance Construct Maintain Operate</td>
<td>ESA (1)</td>
<td>STATE County</td>
<td>STATE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>STATE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>STATE</td>
</tr>
<tr>
<td>Freeway Ramp Terminals</td>
<td>Finance Construct Maintain Operate</td>
<td>ESA (1)</td>
<td>STATE</td>
<td>NOT APPLICABLE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>NOT APPLICABLE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>NOT APPLICABLE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESA (1)</td>
<td>STATE</td>
<td>NOT APPLICABLE</td>
</tr>
</tbody>
</table>

1. ESA refers to the applicable Emergency Service Agency.

2. Applies to non-access controlled state highways only. For access controlled highways, see Design Manual Chapter 850.02(3)(h).
EXAMPLE OPTIMUM CYCLE AND SPLIT CALCULATION

Figure 850-2
(Metric)
SINGLE RING FRAMES
PHASES IN SINGLE RING CONTROLLERS TIME SEQUENTIALLY

DUAL RING FRAMES
PHASES IN EACH RING TIME SEQUENTIALLY. BOTH RINGS MUST ALWAYS CROSS THE BARRIER SIMULTANEOUSLY.

CONTROLLER FRAME CONFIGURATIONS
Figure 850-3
TEE INTERSECTION - REQUIRED TRAFFIC PATTERN

NOTE: See Figure 850-9 for movement identification

CONTROLLER I
FRAME - 4Ø
PHASES - 4
OVERLAPS - 3
A (Ø1 + Ø4)
B (Ø1 + Ø3 + Ø4)
C (Ø1 + Ø2)

CONTROLLER II
FRAME - 8Ø
PHASES - 5
OVERLAPS - 2
A (Ø1 + Ø4)
B (Ø1 + Ø3 + Ø4)

CONTROLLER III
FRAME - 8Ø
PHASES - 6
OVERLAPS - 2
A (Ø1 + Ø4)
B (Ø1 + Ø8)

--- TIMED DISPLAY, DETECTION FOR THIS MOVEMENT CONNECTED TO THIS PHASE.
----- OVERLAPPED DISPLAY, DETECTION FOR THIS MOVEMENT NOT CONNECTED TO THIS PHASE.

CONTROL APPLICATION VARIATIONS
Figure 850-4
CASE 1
- No turn lane
- Permissive turns only

CASE 2
- Turn lane
- Permissive turns only

CASE 3
- Turn lane
- Protective turns
- Permissive turns

CASE 4
- Turn lane
- Protective turns only

*Head 3 shall be:
- Optically programmed
- Conventional with
- Louvered red
- Conventional with sign

SIGNAL DISPLAYS
Figure 850-5a
(Metric)
Case 5
- No turn lane
- Protected left turn
- Applicable for Tee 1/5

Case 6
- Double left turn
- Single turn lane

Case 7
- Tee intersection
- Single left turn

Case 8
- Tee intersection
- Double left turn

SIGNAL DISPLAYS
Figure 850-5b
(Metric)
Strain Pole and Foundation Selection Procedure

1. Determine span length.
2. Calculate the total dead load (P) per span. Use 178 newtons per signal section and 300 newtons per square meter of sign area.
3. Calculate the average load (G) per span. G = P/n where n is the number of signal head assemblies plus the number of signs.
4. Determine cable tension (T) per span. Enter the proper chart with the average load (G) and number of loads (n). If (n) is less than minimum (n) allowed on chart, use minimum (n) on chart.
5. Calculate the pole load (PL) per pole. If only one cable is attached to the pole, the pole load (PL) equals the cable tension (T). If more than one cable is attached, (PL) is obtained by computing the vector resultant of the (T) values.
6. Select the pole class from the “Design Table.” Choose the pole class closest to but greater than the (PL) value.
7. Calculate the required foundation depth (D). Use the formula:

\[ D = \frac{a \cdot P \cdot D_t}{V_S} \]

Select the table foundation depth (D_t) from the “Design Table.” Soil bearing pressure (S) is measured in Pa. The foundation formula variable (a) is for 1 m round foundation, a=350

1.3 m round foundation, a=300

1 m square foundation, a=290

Round (D) upwards to nearest whole number if 30 mm or greater.
8. Check vertical clearance (5 m minimum) assuming 8.7 m maximum cable attachment height and 5% minimum span sag.

---

**STRAIN POLE AND FOUNDATION SELECTION PROCEDURE**

Figure 850-6a

(Metric)
Example Application:

Determine the following:
- Cable Tensions (T)
- Pole Loads (PL)
- Pole Classes
- Foundation Depths (D)

1. Span lengths given above.
2. & 3. Calculate (P) and (G) values.

Span 1-2, n=3

\[
\begin{align*}
\text{Sections} & \times 178 \text{ N/sec} & = 1246 \text{ newtons} \\
560 \text{ mm}^2 \times \text{ sign} \times 0.3 \text{ N/mm}^2 & = 168 \text{ newtons} \\
\text{Total (P)} & = 1414 \text{ newtons} \\
G & = \frac{P}{n} = \frac{1414}{3} = 471 \text{ newtons}
\end{align*}
\]

Span 2-3, n=4

\[
\begin{align*}
\text{Sections} & \times 178 \text{ N/sec} & = 1602 \text{ newtons} \\
560 \text{ mm}^2 \times \text{ sign} \times 0.3 \text{ N/mm}^2 & = 168 \text{ newtons} \\
\text{Total (P)} & = 1770 \text{ newtons} \\
G & = \frac{P}{n} = \frac{1770}{4} = 443 \text{ newtons}
\end{align*}
\]

Span 3-4, n=2

\[
\begin{align*}
\text{Sections} & \times 178 \text{ N/sec} & = 1246 \text{ newtons} \\
\text{Total (P)} & = 1246 \text{ newtons} \\
G & = \frac{P}{n} = \frac{1246}{2} = 623 \text{ newtons}
\end{align*}
\]

Span 4-1, n=3

\[
\begin{align*}
\text{Sections} & \times 178 \text{ N/sec} & = 1602 \text{ newtons} \\
\text{Total (P)} & = 1602 \text{ newtons} \\
G & = \frac{P}{n} = \frac{1602}{3} = 534 \text{ newtons}
\end{align*}
\]

4. Determine (T) values.

<table>
<thead>
<tr>
<th>Span</th>
<th>Length</th>
<th>G</th>
<th>Chart</th>
<th>n</th>
<th>min n</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>42 m</td>
<td>471 N</td>
<td>III</td>
<td>3</td>
<td>4</td>
<td>13400 N</td>
</tr>
<tr>
<td>2-3</td>
<td>45 m</td>
<td>443 N</td>
<td>III</td>
<td>4</td>
<td>4</td>
<td>12900 N</td>
</tr>
<tr>
<td>3-4</td>
<td>30 m</td>
<td>623 N</td>
<td>II</td>
<td>2</td>
<td>3</td>
<td>12500 N</td>
</tr>
<tr>
<td>4-1</td>
<td>36 m</td>
<td>534 N</td>
<td>II</td>
<td>3</td>
<td>3</td>
<td>11100 N</td>
</tr>
</tbody>
</table>

5. Calculate (PL) values by computing the vector resultant of the (T) values.

\[a = \sqrt{b^2 + c^2 - 2bc \cos A}\]

6. Select the pole class from the "Design Table."

<table>
<thead>
<tr>
<th>Pole Number</th>
<th>(PL)</th>
<th>Pole Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15847 N</td>
<td>16450 N</td>
</tr>
<tr>
<td>2</td>
<td>22183 N</td>
<td>24900 N</td>
</tr>
<tr>
<td>3</td>
<td>15466 N</td>
<td>16450 N</td>
</tr>
<tr>
<td>4</td>
<td>16717 N</td>
<td>21350 N</td>
</tr>
</tbody>
</table>

7. Calculate the required foundation depths.

Given: (S) = 47900 Pa.

\[D = \frac{a DT}{v_S}\]

<table>
<thead>
<tr>
<th>Pole No.</th>
<th>Pole Class</th>
<th>DT</th>
<th>1 m Rd</th>
<th>1.3 m Rd</th>
<th>1 m Sq</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16450 N</td>
<td>2.5 m</td>
<td>4.0 m</td>
<td>3.5 m</td>
<td>3.3 m</td>
</tr>
<tr>
<td>2</td>
<td>24900 N</td>
<td>3.1 m</td>
<td>5.0 m</td>
<td>4.3 m</td>
<td>4.1 m</td>
</tr>
<tr>
<td>3</td>
<td>16450 N</td>
<td>2.5 m</td>
<td>4.0 m</td>
<td>3.5 m</td>
<td>3.3 m</td>
</tr>
<tr>
<td>4</td>
<td>21350 N</td>
<td>2.9 m</td>
<td>4.7 m</td>
<td>4.0 m</td>
<td>3.9 m</td>
</tr>
</tbody>
</table>

**STRAIN POLE AND FOUNDATION SELECTION EXAMPLE**

Figure 850-6b
(Metric)

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March 1994

850-19
### Conductor Size Table

<table>
<thead>
<tr>
<th>Type</th>
<th>X-Section Area (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#14</td>
<td>12.9</td>
</tr>
<tr>
<td>#12</td>
<td>16.1</td>
</tr>
<tr>
<td>#10</td>
<td>20.0</td>
</tr>
<tr>
<td>#8</td>
<td>38.7</td>
</tr>
<tr>
<td>#6</td>
<td>52.9</td>
</tr>
<tr>
<td>#4</td>
<td>70.3</td>
</tr>
<tr>
<td>2cs (#14)</td>
<td>58.0</td>
</tr>
<tr>
<td>3cs (#20)</td>
<td>45.2</td>
</tr>
<tr>
<td>4csms</td>
<td>38.7</td>
</tr>
<tr>
<td>3c</td>
<td>77.4</td>
</tr>
<tr>
<td>5c</td>
<td>200.0</td>
</tr>
<tr>
<td>8c</td>
<td>290.0</td>
</tr>
<tr>
<td>11c</td>
<td>380.0</td>
</tr>
<tr>
<td>20c</td>
<td>593.0</td>
</tr>
</tbody>
</table>

*cs = conductor shielded*

*cms = conductor shielded magnetometer*

### Available Conduit Area

<table>
<thead>
<tr>
<th>Size</th>
<th>26% Fill (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm</td>
<td>128</td>
</tr>
<tr>
<td>32 mm</td>
<td>129-209</td>
</tr>
<tr>
<td>40 mm</td>
<td>210-327</td>
</tr>
<tr>
<td>50 mm</td>
<td>328-510</td>
</tr>
<tr>
<td>65 mm</td>
<td>511-863</td>
</tr>
<tr>
<td>80 mm</td>
<td>864-1307</td>
</tr>
<tr>
<td>90 mm</td>
<td>1308-1654</td>
</tr>
</tbody>
</table>

**CONDUIT**

Figure 850-7

(Metric)
CONSTRUCTION NOTES

1. INSTALL ⚫ WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-1m AND TERMINAL CABINET.
2. INSTALL ⚫ WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-1m AND TERMINAL CABINET.
3. INSTALL ⚫ WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-1m AND TERMINAL CABINET.
4. INSTALL ⚫ WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-1m AND TERMINAL CABINET.
5. INSTALL 2m x 1m TYPE 1 LOOP, SEE J-8a.
6. INSTALL CONTROLLER CABINET ON PAD FOUNDATION, J-8a.
7. INSTALL MODIFIED TYPE D SERVICE, SEE DETAIL ...
Phases 1, 2, 5 & 6 will normally be assigned movements to the mainline.

STANDARD INTERSECTION MOVEMENTS AND HEAD NUMBERS

Figure 850-9
TYPICAL PHASE SEQUENCE DIAGRAMS
Figure 850-10a
4Ø OPERATION

Split Approach

Dual Left

Unbalanced Lefts

Tee Intersection

FRAME - 4 Ø
PHASES - 4
OVERLAPS - 0
LOAD SWITCHES - 8

FRAME - 4 Ø
PHASES - 4
OVERLAPS - 0
LOAD SWITCHES - 6

FRAME - 4 Ø
PHASES - 4
OVERLAPS - 2
A (Ø1 + Ø2)
B (Ø2 + Ø3)
LOAD SWITCHES - 7

FRAME - 4 Ø
PHASES - 4
OVERLAPS - 3
A (Ø1 + Ø4)
B (Ø1 + Ø3 + Ø4)
C (Ø1 + Ø2)
LOAD SWITCHES - 7

TYPICAL PHASE SEQUENCE DIAGRAMS
Figure 850-10b
50 OPERATION
Concurrently Timed Crossroad

FRAME - 8 0
PHASES - 6
OVERLAPS - 0
LOAD SWITCHES - 10

TYPICAL PHASE SEQUENCE DIAGRAMS
Figure 850-10c
TYPICAL PHASE SEQUENCE DIAGRAMS
Figure 850-10d
TYPICAL WIRING SCHEMATIC

Figure 850-12
EXAMPLE OPTIMUM CYCLE AND SPLIT CALCULATION

Figure 850-2
CASE 1
- No Turn Lane
- Permissive Turns Only

CASE 2
- Turn Lane
- Permissive Turns Only

CASE 3
- Turn Lane
- Protected Turns
- Permissive Turns

CASE 4
- Turn Lane
- Protected Turns
- Only

HEAD 3 SHALL BE:
- Optically Programmed
- Conventional with Louvered Rod
- Conventional with Sign

SIGNAL DISPLAYS
Figure 850-5a
STRAIN POLE AND FOUNDATION SELECTION PROCEDURE

1. Determine span length.

2. Calculate the total dead load (P) per span. Use 40 pounds per signal section and 6.25 pounds per square foot of sign area.

3. Calculate the average load (G) per span. G = P/n where n is the number of signal head assemblies plus the number of signs.

4. Determine cable tension (T) per span. Enter the proper chart with the average load (G) and number of loads (n). If (n) is less than minimum (n) allowed on chart, use minimum (n) on chart.

5. Calculate the pole load (PL) per pole. If only one cable is attached to the pole, the pole load (PL) equals the cable tension (T). If more than one cable is attached, (PL) is obtained by computing the vector resultant of the (T) values.

6. Select the pole class from the 'Design Table'. Choose the pole class closest to but greater than the (PL) value.

7. Calculate the required foundation depth (D). Use the formula:

   \[
   D = a \cdot \frac{D_T}{V}
   \]

   Select the table foundation depth (D) from the 'Design Table'. Soil bearing pressure (S) is measured in psf. The foundation formula variable (a) is for 3' round foundation, a=50
   4' round foundation, a=43
   3' square foundation, a=41

   Round (D) upwards to nearest whole number if 0.10 foot or greater.

8. Check vertical clearance (16.5 minimum) assuming 25' maximum cable attachment height and 5% minimum span sag.

Notes:
A special design by Office of Bridge & Structures will be required if:
(1) span length exceeds 150'
(2) (PL) value exceeds 7200 lbs.
(3) distance between base plate and first cable attachment exceeds 29'

Charts are based on a cable weight of 3 pounds per foot (0.25 LBS./FT. and conductors 1.75 LBS./FT. Ice). Total dead load (P) includes weight of ice on sign or signal section.

On Timber Strain Pole Designs specify 2 guy wires when the (PL) value exceeds 4500 lbs.

<table>
<thead>
<tr>
<th>DESIGN TABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole Class (pounds)</td>
</tr>
<tr>
<td>1900</td>
</tr>
<tr>
<td>2700</td>
</tr>
<tr>
<td>3700</td>
</tr>
<tr>
<td>4800</td>
</tr>
<tr>
<td>5600</td>
</tr>
<tr>
<td>6300</td>
</tr>
<tr>
<td>7200</td>
</tr>
</tbody>
</table>

Figure 850-6a
Example Application:

1. Span lengths given above.

2. & 3. Calculate (P) and (G) values.
   - Span 1-2, n=3
     7 sections x 40 lbs./sec. = 280 pounds
     6 s.f. sign x 6.25 lbs./s.f. = 38 pounds
     total (P) = 318 pounds
     G = P/n = 318/3 = 106 pounds
   - Span 2-3, n=4
     9 sections x 40 lbs./sec. = 360 pounds
     6 s.f. sign x 6.25 lbs./s.f. = 38 pounds
     total (P) = 398 pounds
     G = P/n = 398/4 = 100 pounds
   - Span 3-4, n=2
     7 sections x 40 lbs./sec. = 280 pounds
     total (P) = 280 pounds
     G = P/n = 280/2 = 140 pounds
   - Span 4-1, n=3
     9 sections x 40 lbs./sec. = 360 pounds
     total (P) = 360 pounds
     G = P/n = 360/3 = 120 pounds

4. Determine (T) values.

5. Calculate (PL) values by computing the vector resultant of the (f) values.

6. Select the pole class from the 'Design Table'.

7. Calculate the required foundation depths.
   \[ D = \frac{a \cdot D_T}{\sqrt{5}} \]

<table>
<thead>
<tr>
<th>Pole Number</th>
<th>Pole Class</th>
<th>Foundation Depths (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3700 lbs.</td>
<td>8' 13' 11' 11'</td>
</tr>
<tr>
<td>2</td>
<td>5600 lbs.</td>
<td>10' 16' 14' 13'</td>
</tr>
<tr>
<td>3</td>
<td>3700 lbs.</td>
<td>8' 13' 11' 11'</td>
</tr>
<tr>
<td>4</td>
<td>4800 lbs.</td>
<td>9' 9' 15' 13'</td>
</tr>
</tbody>
</table>

**STRAIN POLE AND FOUNDATION SELECTION EXAMPLE**

Figure 850-6b
### CONDUCTOR SIZE TABLE

<table>
<thead>
<tr>
<th>TYPE</th>
<th>X-SECTION AREA (IN²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#14</td>
<td>0.020</td>
</tr>
<tr>
<td>#12</td>
<td>0.025</td>
</tr>
<tr>
<td>#10</td>
<td>0.031</td>
</tr>
<tr>
<td>#8</td>
<td>0.060</td>
</tr>
<tr>
<td>#6</td>
<td>0.082</td>
</tr>
<tr>
<td>#4</td>
<td>0.109</td>
</tr>
<tr>
<td>2cs (*#14)</td>
<td>0.090</td>
</tr>
<tr>
<td>3cs (*#20)</td>
<td>0.070</td>
</tr>
<tr>
<td>4csm</td>
<td>0.060</td>
</tr>
<tr>
<td>3c</td>
<td>0.120</td>
</tr>
<tr>
<td>5c</td>
<td>0.310</td>
</tr>
<tr>
<td>8c</td>
<td>0.450</td>
</tr>
<tr>
<td>11c</td>
<td>0.590</td>
</tr>
<tr>
<td>20c</td>
<td>0.920</td>
</tr>
</tbody>
</table>

cs = conductor shielded

csm = conductor shielded magnetometer

### AVAILABLE CONDUIT AREA

<table>
<thead>
<tr>
<th>SIZE</th>
<th>26% FILL (IN²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>0 - 0.23</td>
</tr>
<tr>
<td>1 1/4&quot;</td>
<td>0.24 - 0.39</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>0.40 - 0.53</td>
</tr>
<tr>
<td>2&quot;</td>
<td>0.54 - 0.87</td>
</tr>
<tr>
<td>2 1/2&quot;</td>
<td>0.88 - 1.24</td>
</tr>
<tr>
<td>3&quot;</td>
<td>1.25 - 1.92</td>
</tr>
<tr>
<td>3 1/2&quot;</td>
<td>1.93 - 2.57</td>
</tr>
</tbody>
</table>

CONDUIT
Figure 850-7
CONSTRUCTION NOTES

1. INSTALL \( \bullet \) WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-JAB AND TERMINAL CABINET.

2. INSTALL \( \ominus \) WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-JAB AND TERMINAL CABINET.

3. INSTALL \( \circ \) WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-JAB AND TERMINAL CABINET.

4. INSTALL \( \triangle \) WITH SIGNAL DISPLAYS, PRE-EMPT DETECTOR, 2-PPB-JAB AND TERMINAL CABINET.

5. INSTALL 6' x 40' TYPE 1 LOOP, SEE J-8a.

6. INSTALL CONTROLLER CABINET ON PAD FOUNDATION, J-6a.

7. INSTALL MODIFIED TYPE D SERVICE, SEE DETAIL ... .

EXAMPLE SIGNAL PLAN

Figure 850-8
NOTES

1. Mounting coupling installed by fabricator at offset distance indicated in chart.
2. Field installed.
4. Foundations shall conform to the foundation detail on Standard Plan J-76, except anchor bolt size, material and bolt circle shall conform to details on pre-approved plans or shop drawings approved by the Bridge and Structures Office. A vertical degree shall be No. 72.
5. Mount phase B pre-empt detector 15' above base plate on pole shaft.
6. Orientation shall be per manufacturer's recommendation.
7. Mount phase B pre-empt detector 15' above base plate on pole shaft. Orientation shall be per manufacturer's recommendation.

LIMITS OF VERTICAL CLEARANCE REQUIREMENTS

VERTICAL CLEARANCE MINIMUM 15'-0"
860 Intelligent Transportation Systems

860.01 General

Intelligent Transportation Systems (ITS) apply advanced technologies in communications and computer science to optimize the safety and efficiency of the existing surface transportation network. In highway design, this goal is achieved by collecting and using traffic data to develop predictive models, regulating access to the freeway system, and providing timely information on traffic conditions to motorists. Previously, this technology was called Surveillance, Control, and Driver Information (SC&DI). In the context of highway design, ITS and SC&DI are synonymous.

The Transportation Equity Act (TEA-21) requires ITS projects to comply with the standards being developed in association with the federal government and private industry. These standards will be known as the National ITS Architecture. These standards are intended to ensure interoperability and efficiency to the maximum extent practicable for the many different types of ITS devices under development. The National ITS Architecture organizes a “system of sub-systems” and makes managing ITS deployment easier. The Architecture helps agencies communicate complex ideas by providing a common language and definitions. One benefit of using the National ITS Architecture is that it helps identify all agencies and jurisdictions that should be included in ITS projects.

The ITS program in Washington State is known as “Venture Washington.” It focuses on five areas within Washington State. These areas were chosen because they each have unique characteristics and problems associated with traffic. These five areas are:

- The Greater Puget Sound Region
- The Spokane Area
- The Vancouver Area
- Other Statewide Urban Areas
- Rural Areas and Intercity Corridors

An intelligent transportation system can be implemented in stages, starting with a small project for immediate benefit and then expanding the system as needed. Consider installing an ITS at any of the following locations:

- Where congestion frequently causes accidents.
- At freeway on-ramps where merging problems routinely occur.
- Where heavy traffic volumes occur between closely spaced on-ramps.
- Where the motorist would benefit from information on traffic conditions or alternative routes.

The initial stage of an intelligent transportation system can be as simple as installing a dynamic message sign that warns motorists of unusual driving conditions. Appropriate messages can be displayed on the sign using information obtained by direct observation of road conditions or by reports from law enforcement agencies.

Automated systems incorporate a traffic data collection system. The data collection system provides basic data to determine traffic volumes, vehicular speeds, and levels of congestion. The traffic data can be analyzed and used to verify the locations of traffic problems. This data can also be used in freeway computer models to predict the impacts of proposed improvements.

Design each stage of the system so that the associated technology can be used in subsequent, more sophisticated stages. For example, the stage following data collection could be the installation of closed circuit television cameras (CCTV) to...
monitor freeway locations where congestion is commonplace. The CCTV monitoring is used to detect or confirm incidents noted by other forms of data collection. The installation of motorist information devices such as dynamic message signs or highway advisory radio provides a means of transmitting this information to the motorist. Eventually, as traffic congestion increases, ramp meters are installed to control the traffic flow entering the facility.

When planning a staged system, attempt to determine the ultimate communication system to the degree that underground conduit size and quantity are known and can be installed in the initial construction. Consider long-term maintenance issues and component standardization.

The Northwest Region Traffic Systems Management Center (TSMC) is an example of a traffic operations center (TOC). Because a TOC usually works best with existing radio communication, it is located adjacent to or as part of a radio communication office. In addition to the location of a TOC, consider the work force and equipment costs required to operate and maintain the entire system. The size of a TOC is dependent on the complexity of the system and can vary from a single person at a desk to a large room with advanced equipment requiring continuous staffing.

860.02 References
Transportation Equity Act (TEA-21) of 1998

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT,

SC&DI Design Guide, WSDOT Northwest Region

SC&DI Operations Guide, WSDOT Northwest Region

I-90 Seattle to Spokane, ITS Corridor Study, WSDOT Advanced Technology Branch

I-5 Seattle to Vancouver, BC, ITS Corridor Study, WSDOT Advanced Technology Branch

Portland/Vancouver to Boise, ITS Corridor Study Plan, WSDOT Advanced Technology Branch

Application of Advanced Transportation Technology Within Washington State: Discussion and Policy Recommendations, WSDOT Advanced Technology Branch

State-Wide Communications Strategic Plan, WSDOT Advanced Technology Branch

Seattle to Portland Inter-City ITS Corridor Study and Communications Plan, WSDOT Advanced Technology Branch

Venture Washington, WSDOT Advanced Technology Branch

860.03 Traffic Data Collection

Loop detectors, placed in traffic lanes, are the most common devices used to collect traffic data. In general, data stations are spaced at ½ mile intervals between interchanges. Alternative methods of detection include video detection cameras, microwave detectors, and other newer technologies. This information can be augmented with cellular phone calls from motorists, Washington State Patrol (WSP) reports, and commercial traffic reporters.

The loops sense the amount of time a vehicle is over them. This is called occupancy and is recorded by a data station in a nearby roadside cabinet. The data station periodically transmits the data to a central computer. The information from the detection system is transmitted over leased phone lines, WSDOT phone lines, fiber optic lines, or microwave transmitters to a traffic operations center. A spread spectrum radio is another method of transmitting data. The central computer translates these data into an indication of traffic congestion for incident detection and traffic flow information.

A single loop provides traffic volumes and lane occupancy from which, given some basic assumptions, speeds can be computed. Two loops spaced a known distance apart, longitudinally, provide better determinations of traffic speeds.

CCTV is used by the department to manage the freeway system. It is not usually used as a traffic law enforcement tool. The primary function of CCTV is to confirm or detect incidents. As a
secondary function, this information can be provided to the WSP, incident response teams, maintenance forces, and the local media.

860.04 Traffic Flow Control

During peak traffic volume periods, freeway on-ramps are metered with either roadside or overhead traffic signals. These ramp meters control or regulate the flow of traffic entering the freeway. The metering prevents the entering traffic from exceeding freeway capacity by limiting the number of vehicles that enter within a specific time period. The meters also keep long platoons of cars from merging onto the freeway. This process makes on-ramp merges safer and allows freeway traffic to move at a more efficient speed.

Ramp meters are traffic control signals and an approved traffic signal permit is required. The approval procedures for traffic signal permits are noted in Chapter 850.

Consider the available area for vehicle storage on the ramp when locating a ramp meter. If the arrival rate of the entering traffic exceeds the metered flow rate, traffic queues will develop. A common concern is that this queue might extend onto the crossroads and interfere with local traffic. Chapter 1050 provides guidance on the placement of the ramp meter. This guidance, however, only addresses the required acceleration needed to merge onto the freeway. The storage area needed at the meter varies at each location and is determined separately. If it is not possible to provide an adequate storage length on the ramp, consider alternate methods of addressing the problem.

1. Adjust the ramp metering rate to temporarily increase the rate.
2. Allow two vehicles to pass the meter at a time.
3. Widen to two metered lanes.
4. Provide storage lanes on the crossroad.
5. Provide alternate routes for local traffic.
6. Provide HOV bypass lanes.

(1) Adjust Rate. Ramp metering uses information from the detection loops to determine freeway congestion adjacent to and downstream from the ramps. Data from the loops are sent to a central computer or a local computer that adjusts the metering rate for the traffic congestion and transmits this rate to the ramp meter controllers. The ramp controllers implement the metering rate and control the signal. A ramp metering rate can be determined in two ways: remote metering and standby metering.

For remote metering, the metering rates of all ramp meter locations are determined by the local controller and adjusted by the central computer at the TOC. This is the normal mode of operation for the Seattle system. The central computer is capable of adjusting upstream metering rates on the basis of downstream conditions. A metering rate at an upstream location is decreased if traffic congestion develops downstream. Metering start and end times, as well as metering rates, can be remotely adjusted from the TOC with an override function.

Standby metering, also called local control, is used when communications with the central computer are interrupted or when that computer is not in service. In these cases, each ramp meter determines a metering rate for its on-ramp according to local traffic conditions or by a pre-determined rate based on a time of day table. These time of day tables are developed to predict averages of the actual traffic volume peaking characteristics of the on-ramp. In standby metering, each ramp meter operates independently without coordinating with other controllers.

Single lane metering rates normally vary between 4 and 15 vehicles per minute (240 and 900 vehicles per hour). If a ramp has heavier traffic volumes and queue storage is not adequate, several actions can be taken.

(2) Two Vehicles. The metering capacity can be increased by allowing two vehicles to enter during each green cycle. This can increase a single lane ramp meter maximum capacity to about 1,100 vehicles per hour. This procedure is a temporary, operational solution and is not a recommended design practice.
(3) **Widen.** The metering capacity can be increased by widening the ramp to install additional lanes. Widening a single-lane on-ramp to create two lanes can double the metered traffic volume to 1,800 vehicles per hour, provided no downstream traffic congestion develops. Changes in ramp access to the freeway might require an access point decision report. (See Chapter 1425.)

(4) **Storage Lanes.** If adequate storage length cannot be provided on the ramp, it might be possible to provide storage as turn lanes on the crossroad and adjust the ramp terminal traffic signal timing to limit freeway access movements.

(5) **Diversion.** Diversion of some ramp traffic to local arterial streets might be desirable, assuming a suitable alternate route is available. When diversion occurs, modification of traffic signal timing and coordination plans on the alternative routes might be necessary. Coordinate efforts with the local agency and, if appropriate, initiate public meetings to identify needs and impacts.

(6) **HOV Bypass.** Wherever possible, provide bypass lanes for high occupancy vehicles (HOV) around the traffic queue at the ramp meter. The HOV bypass allows transit vehicles to maintain schedules and indirectly provides an incentive for carpooling. (See Chapter 1050.)

**860.05 Motorist Information**

Motorist information includes dynamic message signs, highway advisory radio, telephone traffic information lines, commercial radio and television messages, and Internet access for personal computers. These are all used to transmit traffic conditions to freeway users. The motorist information system is also used to alert drivers to short term construction and maintenance activities that might affect normal travel patterns. It can also be used to suggest alternative travel routes.

(1) **Dynamic Message Signs**

Dynamic message signs (DMS) are used to provide motorists with current road and traffic conditions. Accidents, incidents, construction and maintenance activities, reversible lane status, traffic congestion, and traction device requirements are examples of this information. Because motorists receive many distractions while driving, consider the location of the DMS. The best location for a DMS is on a tangent section of roadway with few roadside distractions. Overhead installations have more visual impact. When possible, use sign bridges, cantilever sign structures, or bridge mounts on existing overcrossings for DMSs. Use the message displays and sign location requirements contained in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) and Chapter 820.

(2) **Highway Advisory Radio**

The highway advisory radio (HAR) system uses car radios to provide information to motorists. Warning signs, usually with flashing beacons, direct motorists to select a specific AM radio station for information. HAR has an advantage over DMS because longer messages with more detailed information can be relayed to the motorist. The major disadvantages are that not all vehicles have radios that can receive HAR frequencies, and some motorists might not use the radio for this information. HAR works best when used in conjunction with DMS.

HAR locations and assigned radio frequencies are restricted to prevent interference with other frequencies in use. HAR message content is restricted by federal regulations and WSDOT restricts HAR messages to noncommercial voice information pertaining to roadway and mountain pass conditions, major incidents, traffic hazards, and travel advisories.

(3) **Additional Public Information Components**

A telephone number can be provided to give the same prerecorded messages as the HAR and can also include transit and carpool information. A computer generated flow map can be developed, using the data collection system, to graphically depict actual traffic flows within a geographical area. The flow map can be made accessible to the public by providing links to a WSDOT web site.
860.06 Documentation

Preserve the following documents in the project file: See Chapter 330.

☐ Justification for the installation of ramp meters.

☐ Approved traffic signal permit for ramp meters.

☐ All correspondence and coordination with local agencies.

☐ Designs for the ultimate system when staged implementation is used.

P65:DP/DMM
910 Intersections At Grade

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. Guidelines for road approaches are in Chapter 920 and interchanges are in Chapter 940.

If an intersection design situation is not covered in this chapter, contact the Olympic Service Center (OSC) Design Office, for assistance.

910.02 References

- Americans with Disabilities Act of 1990 (ADA)
- Washington Administrative Code (WAC) 468-18-040, “Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings”
- Local Agency Guidelines (LAG), M 36-63, WSDOT
- Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), USDOT,
- FHWA; including the Washington State Modifications to the MUTCD, M 24-01, WSDOT
- Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
- A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO
- NCHRP 279 Intersection Channelization Design Guide

910.03 Definitions

- 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 intersection legs at the point that the center lines intersect.
- intersection at grade: The general area where a state highway or ramp terminal is met or crossed at a common grade or elevation by another state highway, 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.”
- 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 intersection leg for traffic entering the intersection.

**exit leg** The 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 main roadway, as compared to the distance required for safe operation.

**intersection turning radii** The geometric design of the intersection to allow the design vehicle for each turning movement to complete the turn without encroachment.

**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.

**median crossover** An opening in a median provided for crossings by maintenance, law enforcement, emergency, and traffic service vehicles.

**roundabout** A circular intersection at which all traffic moves counterclockwise around a central island.

### 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

An important intersection design characteristic is the intersection angle. The intersection angle is the angle between any two intersection legs. The allowable intersection angles are 75° to 105°.

An approved deviation is required when the following intersection configurations cannot be avoided:

- Intersections with offset legs.
- 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.
- Angle points or short radius curves within the intersection.
- Other nonstandard intersection design.

#### (3) Crossroads

When the crossroad is a city street or county road, design the crossroad according to the applicable standards shown in:

- Chapter 468-18 WAC.
- The LAG manual.
- The standards of the local agency that will be requested to accept the facility.

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 ft long to connect to the grade of the crossroad.

In areas that experience accumulations of snow and ice and for all legs that will require traffic to stop, design a maximum grade of ±6 percent for a length equal to the anticipated queue length for stopped vehicles.

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:

<table>
<thead>
<tr>
<th>Design Symbol</th>
<th>Vehicle Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Passenger car, including light delivery trucks.</td>
</tr>
<tr>
<td>BUS</td>
<td>Single unit bus</td>
</tr>
<tr>
<td>A-BUS</td>
<td>Articulated bus</td>
</tr>
<tr>
<td>SU</td>
<td>Single unit truck</td>
</tr>
<tr>
<td>WB-40</td>
<td>Semitrailer truck, overall wheelbase of 40 ft.</td>
</tr>
<tr>
<td>WB-50</td>
<td>Semitrailer truck, overall wheelbase of 50 ft.</td>
</tr>
<tr>
<td>WB-67</td>
<td>Semitrailer truck, overall wheelbase of 67 ft.</td>
</tr>
</tbody>
</table>

The design vehicle for any intersection is the largest vehicle that normally uses the intersection. The primary use of the design vehicle is to determine turning radii requirements for each leg of the intersection. It is possible for each leg to have a different design vehicle. Figure 910-2 shows the recommended minimum design vehicles. An approved deviation is required for the use of a smaller vehicle, except as noted. As justification for a deviation, include a traffic analysis showing that the proposed vehicle is appropriate.

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Design Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction of Major Truck Routes</td>
<td>WB-67</td>
</tr>
<tr>
<td>Junction of State Routes</td>
<td>WB-50</td>
</tr>
<tr>
<td>Ramp Terminals</td>
<td>WB-50</td>
</tr>
<tr>
<td>Other Rural</td>
<td>WB-50</td>
</tr>
<tr>
<td>Urban Industrial</td>
<td>WB-40</td>
</tr>
<tr>
<td>Urban Commercial</td>
<td>SU 1  2</td>
</tr>
<tr>
<td>Residential</td>
<td>SU 1  2</td>
</tr>
</tbody>
</table>

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 route, use the BUS design vehicle as a minimum. See Chapter 1060 for additional guidance for transit facilities and for the BUS turning path templates.

To minimize the disruption to other traffic, design the intersection to allow the design vehicle to make all legal movements without encroaching on curbs, shoulders, or opposing lanes. An approved deviation is required for a design that allows encroachment on adjacent same-direction lanes at the entrance leg.

Encroachment on same-direction lanes of the exit leg may be necessary to minimize crosswalk distances; however, this might negatively impact vehicular operations. Document and justify the operational trade-offs associated with this encroachment.

Design each turning movement so the largest vehicle that is legal on both legs can make the turn without leaving the paved shoulders or encroaching on a sidewalk. Use the WB-67 as the largest legal vehicle at all state route to state route junctions. Document any required encroachment into other lanes, and any...
degradation of intersection operation. Use the vehicle turning path templates in Figures 910-6a and 6b, or templates from another published source, to verify that this vehicle can make the turning movements.

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 may 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 curve. This results in larger corner radii which increases pavement area and pedestrian crossing distance, resulting in 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 speeds of concurrently turning vehicles. This normally leads to right-corner designs with smaller turning radii. The negative impacts include 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 typical right-turn corner designs for the design vehicles at intersections. These are considered the minimum pavement area to accommodate the design vehicles without their encroaching on the adjacent lane at either leg of the curve. Using the taper at the exit of the right-turn corner reduces the pavement area when compared to a simple radius.

When pedestrians are of primary concern and the exit leg of a turning movement contains multiple lanes, a smaller radius than given in Figure 910-7 may be used to reduce crosswalk distances. However, this requires the design vehicle to encroach on the adjacent same direction lane at the exit leg. This may degrade intersection operations. Document the impacts of this design, including anticipated pedestrian activity, capacity restrictions for right-turning vehicles, and the effects on other traffic movements.

Use a turning template for the design vehicle with a turning radius of 59 ft or larger to determine the vehicle path. When the operational impacts continue for more than one signal cycle, consider a larger turning radius with a raised pedestrian refuge island or elimination of the pedestrian crossing.

910.07 Channelization

Channelization is the separation or regulation of traffic movements into definite 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. (Refer to Chapter 830 and the standard plans for details.)

Nonstandard channelization requires an approved deviation.

(1) Left-Turn Lanes

Left-turn lanes provide storage, out of 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 are an economical way to lessen delays, accidents, and accident potential involving left-turning vehicles. In addition, they may provide for deceleration clear of the through traffic lanes.

At unsignalized intersections on two-lane highways, use the following as a guide to determine whether or not to consider one-way left-turn lanes:

- Recommendation from Figure 910-8 based on total traffic volume (DHV) for both directions and percent left-turn traffic.
- An accident study indicates that a left-turn lane will reduce accidents.
- Restrictive geometrics that require left-turning vehicles to slow greatly below the speed of the through traffic.
- Less than decision sight distance at the approach to the intersection.

Where left-turn lanes are to be used, determine the storage length required using Figures 910-9a through 9d. For those cases that do not fall within range of the charts, or for design of left-turn storage on four lane highways, contact the OSC Design Office.

At signalized intersections, one-way left-turn lanes are normally provided on each main line approach.

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.

Figures 910-10a through 10d show typical one-way left-turn geometrics. Figure 910-10a shows widening to accommodate the new lane. Figures 910-10b and 10c show the use of a median.

1. **Widening (Figure 910-10a)**. It is desirable that offsets and pavement widening be symmetrical about the center line or base line. Where right of way or topographic restrictions, unfavorable alignment of crossroads, or other circumstances preclude symmetrical widening, pavement widening may be on one side only.

2. **Divided Highways (Figure 910-10b and 10c)**. Widening is not required for left-turn lane channelization where medians are 13 ft wide or wider. The median acceleration lane shown on the figure can also be provided where the median is 23 ft or wider. The median acceleration lane may 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.

At intersections on divided highways where channelized left turn lanes are not provided, consider a minimum protected storage area as shown on Figure 910-10d.

(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.

In general, use TWLTLs only in an urban setting 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 closely spaced access points or minor street intersections.
- There are unacceptable through traffic delays or capacity reductions because of left turning vehicles.

The basic guidelines necessary to develop a TWLTL plan are illustrated on Figure 910-10e. Additional criteria are:

- The desirable length of a TWLTL is not less than 250 ft.
- Illumination may be provided 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.
(2) **Right-Turn Lanes**

Right-turn movements influence intersection capacity even though there is no conflict between right-turning vehicles and opposing traffic. Right-turn lanes may be required to maintain efficient intersection operation. Use the following as guidelines to determine when to consider right-turn lanes:

- Recommendation from Figure 910-11 based on approach and right-turn traffic volumes.
- An accident study indicates that a right-turn lane will reduce accidents.
- Presence of pedestrians who would require right-turning vehicles to stop in the through lanes.
- 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 queue analysis to determine the right-turn lane lengths. If possible, make the right-turn lane equal to the longest queue (the right-turn queue or the through queue).

A capacity analysis may be used to determine if right-turn lanes are necessary to maintain the desired level of service.

When designing right-turn lanes at signalized intersections, consider reducing the shoulder width to not more than 4 ft. This reduces the pavement widening for the turn lane and removes the temptation for vehicles to use the shoulder to bypass the other vehicles in the turn lane.

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 910-12a) 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 910-12a shows taper lengths for posted speeds below 40 mph and for 40 mph or above.

A lane may be dropped at an intersection with a turn-only lane or beyond the intersection with an acceleration lane. Minimum acceleration lane lengths are shown on Figure 910-13.

(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 main highways. 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 experience.

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 910-12b and 13. When the design speed of the turning traffic is greater than 20 mph, 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) **Curbing**

Consider channelization with curbing for situations such as:

- Divisional and channelizing islands.
- Islands with luminaires, signals, or other traffic control devices.
• Pedestrian refuge islands.
• Landscaped areas within the roadway.
• Prevention of mid-block left turns.

Avoid using curbs if the same objective can be attained with pavement markings. When prohibiting left turns, an 18-in barrier stripe with appropriate signing is an alternative.

Snow removal operations can be hampered by curbs and raised islands. Contact the regional Operations Engineer when considering raised channelization in areas of heavy snowfall.

In general, neither mountable nor barrier curbs are used on facilities with a posted speed greater than 40 mph. The exceptions are for predominantly urban or rapidly developing areas where sidewalks are provided or where traffic movements are to be restricted.

The two general classes of curbs are mountable curbs and barrier curbs (see the standard plans for designs). Precast traffic curb, precast block curb, and all extruded curbs are considered mountable. Barrier curbs are 6 in or more high with a face batter not flatter than 1H:3V. They are used:

• to inhibit or at least discourage vehicles from leaving the roadway;
• for walkway and pedestrian refuge separations; and
• for raised islands on which a traffic signal, or traffic signal hardware, is located

Mountable curbs have a height of 6 in or less, preferably 4 in or less, with a sloping face that is more readily traversed. When the face slope is steeper than 1:1, the height of a mountable curb is limited to 4 in or less. They are used where a curb is needed but barrier curb is not justified.

When curbing is used, provide the minimum shy distances shown in Figure 910-3. Where mountable curb is used on the left, the shy distance may be omitted. (For traffic islands, also see 910.07(5).)

<table>
<thead>
<tr>
<th>Lane Width</th>
<th>Shy Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Left</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
</tr>
<tr>
<td>12 ft</td>
<td>1 ft</td>
</tr>
<tr>
<td>11 ft</td>
<td>2 ft</td>
</tr>
<tr>
<td>10 ft</td>
<td>3 ft</td>
</tr>
</tbody>
</table>

*For noncontinuous curbs or where bicycles are anticipated, the minimum shy distance to the face of the curb is 3 ft.

Shy Distance for Barrier Curb
Figure 910-3

(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 opposing or same-direction 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 ft wide and 20 ft long. Mountable curb used to discourage turn movements is not considered 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 mph or less, smaller islands may be acceptable. Use islands with at least 200 ft² of area if pedestrians will be crossing or traffic control devices or luminaires will be installed.

Design triangular shaped islands as shown on Figure 910-14a through 14c. The shy distances illustrated are for islands constructed with barrier curbs. Where painted islands are used, such as in rural areas, these shy distances are desirable but may be omitted. Where barrier curbing is used, provide the minimum shy distances as shown in Figures 910-3 and 14b.

Avoid shy distances wider than 6 ft because the wider distances can appear to be another lane.

Island markings may be supplemented with reflective raised pavement markers.

Barrier-free access must be provided at crosswalk locations where raised islands are used. This can be accomplished by one of three methods:

- Reroute pedestrian traffic if feasible.
- For islands 17 ft wide or wider at the crosswalk location, provide ramps as shown in Figure 910-14b.
- For islands less than 17 ft wide at the crosswalk location, provide a passageway through the island.

The 17 ft dimension is for curbs 6 in high. For curbs at any other height, the maximum slope of the ramps is not steeper than 12H:1V. The maximum cross slope of any ramp, passageway, or sidewalk is 2 percent.

(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 910-14c). This design forces the turning traffic to slow down.

### 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. They have been found to reduce injury accidents, traffic delays, fuel consumption, and air pollution. Roundabouts also permit U-turns.

Consider roundabouts at the following intersections:

- Where stop signs result in unacceptable delays for the crossroad 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.

When considering a roundabout, contact the OSC Design Office for additional information, design assistance and intersection approval.

When a roundabout is being considered, submit advance engineering data and a preliminary intersection plan to the OSC Design Office.

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 910-4) as a guide to determine when to consider U-turn locations between intersections. When the U-turning volumes are low, use longer spacing.

<table>
<thead>
<tr>
<th></th>
<th>Desirable</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban (1)</td>
<td>1,000 ft</td>
<td></td>
</tr>
<tr>
<td>Suburban</td>
<td>3,300 ft</td>
<td>1,300 ft (2)</td>
</tr>
<tr>
<td>Rural</td>
<td>6,600 ft</td>
<td>2,600 ft</td>
</tr>
</tbody>
</table>

1 For design speeds greater than 45 mph use suburban spacing.
2 The minimum spacing is the acceleration lane length from a stop plus 300 ft.
3 For design speeds greater than 50 mph, the minimum spacing is the acceleration lane length from a stop plus 300 ft.

When designing U-turn locations, use Figure 910-15 as a guide. Where the median is less than 40 ft wide and a large design vehicle is required, consider the use of a U-turn roadway.

Document the need for U-turn locations, the spacing used, and justify the selected design vehicle.

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 and traffic signals. See Chapter 630 for guidance.

The driver of a vehicle 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. Calculate the length of travel for the design vehicles to clear the intersection and, using Figures 910-16a and 16b, determine minimum sight distance along the through roadway.
The sight triangle is determined as shown in Figures 910-16a through 910-16c. 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.

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 most rural highway conditions. Consider including a school bus in rural areas where they play an important part in the traffic operations. 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 some intersections, the turning volume from a stop-controlled crossroad is significant enough to conflict with vehicles on the through roadway. Consider sight distances as shown on Figure 910-5 at these intersections. This is the sight distance required for a P vehicle to turn left or right onto a two-lane highway and attain average running speed without being overtaken by an approaching vehicle going the same direction at the average running speed.

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Sight Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>300</td>
</tr>
<tr>
<td>30</td>
<td>380</td>
</tr>
<tr>
<td>35</td>
<td>480</td>
</tr>
<tr>
<td>40</td>
<td>590</td>
</tr>
<tr>
<td>45</td>
<td>730</td>
</tr>
<tr>
<td>50</td>
<td>860</td>
</tr>
<tr>
<td>60</td>
<td>1,150</td>
</tr>
<tr>
<td>70</td>
<td>1,560</td>
</tr>
</tbody>
</table>

Sight Distance for Turning Vehicles

Figure 910-5

Designs for movements across divided highways are influenced by the median widths. If the median is wide enough to store the design 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 for at-grade intersections with a turning movement. An added element at ramp terminals is the grade separation structure between the main line and the crossroad. Figure 910-16c 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 ft and an object height of 1.5 ft.

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 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 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 involving turning vehicles. 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, submit advance engineering data and a preliminary signal plan to the Olympia Service Center Traffic Office (Chapter 850). If a new permit is required, it must be approved before the design is approved.

### 910.12 Interchange Ramp Terminals

On one-way ramp terminals with stop or traffic signal control at the local road, the design to be used or modified for use is shown on Figure 910-17. 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. Median channelization is always provided when justified by capacity determination and analysis of the intersection, 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 access control, see Chapter 1420 for access control requirements.

1. **Approval**

An intersection is approved in accordance with Chapter 330. When required, the following items must be in the project file before an intersection may be approved:

   - Traffic analysis
   - Deviations approved in accordance with Chapter 330
   - Preliminary traffic signal plan approved by the OSC Traffic Office. (See Chapter 850.)
   - Intersections with roundabouts require OSC Design Office approval. See 910.08 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, public meeting comments, and so forth.

Include the following as applicable:

   - Drawing of the crossroad, existing and realigned.
   - Main line stationing of the intersection and angle between intersection legs.
   - Curve data on main line and crossroads.
   - Right of way lines.
   - Location and type of channelization.
   - Numbers of lanes; width of lanes and shoulders on main line and crossroads (Chapter 620).
   - Proposed access control treatment (Chapter 1420).
• Traffic data including volumes for all movements and vehicle classification.
• Classes of highway for main line and crossroads and design speeds (Chapter 440).
• Traffic signals.

(3) Local Agency or Developer Initiated Intersections

There is a separate procedure for local agency or developer-initiated projects at intersections with state highways. 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 following documents are to be preserved for future reference in the project file. See Chapter 330.

- Design vehicle selection justifications
- Traffic analyses
- Accident studies
- Approved deviations
- Approved traffic signal plans
- Intersection plans and supporting information
- Justification for encroachment on other lanes
- Sight distance documentation
- U-turn documentation
Path of inside rear trailer wheels

WB-40
59 ft Turning radius

Path of inside rear trailer wheels

WB-50
59 ft Turning radius

Scale in feet

Turning Path Template
Figure 910-6a
Path of inside rear trailer wheels

WB-67
59 ft Turning radius

Turning Path Template
Figure 910-6b

Scale in feet
When the lane width (L₁ or L₂) is less than the values given, widen to the given value at 25:1.

12.5 ft when widening is required.

211 ft at 120°.
LEFT TURN STORAGE GUIDELINES
Unsignalized intersection
Two-lane highway

KEY:

1. Below curve, storage not needed for capacity.
2. Above curve, storage recommended.

% Total DHV* Turning Left (single turning movement)

Total DHV*

*DHV is total volume from both directions.
**Speeds are posted speed limits.
Left-Turn Storage Length

Figure 910-9a

40 mph Posted speed
Unsignalized intersection
Two-lane highway

Left turns
One direction
DDHV

250 ft
200 ft
150 ft
100 ft
700
800
900
1000
1100
1200
1300
1400

DHV
(total, both directions)

600
300
200
100
0
Left-Turn Storage Length

Figure 910-9c

60 mph posted speed
Unsignalized intersection
Two-lane highway

Left turns
One direction
DDHV

250 ft
200 ft
150 ft
100 ft
500
1000
1300
1400

0
500
100
200
300

DHV
(total, both directions)
Storage length to be added to charts of left-turn storage lengths (feet).

<table>
<thead>
<tr>
<th>Storage Length Required from Chart</th>
<th>Percent Trucks in Left-Turn Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ft</td>
<td>25  25  50  50  50</td>
</tr>
<tr>
<td>150 ft</td>
<td>25  50  50  75  75</td>
</tr>
<tr>
<td>200 ft</td>
<td>25  50  75  100 100</td>
</tr>
</tbody>
</table>

Additional Left-Turn Storage for Trucks
Unsignalized Intersection Two-Lane Highway

*Figure 910-9d*
### Table 1

<table>
<thead>
<tr>
<th>Posted Speed</th>
<th>Taper Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 mph</td>
<td>55:1</td>
</tr>
<tr>
<td>50 mph</td>
<td>50:1</td>
</tr>
<tr>
<td>45 mph</td>
<td>45:1</td>
</tr>
<tr>
<td>40 mph</td>
<td>40:1</td>
</tr>
<tr>
<td>35 mph</td>
<td>35:1</td>
</tr>
<tr>
<td>30 mph</td>
<td>30:1</td>
</tr>
<tr>
<td>25 mph</td>
<td>25:1</td>
</tr>
</tbody>
</table>

Notes:

1. The minimum width of the left turn storage lane \((T_1 + T_2)\) is 11 ft. The desirable width is 12 ft. See Figures 910-9a-9d for left turn storage length.
2. Use templates for WB-20 design vehicles.

- \(W_1\) = Approaching through lane
- \(W_2\) = Departing lane
- \(T_1\) = Width of left turn lane on approach side of \(Q\)
- \(T_2\) = Width of left turn lane on departure side of \(Q\)
- \(W_T\) = Total width of channelization \((W_1+W_2+T_1+T_2)\)
Median Channelization — Median Width 23 ft to 26 ft

NOTES:

1. Lane widths of 13 ft are desirable for both the left turn storage lane and the median acceleration lane.

2. For increased storage capacity, the left turn deceleration taper alternate design should be considered.

3. The total length of the median acceleration lane shall not be less than the minimum acceleration lane length shown in Figure 910-13.

4. \( R = 50 \text{ ft min} \); use templates for WB-67 design vehicles.

ACCELERATION TAPER FORMULA

When posted speed is 45 mph or higher:

\[
\text{Taper length} = \text{lane width} \times \frac{\text{posted speed}^2}{60}
\]

When posted speed is less than 45 mph:

\[
\text{Taper length} = \frac{\text{lane width} \times (\text{posted speed})^2}{60}
\]
Median Channelization — Median Width of More Than 26 ft

Figure 910-10c
Minor Intersection on Divided Highway

Figure 910-10d
Right-Turn Lane Guidelines

Right-turn pocket or taper (Figure 910-12a) recommended
Right-turn lane (Figure 910-12b)
Radius only recommended (Figure 910-7)

* For two-lane highways, use the peak hour approach volume (through + right-turn).
For multilane, high speed highways (posted speed 45 mph or above), use the right-lane peak hour approach volume (through + right-turn).
For multilane, low speed highways (posted speed less than 45 mph), no right-turn lane or taper is required.
Note: When all three of the following conditions are met, reduce the right-turn DDHV by 20.
1. The posted speed is 45 mph or less
2. The right-turn volume is greater than 40 VPH.
3. The total approach volume is less than 300 VPH.
Right-Turn Pocket and Right-Turn Taper

Figure 910-12a

<table>
<thead>
<tr>
<th>Posted Speed limit</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 40 mph</td>
<td>100 ft</td>
</tr>
<tr>
<td>40 mph or above</td>
<td>165 ft</td>
</tr>
</tbody>
</table>
Minimum Deceleration Lane Length (ft)

<table>
<thead>
<tr>
<th>Highway Design Speed (mph)</th>
<th>Turning Traffic Design Speed (mph)</th>
<th>Stop*</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>235</td>
<td>185</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>335</td>
<td>305</td>
<td>275</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>425</td>
<td>390</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>530</td>
<td>490</td>
<td>470</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>605</td>
<td>580</td>
<td>565</td>
<td></td>
</tr>
</tbody>
</table>

Adjustment Multiplier for Grades Greater Than 3%

<table>
<thead>
<tr>
<th>Percent Grade</th>
<th>Upgrade</th>
<th>Downgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>3% to less than 5%</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>5% or more</td>
<td>0.8</td>
<td>1.35</td>
</tr>
</tbody>
</table>

*For use when the turning traffic is likely to stop before completing the turn, (for example - where pedestrians are present.)
Acceleration Lane

Figure 910-13

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Minimum Acceleration Lane Length (feet)

<table>
<thead>
<tr>
<th>Highway Design Speed (mph)</th>
<th>Turning Roadway Design Speed (mph)</th>
<th>Stop</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>180</td>
<td>320</td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>395</td>
<td>640</td>
<td>560</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>640</td>
<td>1115</td>
<td>955</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>1115</td>
<td>1015</td>
<td>955</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>1495</td>
<td>1415</td>
<td>1350</td>
<td></td>
</tr>
</tbody>
</table>

Adjustment Multiplier for Grades Greater Than 3%

<table>
<thead>
<tr>
<th>Highway Design Speed</th>
<th>Percent Grade</th>
<th>Upgrade</th>
<th>Downgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>3% to less than 5%</td>
<td>1.3</td>
<td>0.7</td>
</tr>
<tr>
<td>50</td>
<td>5% or more</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>60</td>
<td>5% or more</td>
<td>1.5</td>
<td>0.55</td>
</tr>
<tr>
<td>70</td>
<td>5% or more</td>
<td>2.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

NOTES:

1. The minimum acceleration lane length for freeway or expressway is 900 ft.
NOTES:

1. Widened shoulders, indicated by hachures, are used when adequate right turn radii cannot be provided for long wheelbase trucks.

2. Use the truck turning path templates to determine the width of the widened shoulder.

3. Design widened shoulder pavements the same depths as the right turn lane.

4. See Chapter 640 for turning roadway widths.
NOTES:

1. The 5 ft min landing between the curb ramps shall be clear of obstructions.
2. Curb ramp details are shown in the Standard Plans.
3. Crosswalk types and locations may vary.
Notes:

1. Locate crosswalks at 90 degrees to traffic for shortest possible crossing distance.

2. Curb ramps or barrier-free passageways as shown on Figure 910-14b are required.

3. See Figure 910-14b for additional details on island placement and curb ramps.

COMPOUND CURVE TRAFFIC ISLAND

Traffic Island Designs

*Figure 910-14c*
### U-Turn Locations

**Figure 910-15**

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>W</th>
<th>R</th>
<th>L</th>
<th>F1</th>
<th>F2</th>
<th>Taper</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>52.0</td>
<td>14.0</td>
<td>14.0</td>
<td>12.0</td>
<td>12.0</td>
<td>—</td>
</tr>
<tr>
<td>SU</td>
<td>87.0</td>
<td>29.5</td>
<td>19.5</td>
<td>13.0</td>
<td>15.0</td>
<td>10:1</td>
</tr>
<tr>
<td>BUS</td>
<td>87.0</td>
<td>27.8</td>
<td>23.0</td>
<td>13.4</td>
<td>18.0</td>
<td>10:1</td>
</tr>
<tr>
<td>WB-40</td>
<td>84.0</td>
<td>24.6</td>
<td>26.5</td>
<td>14.5</td>
<td>20.3</td>
<td>6:1</td>
</tr>
<tr>
<td>WB-50</td>
<td>94.0</td>
<td>26.3</td>
<td>31.0</td>
<td>16.1</td>
<td>25.3</td>
<td>6:1</td>
</tr>
<tr>
<td>WB-67</td>
<td>94.0</td>
<td>22.4</td>
<td>48.5</td>
<td>14.8</td>
<td>34.4</td>
<td>6:1</td>
</tr>
<tr>
<td>MH</td>
<td>84.0</td>
<td>26.5</td>
<td>19.5</td>
<td>14.8</td>
<td>16.2</td>
<td>10:1</td>
</tr>
<tr>
<td>P/T</td>
<td>52.0</td>
<td>11.0</td>
<td>12.5</td>
<td>12.0</td>
<td>18.0</td>
<td>6:1</td>
</tr>
<tr>
<td>MH/B</td>
<td>103.0</td>
<td>36.0</td>
<td>21.5</td>
<td>14.7</td>
<td>16.3</td>
<td>10:1</td>
</tr>
</tbody>
</table>

**Design Manual Intersections At Grade**

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SD = Sight Distance
\( t_a = \) Time for acceleration
\( V = \) Design speed on the through highway
\( L = \) Length of vehicle
\( X = \) Length of vehicle travel

Note: If the crossroad is not level, multiply \( t_a \) by the adjustment factor to consider the grade.

<table>
<thead>
<tr>
<th>L Values</th>
<th>Design Vehicle</th>
<th>Crossroad Grade, Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P = 19 \text{ ft} )</td>
<td>( \text{P} )</td>
<td>-4</td>
</tr>
<tr>
<td>( \text{SU} = 30 \text{ ft} )</td>
<td>( \text{SU} )</td>
<td>0.7</td>
</tr>
<tr>
<td>( \text{WB-50} = 55 \text{ ft} )</td>
<td>( \text{WB-50} )</td>
<td>0.8</td>
</tr>
<tr>
<td>( \text{WB-67} = 69 \text{ ft} )</td>
<td>( \text{WB-67} )</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**EXAMPLE**

Given:
Two - 12 ft lanes to be crossed by a WB-50
Intersection angle approximately \( 90^\circ \).
Through highway design speed = 70 mph

Find:
The minimum required sight distance.

Solution:
\[
X_{\text{right}} = 10 \text{ ft} + W_R + L = 10 \text{ ft} + 24 \text{ ft} + 55 \text{ ft} = 89 \text{ ft}
\]
\[
X_{\text{left}} = 10 \text{ ft} + W_L + L = 10 \text{ ft} + 12 \text{ ft} + 55 \text{ ft} = 77 \text{ ft}
\]

From the charts as shown, the required minimum SD = 1,260 ft right and 1,180 ft left.
Sight Distance for Grade Intersection With Stop Control

Figure 910-16b
For bridge pier or bridge rail:

\[ S = \frac{26(X)}{18 - n} \]

Where:
- \( S \) = Available sight distance (ft)
- \( n \) = Offset from sight obstruction to edge of lane (ft)
- \( X \) = Distance from center line of lane to sight obstruction (ft)

For crest vertical curve over a curb where \( S < L \):

\[ S = \sqrt{\frac{100L\left[\sqrt{2(H_1 - HC) + \sqrt{2(H_2 - HC)}}\right]^2}{A S^2}} \]

\[ L = \frac{AS^2}{100\left[\sqrt{2(H_1 - HC) + \sqrt{2(H_2 - HC)}}\right]^2} \]

Where:
- \( S \) = Available sight distance (ft)
- \( H_1 \) = Eye height (3.5 ft)
- \( H_2 \) = Object height (4.25 ft)
- \( HC \) = Curb height (ft)
- \( L \) = Vertical curve length (ft)
- \( A \) = Algebraic difference in grades (%)
NOTES

1. 12 ft through-lanes and 13 ft left turn lane desirable.
2. For right-turn corner design see Figure 910-7.
3. Higher type intersections will be designed individually.
4. Use templates for the WB-67 design vehicle.
5. Taper rate = Posted Speed(mph):1

Interchange Ramp Details
Figure 910-17
920 Road Approaches

920.01 General
Every owner of property that abuts the state highway system where limited access rights have not been acquired has a right to reasonable access to the state highway system. The right of access to the state highway system may be restricted if reasonable access can be provided by way of another public road that abuts the property. General restrictions concerning road approaches are in RCWs, WACs, and amendments thereto. For considerations, requirements, and restrictions concerning road approaches on state highways where limited access rights have been acquired, see Chapters 1410 and 1420.

This chapter applies to road approaches on state highways in unincorporated areas. Road approaches on state highways within incorporated areas where limited access rights have not been acquired are the jurisdiction of the local agency, but conformance to these standards is encouraged.

920.02 References
Revised Code of Washington (RCW) 47.32.150, “Approach roads, other appurtenances — Permit”
Revised Code of Washington (RCW) 47.32.160, “Approach roads, other appurtenances — Rules — Construction, maintenance of approach roads”
Revised Code of Washington (RCW) 47.32.170, “Approach roads, other appurtenances — Removal of installations from right of way for default”

920.03 Definitions
authorized road approach A road approach or the replacement for a road approach that has been permitted or was open to use prior to July 1, 1990.
average weekday vehicle trip ends (AWDVTE) The estimated total of all trips entering plus all trips leaving a road approach on a weekday for the final stage of development of the property served by the road approach
conforming road approach A road approach that meets all current requirements for location, quantity, spacing, sight distance, and geometric elements
corner clearance The distance from an intersection at grade to the nearest road approach. The distance is measured from the closest edge of the traveled way of the crossroad to the closest edge of the traveled way of the road approach measured along the edge of the traveled way of the highway
intersection at grade The general area where a state highway or ramp terminal is met or crossed at a common grade or elevation by another state highway, a county road, or a city street

Revised Code of Washington (RCW) 47.50, “Highway Access Management”
Right of Way Manual, M 26-01, WSDOT
Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

920.04 Design Considerations

920.05 Road Approach Category

920.06 Road Approach Design Template

920.07 Sight Distance

920.08 Road Approach Spacing

920.09 Drainage Requirements

920.10 Procedures

920.11 Documentation

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April 1998

Road Approaches
English Version
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**Joint Use Approach** A single approach that serves more than one property

**Nonconforming Road Approach** A road approach that does not meet current requirements for location, quantity, spacing, sight distance, or geometric elements

**Permit** The written approval issued by WSDOT authorizing construction, reconstruction, maintenance, or change of category of a road approach

**Road Approach** A connection providing private access to or from the state highway system

**Road Approach Connection Category** A category of road approach based on the estimated traffic generated

**Road Approach Design Template** The design geometric standards for a road approach based on the approach usage, types of vehicles that use the approach, and the traffic volume

**Road Approach Type** The designation of road approaches on limited access facilities based on use of the property served

**Temporary Road Approach** A road approach for a specific property use, conditioned to be open for a specific purpose and traffic volume for a specific period of time with the right of way to be restored to its original condition upon road approach closure

### 920.4 Design Considerations

When a highway project impacts existing road approaches, replace all conforming authorized road approaches. Evaluate existing nonconforming authorized road approaches for ways to bring them into conformance. Solutions may include relocation, combining with the road approach of the adjacent property as a joint use approach alteration, closure to the highway system, or addition of access to another public road.

When the evaluation determines that a nonconforming road approach cannot be made conforming and that closure of the road approach would leave the property without a reasonable means of access, issue a nonconforming access connection permit. Document the evaluation that justifies the use of a nonconforming road approach and how it is nonconforming. List these nonconforming road approaches as Design Exceptions (DE).

New road approaches or upgrades to existing road approaches, requested by the property owner, may be included in the project at the expense of the property owner.

Design road approaches at transit facilities in accordance with Chapter 1060.

### 920.05 Road Approach Connection Category

**Category I — Minimum Connection** provides access for up to ten (10) dwelling units of single family residences, duplexes, or other small multifamily complexes; permanent agricultural or forest lands road approaches; the operation, maintenance, and repair of utilities; and road approaches serving other low volume traffic generators with an AWDVTE of 100 or less.

**Category II — Minor Connection** provides access to the state highway system for medium volume traffic generators with an AWDVTE of 1500 or less, that are not included in Category I.

**Category III — Major Connection** provides access to the state highway system for high volume traffic generators with an AWDVTE exceeding 1500.

**Category IV — Temporary Connection** provides access to the state highway system for a limited time.

### 920.06 Road Approach Design Template

The road approach design template is dependent upon the approach usage, types of vehicles that use the approach, and the traffic volume.

Figure 920-1 lists the road approach design templates, the approach usage, and the largest vehicle that Figures 920-3 through 5 provide for. When a larger design vehicle is required, use the turning path templates in Chapter 910, or from another source, to determine what adjustments to make.
**Table: Design Template Usage**

<table>
<thead>
<tr>
<th>Template</th>
<th>Property Usage</th>
<th>Design Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Residential</td>
<td>P</td>
</tr>
<tr>
<td>B</td>
<td>Farm</td>
<td>SU &amp; BUS</td>
</tr>
<tr>
<td>C</td>
<td>Utility and special use</td>
<td>SU &amp; BUS</td>
</tr>
<tr>
<td>D</td>
<td>Single Commercial</td>
<td>WB-50</td>
</tr>
</tbody>
</table>

Road Approach Design Templates

*Figure 920-1*

The approach type on limited access facilities uses the design template with the same designation. For example a Type B approach will be designed using Design Template B.

**1) Noncommercial Approaches**

Design noncommercial road approaches for rural highways in accordance with Figures 920-3 and 4. Template C is the same basic design as Template B with an added option for a locked gate. If there is a predominance of semitrailer traffic for Templates B and C, the design can be modified to accommodate larger vehicles. Design road approaches to fit the conditions within the limits shown in Figures 920-3 and 4.

Noncommercial road approaches are normally Category I connections. When they are Category II or III, the use of one of the commercial road approach design templates is desirable.

**2) Commercial Approaches**

Determine the predominant type of vehicle using the approach and design the commercial approach in accordance with Figure 920-5. If the width of the frontage precludes such an approach, use the turning path templates in Chapter 910, or from another source, to determine what adjustments may be made to provide safe and efficient access and to avoid encroachment upon the frontage of abutting property.

Commercial approaches are normally Category II or III connections.

Commercial approaches are allowed only on access managed or modified limited access state highways. They must not cause undue interference or hazard to the free movement of highway traffic and, when not joint use approaches, they must not infringe on the frontage of adjoining property. For further restrictions, see the RCWs referenced in 920.02 and Chapter 1420.

Where traffic volumes are heavy, such as for a shopping center or an industrial park, design the road approach as an intersection. (See Chapter 910.)

**920.07 Sight Distance**

The driver of a vehicle entering a roadway from a road approach needs obstruction-free sight triangles in order to see enough of the roadway to safely enter before an approaching vehicle can reach the road approach.

Locate the road approach where the sight distances shown on Figure 920-6 are available. Road approaches with sight distances less than indicated are considered nonconforming road approaches.

**920.08 Road Approach Spacing and Corner Clearance**

**1) Road Approach Spacing**

The minimum distance, measured along the edge of the traveled way, from the closest edge of the traveled way of one road approach to the closest edge of the traveled way of an adjacent road approach, is determined by the Highway Access Management Class. The minimums to be used are shown in Figure 920-7.

Road approach spacing less than these minimums may be required to provide access to properties where highway frontage, topography, or location would otherwise preclude access. Where a joint use approach or access to another public road meeting or exceeding these minimums cannot be obtained or is determined not to be feasible, less than minimum spacing may be necessary. Closely spaced road approaches are nonconforming road approaches and require listing as Design Exceptions (DE).

**2) Corner Clearance**

Corner clearances shall meet or exceed the minimums shown in Figure 920-7. If, due to property size, corner clearance requirements
cannot be met, and where a joint use approach or access to another public road meeting or exceeding the minimum corner clearance cannot be obtained or is determined not to be feasible, then the following minimum S values may be used:

<table>
<thead>
<tr>
<th>Position</th>
<th>Access Allowed</th>
<th>S Min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With Restrictive Medians</td>
<td></td>
</tr>
<tr>
<td>Approaching Intersection</td>
<td>Right In/ Right Out</td>
<td>115 ft</td>
</tr>
<tr>
<td>Approaching Intersection</td>
<td>Right In Only</td>
<td>75 ft</td>
</tr>
<tr>
<td>Departing Intersection</td>
<td>Right In/ Right Out</td>
<td>230 ft*</td>
</tr>
<tr>
<td>Departing Intersection</td>
<td>Right Out Only</td>
<td>100 ft</td>
</tr>
<tr>
<td></td>
<td>Without Restrictive Medians</td>
<td></td>
</tr>
<tr>
<td>Approaching Intersection</td>
<td>Full Access</td>
<td>230 ft*</td>
</tr>
<tr>
<td>Approaching Intersection</td>
<td>Right In Only</td>
<td>100 ft</td>
</tr>
<tr>
<td>Departing Intersection</td>
<td>Full Access</td>
<td>230 ft*</td>
</tr>
<tr>
<td>Departing Intersection</td>
<td>Right Out Only</td>
<td>100 ft</td>
</tr>
</tbody>
</table>

*For Highway Access Management Class 5 or for speeds less than 35 mph, 125 ft may be used.

Minimum Corner Clearance  
_Figure 920-2_

920.09 Drainage Requirements
In a roadway section with a drainage ditch, a culvert pipe is placed under the approach. The approach is graded as shown in Figure 920-5. Be careful that roadway runoff is not a problem in the case of a minus grade to the right of way line.

Design foreslopes not steeper than 6H:1V. Bevel the culvert ends in accordance with Chapter 700.
Locate culverts as far from the traveled way as possible. Minimum distances are shown in Figures 920-3 through 5.

A turnpike section (a standard roadway section with a shallow V-shaped paved gutter at the shoulder edge) may be used. Consider continuing the turnpike section throughout the area between the shoulder and the backslope. In the profile controls on Figure 920-5, if the grade from the edge of shoulder to the right of way line is a flat or minus grade and roadway runoff is a consideration, curb may be placed as shown.

Approaches and related areas must be constructed so they do not impair drainage within the right of way or alter the stability of the roadway subgrade.

920.10 Procedures
Verify the validity of all road approaches. Show on a plan or a list the location, template, validity, and justification for all road approaches. Where road approaches are to be included in a project, consider location and function as early as possible, preferably in the preliminary planning stage.

920.11 Documentation
The following documents are to be preserved in the project file. See Chapter 330.
- Plan or list of the road approaches
- Evaluation of nonconforming authorized road approaches
Edge of shoulder

R = 20 ft

Culvert pipe with beveled end treatment see Chapter 700

10 ft min

Asphalt concrete*

14 ft to 30 ft. As necessary to fit conditions

Continue 20 ft radius as required if approach is at an angle

R = 20 ft

For mailbox location see Chapter 700

Edge of traveled way

Shoulder slope 20 ft min ±6% max**

+15% max

-15% max

Vertical curves not to exceed a 3 1/4 inch hump or a 2 inch depression in a 10 ft chord.

*When the travel lanes are bituminous, a similar type may be used on the approaches.

** ± 8% max difference from shoulder slope.
Noncommercial Approach Design Template B and C

Figure 920-4

*When the travel lanes are bituminous, a similar type may be used on the approaches.

** ± 8% max difference from shoulder slope.

Vertical curves not to exceed 3 1/4 inch hump or a 2 inch depression in a 10 ft chord.
Profile Controls

<table>
<thead>
<tr>
<th>Condition</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary SU and less</td>
<td></td>
<td></td>
<td>10</td>
<td>30</td>
<td>15</td>
<td></td>
<td></td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Primary combination vehicle WB 40</td>
<td>4</td>
<td>25</td>
<td>6</td>
<td>50</td>
<td>15</td>
<td>7</td>
<td>25</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>Primary combination vehicle WB 50 and doubles</td>
<td>4</td>
<td>25</td>
<td>6</td>
<td>55</td>
<td>20</td>
<td></td>
<td></td>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>

All values in feet
For larger vehicles, use turning templates

Note: Vertical curves between the shoulder slope and the approach grade not to exceed a 3 1/4 inch hump or a 2 inch depression in a 10 ft chord.
Road Approach Sight Distance

Figure 920-6

<table>
<thead>
<tr>
<th>Posted Speed Limit (mph)</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category I</td>
<td>150</td>
<td>180</td>
<td>230</td>
<td>280</td>
<td>380</td>
<td>510</td>
<td>630</td>
</tr>
<tr>
<td>Road Approach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category II</td>
<td>150</td>
<td>200</td>
<td>270</td>
<td>330</td>
<td>480</td>
<td>640</td>
<td>860</td>
</tr>
<tr>
<td>Road Approach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not to exceed 18 ft from the edge of traveled way.

These distances require an approaching vehicle to reduce speed or stop to prevent a collision.

Design Category III road approach sight distance as an intersection (see Chapter 910).

For road approaches where left turns are not allowed, a sight triangle need only be provided to the left, as shown.

For road approaches where left turns are allowed, provide a sight triangle to the right in addition to the one to the left. The sight distance to the right is measured along the center line of the roadway.

For additional information on calculating the sight triangle, see Chapter 910.
Road Approach Spacing and Corner Clearance

<table>
<thead>
<tr>
<th>Highway Access Management Class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>1320 ft</td>
<td>660 ft</td>
<td>330 ft</td>
<td>250 ft</td>
<td>125 ft</td>
</tr>
</tbody>
</table>

Note:

For Road Approach Spacing, S is the distance between closest edge of the traveled way of the two road approaches, measured along the edge of the traveled way of the highway.

For corner clearance, S is measured from the closest edge of the traveled way of the crossroad to the closest edge of the traveled way of the road approach, measured along the edge of the traveled way of the highway.
930
Railroad Grade Crossings

930.01 GENERAL
An at-grade railroad crossing is, in effect, a traffic crossing and due consideration must be given to the design and traffic control of the intersection.

930.02 REFERENCES


WSDOT Utilities Manual (M 22-87) Chapter 3, Railroads. (Explains the details for agreements with the railroads and the responsibilities of WSDOT district and headquarters personnel.)

RCW 81.53 Railroad - Crossings.


930.03 PLANS
Provide design plans for all improvements of existing crossings and for all new crossings. These plans normally are included in the design report. (See Chapter 330.)

Indicate on the preliminary design plan the basic roadway dimensions of shoulders, medians, traffic lanes, stopping lanes, acceleration lanes, guardrail, attenuation, advance warning devices, etc., for existing facilities. Show the angle of crossing, number of tracks, location of signals, and any other railway facilities such as signal powerlines, signal control boxes, switch control boxes, etc. on existing facilities. On proposed railroad crossings show the location of the improvement on the plan.

Sight distance is of primary consideration at grade crossings. The condition at a railroad grade crossing is comparable to that of intersecting highways where a corner sight triangle must be kept clear of obstructions. The desirable corner sight distance arrangement is that which allows a driver approaching the grade crossing to see a train at such a distance that if the train proceeded without slowing down it would reach the crossing at about the time the highway vehicle can be brought to a stop in advance of the crossing. See Figure 930-1, Case 2. Sight distances of the order shown are desirable at any railroad crossing not controlled by active warning devices. Their attainment, however, is difficult and often impracticable except in flat open terrain.

For safety, the driver of a stopped vehicle at a crossing should be able to see down the tracks far enough to be able to cross it before the train reaches the crossing. See Figure 930-1, Case 1.

When it is unreasonable to achieve the minimum sight triangle, installation of active control devices should be considered.

Plan and profile on both the railroad and highway should be shown for a minimum of 500 feet on both sides of the crossing. The roadway profile should be extended as necessary to show all important vertical alignment data. Show other important features that may affect the design or traffic operation of the crossings, such as proximity of crossroads or city street intersections, nearby driveways or entrances, highway structures, vehicular ADT (including percentage of trucks and number of school buses), and train ADT.

When a highway crosses a railroad at grade, the highway grade should be constructed so that a low-hung vehicle will not damage the tracks or get hung up on the tracks. The highway surface should be no more than 3 inches higher nor 6 inches lower than the top of the nearest rail in the plane of the rails at a point 30 feet from the rail, measured at right angles to the railroad. See Chapter 630.

The skew angle of all at-grade crossings shall be as safe as is practicable. For motorized traffic, wherever possible, the crossing should be at right angles to the rails.

Whenever it is necessary to cross railroad tracks with a bikeway, the crossing should be at least as wide as the approaches of the bikeway and at right angles to the rails. Where a skew is unavoidable, the shoulder should be widened to permit the bicycles to cross at right angles. See Chapter 1020.

930.04 TRAFFIC CONTROL SYSTEMS
The function of traffic control systems is to permit safe and efficient operation of railroad and highway traffic crossings. These systems along highways approaching at-grade railroad crossings may include one or more of the following:
(a) Signing is a part of the Passive Traffic Control System which also includes pavement markings and grade crossing illumination. Signing used at railroad grade crossings includes one or more of the following:

- Railroad Crossing Sign, commonly identified as the “crossbuck” sign. The railroad is responsible for placement and maintenance of the crossbuck sign.
- Railroad Crossing Auxiliary Sign of an inverted T shape mounted below the crossbuck sign to indicate the number of tracks when two or more tracks are between the signs.
- Railroad Advance Warning Sign.
- Exempt Crossing Sign. A supplemental sign that, when authorized by law or regulation, may be mounted below the crossbuck and railroad advance warning signs. See Part 8 of the MUTCD.
- Do Not Stop on Tracks Sign.

Signing design elements are shown in Chapter 820 and the Manual on Uniform Traffic Control Devices (MUTCD).

(b) Pavement markings placed in advance of a grade crossing on all paved approaches shall consist of railroad pavement markings, no passing marking (two-lane roads), and stopping lanes (if needed). Generally, other pavement markings will be used as shown in Chapter 830.

(c) Illumination at and adjacent to railroad crossings should be installed to supplement other traffic control devices where railroad operations are conducted at night. Railroad crossings of state highways warrant illumination if warrants for gates or signals are met. Other crossings with a nighttime accident pattern may be considered for illumination. See Chapter 840. Deviations will be considered for not illuminating crossings with gates or signals if there is no nighttime activity and if the crossing is not used as a school bus route.

(d) Signals and gates are considered part of the active grade crossing traffic control system. Signals consist of post mounted flashing light signals and cantilever flashing light signals, and where warranted, the addition of automatic gates. Any of the foregoing may incorporate a bell.

Due to the large number of significant variables that must be considered, there is no single standard system of active traffic control devices universally applicable for grade crossings. Based on an engineering and traffic investigation, a determination is made as to what type of active traffic control system is appropriate.

Figure 930-2 gives guidelines for determining the amount of crossing protection to be provided. The district’s recommendations and support data are to be forwarded to the headquarters Project Development Office as part of the design report. (See Chapter 330.)

Signal installations will use the signals shown in the current edition of the MUTCD and the Railroad-Highway Grade Crossing Handbook published by the FHWA.

The locations of signals and automatic gates are shown in the MUTCD.

A railroad signal may be a point hazard warranting the use of a traffic barrier or a crash cushion. Traffic barrier and crash cushion guidelines are shown in Chapters 710 and 720. Traffic barriers or crash cushions shall be placed outside the minimum railroad clearance as shown in the MUTCD.

Railroad crossing improvements are usually funded as separate projects. When separately funded projects are combined into a single contract, the railroad improvements shall be separated out.

930.05 STOPPING LANES

Stopping lanes for certain vehicles (school buses, vehicles carrying hazardous materials, etc.) shall be provided when constructing all railroad grade crossings except:

- Any railroad grade crossing at which traffic is controlled by a police officer or a duly authorized flagman.
- Any railroad grade crossing at which traffic is regulated by a traffic control signal.
- Any railroad grade crossing protected by signals with or without an automatic gate, intended to give warning of the approach of a railroad train.
- Any railroad grade crossing for which the Utilities and Transportation Commission, pursuant to RCW 81.53.060, gives notice that the stopping requirement imposed by this section does not apply (Exempt Signing).

The stopping lane geometrics shall be in accordance with Figure 930-3. The shoulder along the stopping lane shall be a minimum of 3 feet.

930.06 TYPES OF CROSSING SURFACES

A smooth surface is an important part of any railroad-highway grade crossing; it contributes to the safety of vehicles. Typical types of crossing surfaces for railroad-highway grade crossing are:

- Asphalt or bituminous.
- Concrete.
- Steel.
- Timber.
- Rubber (elastomeric) panels.
- Linear high density polyethylene modules.
• Epoxy-rubber mix cast-in-place.

Railroad Highway Grade Crossing Handbook (FHWA), and Implementation Package 798 (Railroad-Highway Grade Crossing Surfaces), although neither constitutes a standard, specification, or regulation, detail a number of crossing surfaces, some of which are a modification of those listed above.

When the highway is resurfaced, each crossing may require removal and reinstallation. Hence, the crossing surface installation must be compatible with railroad operations and maintenance requirements.

930.07 CROSSING CLOSURE

Any railroad grade crossing for which there is not a demonstrated need should be closed.

Where a railroad track has been abandoned or its use discontinued, all related traffic control devices shall be removed, and the tracks should be removed or paved over.

Recommendations for crossing closures are sent to the headquarters Utilities/Railroad Engineer.

930.08 TRAFFIC CONTROLS DURING CONSTRUCTION AND MAINTENANCE

Traffic controls for street and highway construction and maintenance operations are discussed in Chapter 810. Similar traffic control methods should be used where highway traffic is affected by construction and maintenance at railroad grade crossings.

930.09 RAILROAD GRADE CROSSING ORDERS

The Utilities and Transportation Commission issues the necessary orders authorizing highway-railroad grade crossings. Petition and interrogatory form issued by the Utilities and Transportation Commission provides guidance to obtain the necessary order. Figure 930-4 shows the format. The plan should be drawn on 8 1/2 x 11 inch or 8 1/2 x 13 inch sheets or multiples of these sizes.

Show the information required for preliminary plans noted above and submit the tracing and one copy of the interrogatory form to the headquarters Project Development Office with the right of way plans.

930.10 LONGITUDINAL EASEMENTS FROM RAILROAD

In general, right of way is not acquired in fee from a railroad company. Instead, the state acquires easements, access rights, construction permits, encroachments, etc. Refer to the Utilities Manual Chapter 3, Railroads for details.

Longitudinal cross sections are required. Figure 930-5 shows some typical encroachment cross sections.

Prepare the cross sections on 24 x 36 inch transparent 10 x 10 cross section paper. Draw the sections to a scale of 1 inch equals 10 feet. Identify each sheet by penciling project name, county, and sign route, sheet, control section, and project number on the left margin.

Each cross section is to show the following data:

• Distance between the highway and railway center line taken normal to the highway center line at each highway station.
• The highway station and the equivalent railway station.
• The finished highway profile grade.
• Existing ground elevation at highway center line.
• Distances from the highway center line to the encroachment lines and to existing right of way lines.
• Highway and railway stationing for the beginning and end of the encroachment.

Cross section measurements and location must agree with those shown on the right of way plans and as outlined in the Plans Preparation Manual.

Longitudinal cross sections shall be submitted with the right of way plans.
<table>
<thead>
<tr>
<th>Case 1</th>
<th>Case 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Departure</strong></td>
<td><strong>Moving Vehicle</strong></td>
</tr>
<tr>
<td><strong>From Stop</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Train Speed</strong></td>
<td><strong>Vehicle Speed (km/h) Vv</strong></td>
</tr>
<tr>
<td>(km/h) V_T</td>
<td>20  30  40  50  60  70  80  90  100  110</td>
</tr>
<tr>
<td>0</td>
<td>0.40  0.40  0.38  0.35  0.33  0.31  0.30  0.30  0.29  0.28</td>
</tr>
<tr>
<td>20 95</td>
<td>50  40  40  40  40  40  45  45  50  50</td>
</tr>
<tr>
<td>40 185</td>
<td>100  80  75  75  80  85  90  95  100</td>
</tr>
<tr>
<td>60 105</td>
<td>145  120 115 115 115 125 120 135 145 155</td>
</tr>
<tr>
<td>80 135</td>
<td>195  160 150 150 155 165 170 180 190 205</td>
</tr>
<tr>
<td>100 455</td>
<td>240  200 190 190 195 205 215 225 235 255</td>
</tr>
<tr>
<td>120 550</td>
<td>290  240 225 225 230 245 255 265 285 305</td>
</tr>
<tr>
<td>140 640</td>
<td>335  285 265 260 270 285 300 310 330 355</td>
</tr>
<tr>
<td><strong>Distance along highway from crossing - d_H (meters)</strong></td>
<td>25  40  55  70  95  120  150  180  215  255</td>
</tr>
<tr>
<td><strong>Required design sight distance for combination of highway and train vehicle speeds; 19.5 m truck crossing a single set of tracks at 90°.</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Case 1**
(stopped vehicle)

**Case 2**
(moving vehicle)

Adjustments must be made for skew crossings.
Assumed flat highway grades adjacent to and at crossings.
W = Distance between outer rails (single track W = 1.5 m)
D = Distance from stop line to nearest rail (assumed 4.5 m)
D_e = Distance from driver to front of vehicle (assumed 3.0 m)

\[
d_s = \text{Sight distance along highway} \\
d_H = \text{Sight distance along railroad tracks} \\
V_v = \text{Velocity of vehicle} \\
f = \text{Coefficient of friction} \\
V_t = \text{Velocity of train} \\
L = \text{Length of vehicle (assumed 19.5 m)}
\]

**SIGHT DISTANCE AT RAILROAD CROSSING**

Figure 930-1
(Metric)
All conditions not covered in this chart, or marginal situations, are to be referred to headquarters, Project Development Office with the district's recommendation and support data.

<table>
<thead>
<tr>
<th>TYPE OF HIGHWAY</th>
<th>EXPOSURE FACTOR x</th>
<th>TYPE OF RAILROAD FACILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NONMAIN LINE</td>
</tr>
<tr>
<td>Two Lane</td>
<td>Under 1,500</td>
<td>Reflectorized Signs</td>
</tr>
<tr>
<td></td>
<td>1,500 - 5,000</td>
<td>Flashing Lights</td>
</tr>
<tr>
<td></td>
<td>Over 50,000</td>
<td>Separation</td>
</tr>
<tr>
<td></td>
<td>Over 50,000</td>
<td>Separation</td>
</tr>
<tr>
<td>All Fully Controlled Access</td>
<td>In All Cases</td>
<td>Separation</td>
</tr>
</tbody>
</table>

* x Exposure Factor = Trains per day x vehicle ADT.
** xx Automatic Gates to be used in urban areas and flashing lights in rural areas, unless conditions warrant otherwise.

GUIDELINES FOR RAILROAD CROSSING PROTECTION
Figure 930-2
**Approach Length of Pullout Lane, $L_d$**

<table>
<thead>
<tr>
<th>Vehicle Speed (km/h)</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>60</td>
<td>85</td>
</tr>
<tr>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>80</td>
<td>115</td>
</tr>
<tr>
<td>90</td>
<td>130</td>
</tr>
<tr>
<td>100</td>
<td>145</td>
</tr>
</tbody>
</table>

**Downstream Length of Pullout Lane, $L_a$**

<table>
<thead>
<tr>
<th>Vehicle Speed (km/h)</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>60</td>
<td>25</td>
</tr>
<tr>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>80</td>
<td>130</td>
</tr>
<tr>
<td>90</td>
<td>200</td>
</tr>
<tr>
<td>100</td>
<td>265</td>
</tr>
</tbody>
</table>

$L_d$ = Total length of pullout lane, approach
$L_a$ = Total length of pullout lane, exit

**TYPICAL PULLOUT LANE AT RAILROAD CROSSING**

Figure 930-3
(Metric)
NOTES:
1. Minimum scale to be used: Horizontal 1:4800
   Vertical 1:4800
2. Railroad stationing in units designated by the railroad.

RAILROAD CROSSING PLAN FOR
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

Figure 930-4
(Metric)
BEGINNING OF EASEMENT - HIGHWAY STATION 3+855.80 - RAILWAY STATION 57294+57.6

ELEVATION
TOP OF RAIL
RR Q  RR R/W  L  G
131.67  26.8 m  17.7 m  11.3 m  130.15  135.61
57295+15.1  3+875.00

GROUND ELEVATION

EASEMENT LINE

RR Q  RR R/W  L  G
131.67  24.4 m  17.7 m  8.8 m  130.15  135.74
57296+05.1  3+900.00

EASEMENT LINE

RR Q  RR R/W  L  G
131.67  25.0 m  17.7 m  9.1 m  130.76  135.90
57296+95.1  3+925.00

FINISHED HIGHWAY GRADE ELEVATION

END OF EASEMENT - HIGHWAY STATION 3+932.70 - RAILROAD STATION 57297+73.1

NOTE:
1. All measurements between Railroad and Highway Center lines shall be taken normal to Highway Center line.
3. Railroad stationing in units designated by the railroad.

LONGITUDINAL EASEMENT CROSS SECTIONS

Figure 930-5
(Metric)
Case 1  
Departure from stop  
Train Speed (MPH) $V_t$  
0 10 20 30 40 50 60 70  
f$=0.40 0.40 0.35 0.32 0.30 0.29 0.28  
Consumer:  
Distance Along Railroad from Crossing $d_L$ (ft)  
10 240 145 105 100 105 115 125 135  
20 480 290 210 200 210 225 245 270  
30 720 335 310 300 310 340 370 405  
40 960 580 415 400 415 450 490 540  
50 1160 725 520 500 520 565 615 675  
60 1440 870 620 600 620 675 735 810  
70 1680 1015 725 700 725 780 860 940  
80 1920 1160 830 800 830 900 980 1075  
90 2160 1305 930 900 930 1010 1100 1210  

distance Along Highway from Crossing (ft) $d_H  
70 1.35 225 340 490 660 865  
Required design sight distance for combination of highway and train vehicle speeds: 85 ft truck crossing a single set of tracks at 90°.  

CASE 1 (stopped vehicle)  
Stop Line  
Stop Line  

d = Distance from outer rail  
$V_t$ = Train speed  
$V$ = Highway speed  
Obstruction  

d_L = Sight distance along railroad tracks  
d_H = Sight distance along highway  
$V_t$ = Velocity of train  
$V$ = Velocity of vehicle  
f = Coefficient of friction  
D = Distance between outer rails (single track V=5 ft.)  
$d_e$ = Distance from stop line to nearest rail (assumed 15 ft.)  
$d_e$ = Distance from driver to front of vehicle (assumed 10 ft.)  
L = Length of vehicle (assumed 65 ft.)  

SIGHT DISTANCE AT RAILROAD CROSSING  
Figure 930-1  

Design Manual  
March 1994  

930-9
Typical Pullout Lane at Railroad Crossing

Figure 930-3
GRADE CROSSING
Highway Sta. 109+25 = Railroad Sta. 1090+00

NOTE:
Minimum scale to be used: Horizontal 1"=400'
Vertical 1"=40'

Highway Sta. 109+25 = Railroad Sta. 1090+00

RAILROAD CROSSING PLAN FOR
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION
Figure 930-4

Design Manual
March 1994

930-11
BEGINNING OF EASEMENT - HIGHWAY STATION 126+32.5 - RAILWAY STATION 57284+57.6

END OF EASEMENT - HIGHWAY STATION 129+58.0 - RAILROAD STATION 57297+73.1

NOTES:
All measurements between Railroad and Highway Center Lines shall be taken NORMAL TO HIGHWAY CENTER LINE.
Measurements on Cross Sections shall agree with those shown on Right of Way Plans.

LONGITUDINAL EASEMENT CROSS SECTIONS
Figure 930-5
940.01 General

The primary purpose of an interchange is to eliminate conflicts caused by vehicle crossings and to minimize conflicting left-turn movements. Interchanges are provided on all Interstate highways, freeways, other routes on which full access control is required, and at other locations where traffic cannot be controlled safely and efficiently by intersections at grade.

See the following chapters for additional information:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>640</td>
<td>Superelevation</td>
</tr>
<tr>
<td>640</td>
<td>Turning Widths</td>
</tr>
<tr>
<td>640</td>
<td>Ramp Sections</td>
</tr>
<tr>
<td>910</td>
<td>Intersections</td>
</tr>
<tr>
<td>1050</td>
<td>HOV Lanes</td>
</tr>
<tr>
<td>1420</td>
<td>Access Control</td>
</tr>
<tr>
<td>1425</td>
<td>Access Point Decision Report</td>
</tr>
</tbody>
</table>

940.02 References

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

Plans Preparation Manual, M 22-31, WSDOT

HOV Direct Access Design Guide, Draft M 22-98, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT.
federal aid acts as being the most important to the development of a national transportation system. The Interstate System is part of the principal arterial system.

**lane** A strip of roadway used for a single line of vehicles.

**median** The portion of a divided highway separating the traveled ways for traffic in opposite directions.

**outer separation** The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road.

**physical nose** The point, upstream of the gore, where the separation between the roadways equals the sum of the shoulder widths, but not less than 10 ft.

**ramp** A short roadway connecting a main lane of a freeway with another facility for vehicular use such as a local road or another freeway.

**ramp connection** The pavement at the end of a ramp, connecting it to a main lane of a freeway.

**ramp meter** A traffic signal at a freeway entrance ramp that allows a measured or regulated amount of traffic to enter the freeway.

**ramp terminal** The end of a ramp at a local road.

**roadway** The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

**sight distance** The length of highway visible to the driver.

**shoulder** The portion of the roadway contiguous with the traveled way, primarily for accommodation of stopped vehicles, emergency use, lateral support of the traveled way, and where permitted use by bicyclists and pedestrians.

**stopping sight distance** The sight distance required to detect a hazard and safely stop a vehicle traveling at design speed.

**traffic interchange** A system of interconnecting roadways, in conjunction with one or more grade separations, providing for the exchange of traffic between two or more intersecting highways or roadways.

**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.

### 940.04 Interchange Design

#### (1) General

All freeway exits and entrances are to connect on the right of through traffic. Deviations from this requirement will be considered for special conditions with an approved deviation.

Provide complete ramp facilities for all directions of travel wherever possible. However, give primary consideration to the basic traffic movement function that the interchange is to fulfill.

Few complications will be encountered in the design and location of rural interchanges that simply provide a means of exchanging traffic between a limited access freeway and a local crossroad. The economic and operational effects of locating traffic interchanges along a freeway through a community requires more careful consideration, particularly with respect to local access, to provide the best local service possible without reducing the capacity of the major route or routes.

Where freeway to freeway interchanges are involved, do not provide ramps for local access unless they can be added conveniently and without detriment to safety or reduction of ramp and through-roadway capacity. When exchange of traffic between freeways is the basic function and local access is prohibited by access control restrictions or traffic volume, it may be necessary to provide separate interchanges for local service.

#### (2) Interchange Patterns

Basic interchange patterns have been established that can be used under certain general conditions and modified or combined to apply to many more. Alternatives must be considered in the design of a specific facility, but the conditions in the area and on the highway involved must govern and rigid patterns must not be indiscriminately imposed.
Selection of the final design must be based on a study of projected traffic volumes, site conditions, geometric controls, criteria for intersecting legs and turning roadways, driver expectancy, consistent ramp patterns, continuity, and cost.

The patterns most frequently used for interchange design are those commonly described as directional, semidirectional, cloverleaf, partial cloverleaf, diamond, and single point (urban) interchange. (See Figure 940-4.)

(a) **Directional** A directional interchange is the most effective design for connection of intersecting freeways. The directional pattern has the advantage of reduced travel distance, increased speed of operation, and higher capacity. These designs eliminate weaving and have a further advantage over cloverleaf designs in avoiding the loss of sense of direction drivers experience in traveling a loop. This type of interchange is costly to construct, commonly using a four-level structure.

(b) **Semidirectional** A semidirectional interchange has ramps that loop around the intersection of the highways. This requires multiple single-level structures and more area than the directional interchange.

(c) **Cloverleaf** The full cloverleaf interchange has four loop ramps that eliminate all the left-turn conflicts. Outer ramps provide for the right turns. A full cloverleaf is the minimum type interchange that will suffice for a freeway-to-freeway interchange. Cloverleaf designs often incorporate a C-D road to minimize signing difficulties and to remove weaving conflicts from the main roadway.

The principal advantage of this design is the elimination of all left-turn conflicts with one single-level structure. Because all movements are merging movements, it is adaptable to any grade line arrangement.

The cloverleaf has some major disadvantages. The left-turn movement has a circuitous route on the loop ramp, the speeds are low on the loop ramp, and there are weaving conflicts between the loop ramps. The cloverleaf also requires a large area. The weaving and the radius of the loop ramps are a capacity constraint on the left-turn movements.

(d) **Partial Cloverleaf (PARCLO)** A partial cloverleaf has loop ramps in one, two, or three quadrants that are used to eliminate the major left-turn conflicts. These loops may also serve right turns for interchanges that have one or two quadrants that must remain undeveloped. Outer ramps are provided for the remaining turns. Design the grades to provide sight distance between vehicles approaching these ramps.

(e) **Diamond** A diamond interchange has four ramps that are essentially parallel to the major arterial. Each ramp provides for one right and one left-turn movement. Because left-turns are made at grade across conflicting traffic on the crossroad, intersection sight distance is a primary consideration.

The diamond design is the most generally applicable and serviceable interchange configuration and usually requires less space than any other type. Consider this design first when a semidirectional interchange is required unless another design is clearly dictated by traffic, topography, or special conditions.

(f) **Single Point (Urban)** A single point urban interchange is a modified diamond with all of its ramp terminals on the crossroad combined into one signalized at-grade intersection. This single intersection accommodates all interchange and through movements.

A single point urban interchange can improve the traffic operation on the crossroad with less right of way than a standard diamond interchange; however, a larger structure is required.

**3) Spacing**

To avoid excessive interruption of main line traffic, consider each proposed facility in conjunction with adjacent interchanges, intersections, and other points of access along the route as a whole.

The minimum spacing between adjacent interchanges is 1 mi in urban areas and 2 mi in rural areas. In urban areas, spacing less than 1 mi may be used with C-D roads or grade
(6) Uniformity of Exit Pattern

While interchanges are of necessity custom designed to fit specific conditions, it is desirable that the pattern of exits along a freeway have some degree of uniformity. From the standpoint of driver expectancy, it is desirable that each interchange have only one point of exit, located in advance of the crossroad.

940.05 Ramps

(1) Ramp Design Speed

The design speed for a ramp is based on the design speed for the freeway main line. Use the design speeds shown in Figure 940-1 for ramps.

<table>
<thead>
<tr>
<th>Main Line Design Speed mph</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp Design Speed (mph)</td>
<td>35</td>
<td>45</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

Ramp Design Speed

Figure 940-1

These guidelines are for the ramp at the interchange connection. Vary the ramp design speed to provide a smooth speed transition from the interchange connection to the crossroad speed or the stop at the intersection. Variations in curvature may prevent design of an interchange ramp for a constant design speed, but under no conditions may design speed be reduced below 35 mph for freeway to freeway ramps and 25 mph for other ramps. For loop ramps the design speed may be reduced to 25 mph; however, it is desirable that the design speed be as high as practical. For C-D roads the design speed is 10 mph below the main line design speed. Use the allowed skew at the crossroad intersection to minimize ramp curvature.

(2) Sight Distance

Design ramps in accordance with provisions in Chapter 650 for stopping sight distances.

(3) Grade

The maximum grade for ramps for various design speeds is given in Figure 940-2.

separated (braided) ramps. Generally, the average interchange spacing is not less than 2 mi in urban areas and not less than 4 mi in suburban areas. Interchange spacing is measured along the freeway center line between the center lines of the crossroads.

The spacing between interchanges may also be dependent on the spacing between ramps. The minimum spacing between the noses of adjacent ramps is given on Figure 940-5.

Consider either frontage roads or C-D roads when it is necessary to facilitate the operation of near-capacity volumes between closely spaced interchanges or ramp terminals. C-D roads may be required where cloverleaf loop ramps are involved or where a series of interchange ramps that require overlapping of the speed change lanes. Base the distance between successive ramp terminals on capacity requirements and check the intervening sections by weaving analysis to determine whether adequate capacity, sight distance, and effective signing can be ensured without the use of auxiliary lanes or C-D roads.

(4) Route Continuity

Route continuity refers to the providing of a directional path along the length of a route designated by state route number. Provide the driver of a through route a path on which lane changes are minimized and other traffic operations occur to the right.

In maintaining route continuity, interchange configuration may not always favor the heavy traffic movement, but rather the through route. In this case, design the heavy traffic movements with multilane ramps, flat curves, and reasonably direct alignment.

(5) Drainage

Avoid interchanges located in proximity to natural drainage courses. These locations often result in complex and unnecessarily costly hydraulic structures.

The open areas within an interchange can be used for storm water detention facilities when these facilities are required.

(6) Uniformity of Exit Pattern

While interchanges are of necessity custom designed to fit specific conditions, it is desirable that the pattern of exits along a freeway have some degree of uniformity. From the standpoint of driver expectancy, it is desirable that each interchange have only one point of exit, located in advance of the crossroad.

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<th>40</th>
<th>50</th>
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<th>70</th>
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<tbody>
<tr>
<td>Ramp Design Speed (mph)</td>
<td>35</td>
<td>45</td>
<td>50</td>
<td>60</td>
<td>70</td>
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</tbody>
</table>

Ramp Design Speed

Figure 940-1

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(2) Sight Distance

Design ramps in accordance with provisions in Chapter 650 for stopping sight distances.

(3) Grade

The maximum grade for ramps for various design speeds is given in Figure 940-2.
Ramp Design Speed (mph) | 25-30 | 35-40 | 45 and above
--- | --- | --- | ---
Desirable Grade (%) | 5 | 4 | 3
Maximum Grade (%) | 7 | 6 | 5

On one-way ramps down grades may be 2% greater.

Maximum Ramp Grade
Figure 940-2

(4) Cross Section
Provide the minimum ramp widths given in Figure 940-3. Ramp traveled ways may require additional width to these minimums as one-way turning roadways. See Chapter 640 for additional information and roadway sections.

<table>
<thead>
<tr>
<th>Number of Lanes</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traveled Way(1)</td>
<td>15(2)</td>
<td>25(3)</td>
</tr>
<tr>
<td>Shoulders</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Medians(4)</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

(1) See Chapter 1050 for additional width when an HOV lane is present.
(2) May be reduced to 12 ft on tangents.
(3) Add 12 ft for each additional lane.
(4) In addition to shoulder width.

Ramp Widths (ft)
Figure 940-3

Cross slope and superelevation requirements for ramp traveled way and shoulders are as given in Chapter 640 for roadways.

Whenever feasible, make the ramp cross slope at the ramp beginning or ending station equal to the cross slope of the through lane pavement. Where space is limited and superelevation runoff is long or when parallel connections are used, the superelevation transition may be ended beyond (for on-ramps) or begun in advance of (for off-ramps) the ramp beginning or ending station, provided that the algebraic difference in cross slope at the edge of the through lane and the cross slope of the ramp does not exceed 4%. In such cases, ensure smooth transitions for the edge of traveled way.

(5) Ramp Lane Increases
When off-ramp traffic and left-turn movements volume at a crossroad terminal cause congestion, it may be desirable to add lanes to the ramp to reduce the queue length caused by turning conflicts. Make provision for the addition of ramp lanes whenever ramp exit or entrance volumes, after the design year, are expected to result in poor service. See Chapter 620 for width transition design.

(6) Ramp Meters
Ramp meters are used to allow a measured or regulated amount of traffic to enter the freeway. When operating in the “measured” mode, they release traffic at a measured rate to keep downstream demand below capacity and improve system travel times. In the “regulated” mode, they break up platoons of vehicles that occur naturally or result from nearby traffic signals. Even when operating at near capacity, a freeway main line can accommodate merging vehicles one or two at a time, while groups of vehicles will cause main line flow to break down.

The location of the ramp meter is a balance between the storage and acceleration requirements. Locate the ramp meter to maximize the available storage and so that the acceleration lane length, from a stop to the freeway main line design speed, is available from the stop bar to the merging point. With justification, the main line design speed may be reduced to the average running speed during the hours of meter operation. See 940.06(4) for information on the design of on-connection acceleration lanes. See Chapter 860 for additional information on the design of ramp meters.

Driver compliance with the signal is required for the ramp meter to have the desired results. Consider enforcement areas with ramp meters. Consider HOV bypass lanes with ramp meters. See Chapter 1050 for design data for ramp meter bypass lanes.
940.06 Interchange Connections

Provide uniform geometric design and uniform signing for exits and entrances, to the extent possible, in the design of a continuous freeway. Do not design exit ramps as an extension of a main line tangent at the beginning of a main line horizontal curve.

Provide spacing between interchange connections as given by Figure 940-5.

Avoid on-connections on the inside of a main line curve, particularly when the ramp approach angle is accentuated by the main line curve, the ramp approach requires a reverse curve to connect to the main line, or the elevation difference will cause the cross slope to be steep at the nose.

Keep the use of mountable curb at interchange connections to a minimum. Justification is required when it is used adjacent to traffic expected to exceed 40 mph.

(1) Lane Balance

Design interchanges to the following principles of lane balance:

(a) At entrances, make the number of lanes beyond the merging of two traffic streams not less than the sum of all the lanes on the merging roadways less one. (See Figure 940-6a.)

(b) At exits, make the number of approach lanes equal the number of highway lanes beyond the exit plus the number of exit lanes less one. (See Figure 940-6b.) Exceptions to this would be at a cloverleaf or at closely spaced interchanges with a continuous auxiliary lane between the entrance and exit. In these cases the auxiliary lane may be dropped at a single-lane, one lane reduction, off-connection with the number of approach lanes being equal to the sum of the highway lanes beyond the exit and the number of exit lanes. Closely spaced interchanges have a distance of less than 2,100 ft between the end of the acceleration lane and the beginning of the deceleration lane.

Maintain the basic number of lanes, as described in Chapter 620, through interchanges. When a two-lane exit or entrance is used, maintain lane balance with an auxiliary lane. The only exception to this is when the basic number of lanes is changed at an interchange.

(2) Main Line Lane Reduction

The reduction of a basic lane or an auxiliary lane may be made at a two-lane exit or may be made between interchanges. When a two-lane exit is used, provide a recovery area with a normal acceleration taper. When a lane is dropped between interchanges, drop it 1,500 to 3,000 ft from the end of the acceleration taper of the previous interchange. This will allow for adequate signing but not be so far that the driver will become accustomed to the number of lanes and be surprised by the reduction. (See Figure 940-7.)

Reduce the traveled way width of the freeway by only one lane at a time.

(3) Sight Distance

Locate off-connections and on-connections on the main line to provide decision sight distance for a speed/path/direction change as described in Chapter 650.

(4) On-Connections

On-connections are the pavement at the end of on-ramps, connecting them to the main lane of a freeway. They have two parts, an acceleration lane and a taper. The acceleration lane allows entering traffic to accelerate to the freeway speed and evaluate gaps in the freeway traffic. The taper is for the entering vehicle to maneuver into the through lane.

On-connections are either taper type or parallel type. The tapered on-connection provides direct entry at a flat angle, reducing the steering control needed. The parallel on-connection adds a lane adjacent to the through lane for acceleration with a taper at the end. Vehicles merge with the through traffic with a reverse curve maneuver similar to a lane change. While the taper requires less steering control, the parallel is narrower at the end of the ramp and has a shorter taper at the end of the acceleration lane.

(a) Provide the minimum acceleration lane length given on Figure 940-8 for all on-ramps. When the grade of the acceleration lane is 3% or
greater, multiply the distance from the Minimum Acceleration Lane Length table by the factor from the Adjustment Factor for Grades table. Design the acceleration lane for a higher speed than the ramp to accommodate the increasing speed of the entering traffic.

The acceleration lane is measured from the last point designed at the ramp design speed (usually the PT of the last curve) to the last point with a ramp width of 12 ft. When the transition curve is designed for at least the posted speed of the freeway, its length may be included as part of the acceleration length.

(b) Provide the minimum gap acceptance length to allow entering traffic to evaluate gaps in the freeway traffic and position the vehicle to use the gap. The length is measured beginning at the point that the left edge of traveled way for the ramp is 10 ft from the right edge of traveled way of the main line to the ending of the acceleration lane. The gap acceptance length and the acceleration length overlap with the ending point controlled by the longer of the two.

(c) Single-lane on-connections may be either taper type or parallel type. The taper type is preferred; however, the parallel may be used with justification. Design single-lane taper type on-connections as shown on Figure 940-9a and single lane parallel type on-connections as shown on Figure 940-9b.

(d) For two-lane on-connections, the parallel type is preferred. Design two-lane parallel on-connections as shown on Figure 940-9c. A capacity analysis will normally be the basis for determining whether a freeway lane or an auxiliary lane is to be provided.

When justification is documented, a two-lane tapered on-connection may be used. Design two-lane tapered on-connections in accordance with Figure 940-9d.

(5) Off-Connections

Off-connections are the pavement at the beginning of an off-ramp, connecting it to a main lane of a freeway. They have two parts, a taper for maneuvering out of the through traffic and a deceleration lane to slow to the speed of the first curve on the ramp. Deceleration is not assumed to take place in the taper.

Off-connections are either taper type or parallel type. The taper type is preferred because it fits the path preferred by most drivers. When a parallel type connection is used, drivers tend to drive directly for the ramp and not use the parallel lane. However, when a ramp is required on the outside of a curve, the parallel off-connection is preferred. An advantage of the parallel connection is that it is narrower at the beginning of the ramp.

(a) Provide the minimum deceleration lane length given on Figure 940-10 for all off-ramps. When the grade of the deceleration lane is 3% or greater, multiply the distance from the Minimum Deceleration Lane Length table by the factor from the Adjustment Factor for Grades table. Design the deceleration lane to provide a higher speed than the ramp to accommodate the changing speed of the exiting traffic.

The deceleration lane is measured from the point where the taper reaches a width of 12 ft to the first point designed at the ramp design speed (often the PC of the first ramp curve). When the first curve is designed for at least the posted speed of the freeway, its length may be included as part of the deceleration length.

(b) Gores, Figure 940-11, are decision points that must be clearly seen and understood by approaching drivers. In a series of interchanges along a freeway, it is desirable that the gores be uniform and have the same appearance to the drivers.

The minimum distance from the physical nose to the gore nose is 90 ft (see figure 940-11).

In addition to striping, raised pavement marker rumble strips may be placed for additional warning and delineation at gores. See the Standard Plans for striping and rumble strip details.

The accident rate in the gore area is greater than at other locations. Keep the unpaved area beyond the gore nose as free of obstructions as possible to provide a clear recovery area. Grade this unpaved area as nearly level with the roadways.
as possible. Avoid placing obstructions such as heavy sign supports, luminaire poles, and structure supports in the gore area.

When a major obstruction must be placed in a gore area, provide an impact attenuator (Chapter 720) and barrier (Chapter 710). Place the beginning of the attenuator as far back as possible, preferably after the gore nose.

(c) For single-lane off-connections, the taper type is preferred. Use the design shown on Figure 940-12a for tapered single-lane off-connections. When justification is documented, a parallel single-lane off-connection, as shown on Figure 940-12b, may be used.

(d) The single-lane off-connection with one lane reduction, Figure 940-12c, is only used when the conditions from lane balance for a single lane exit, one lane reduction, are met.

(e) The tapered two-lane off-connection design shown on Figure 940-12d is preferred where the number of freeway lanes is to be reduced, or where high volume traffic operations will be improved by the provision of a parallel auxiliary lane and the number of freeway lanes is to be unchanged.

The parallel two-lane off-connection, Figure 940-12e, allows less operational flexibility than the taper, requiring more lane changes. Use a parallel two-lane off-connection only with justification.

(6) Collector Distributor Roads

A C-D road can be within a single interchange, through two closely spaced interchanges, or continuous through several interchanges. Design C-D roads that connect three or more interchanges to be two lanes wide. All others may be one or two lanes in width, depending on capacity requirements. Consider intermediate connections to the main line for long C-D roads. See Figure 940-13a for designs of collector distributor outer separations. Use Design A, with concrete barrier, when adjacent traffic in either roadway is expected to exceed 40 mph. Design B, with mountable curb, may be used only when adjacent traffic will not exceed 40 mph.

(a) The details shown in Figure 940-13b apply to all single-lane C-D road off-connections. Where conditions require two-lane C-D road off-connections, a reduction in the number of freeway lanes, the use of an auxiliary lane, or a combination of these, design it as a standard off-connection per 940.06(5).

(b) Design C-D road on-connections as required by Figure 940-13c.

(7) Loop Ramp Connections

Loop ramp connections at cloverleaf interchanges are distinguished from other ramp connections by a low speed ramp on-connection followed closely by an off-connection for another low speed ramp. The loop ramp connection design is shown on Figure 940-14. The minimum distance between the ramp connections is dependent on a weaving analysis. When the connections are spaced far enough apart that weaving is not a consideration, design the on-connection per 940.06(4) and off-connection per 940.06(5).

(8) Weaving Sections

Weaving sections are highway segments where one-way traffic streams cross by merging and diverging. Weaving sections may occur within an interchange, between closely spaced interchanges, or on segments of overlapping routes. Figure 940-15 gives the length of the weaving section required for the total weaving traffic in equivalent passenger cars. The total weaving traffic is the sum of the traffic entering from the ramp to the main line and the traffic leaving the main line to the exit ramp. For trucks, a passenger car equivalent of two may be estimated. Design weaving sections in accordance with the Highway Capacity Manual.

Because weaving sections cause considerable turbulence, interchange designs that eliminate weaving or remove it from the main roadway are desirable. Use C-D roads for weaving between closely spaced ramps when adjacent to high speed highways. C-D roads are not required for weaving on low speed roads.
940.07 Ramp Terminal Intersections at Crossroads

Design ramp terminal intersections at grade with crossroads as intersections at grade. (See Chapter 910.) Whenever possible, design ramp terminals to discourage wrong way movements. Review the location of ramp intersections at grade with crossroads to ensure signal progression if the intersection becomes signalized in the future. Provide intersection sight distance as described in Chapter 910.

In urban and suburban areas match design speed at ramp terminal to the speed of the crossroad. Provide steeper intersection angles between the ramp terminal and crossroad to slow motor vehicle traffic speeds and reduce crossing distances for bicyclists and pedestrians.

The intersection configuration requirements for ramp terminals is normally the same as for other intersections. One exception to this is an angle point is allowed between an off ramp and an on ramp. This is because the through movement of traffic getting off the freeway, going through the intersection, and back on the freeway is minor.

Another exception is at ramp terminals where the through movement is eliminated (for example at a Single Point interchange). For ramp terminals that have two wye connections, one for right turns and the other for left turns, and no through movement the intersection angle has little meaning and does not need to be considered.

940.08 Interchanges on Two-Lane Highways

Occasionally, the first stage of a conventional interchange will be built with only one direction of the main roadway and operated as a two-lane two-way roadway until the ultimate roadway is warranted and construction completed.

The design of interchanges on two-lane two-way highways may vary considerably from traditional concepts due to the following conditions:

- The potential for center-line-crossing related accidents due to merge conflicts or motorist confusion.
- The potential for wrong way or U-turn movements.
- Future construction considerations.
- Traffic type and volume.
- The proximity to multilane highway sections that might influence the driver’s impression that these roads are also multilane.

The deceleration taper is required for all exit conditions. Design the entering connection with either the standard acceleration taper or a “button hook” type configuration with a stop condition before entering the main line. Consider the following items:

- Design the stop condition connection in accordance with the requirements for a Tee intersection in Chapter 910. Use this type of connection only when an acceleration lane is not possible. Provide decision sight distance as described in Chapter 650.

- Since each design will probably vary from project to project, analyze each project for most efficient signing placement such as one way, two way, no passing, do not enter, directional arrows, guide posts, and traffic buttons.

- Prohibit passing through the interchange area on two lane highways by means of signing, pavement marking, or a combination of both. A 4 ft median island highlighted with raised pavement markers and diagonal stripes is the preferred treatment. When using a 4 ft median system, extend the island 500 ft beyond any merging ramp traffic acceleration taper. The width for the median can be provided by reducing each shoulder 2 ft through the interchange. (See Figure 940-16.)

- Inform both the entering and through motorists of the two-lane two-way characteristic of the main line. Include signing and pavement markings.

- Use as much of the ultimate ramp and throughway roadway system as possible. Where this is not possible, leave the area for future lanes and roadway ungraded.
• Design and construct temporary ramps as if they were permanent unless second stage construction is planned to rapidly follow the first. In all cases, design the connection to meet the safety needs of the traffic. (See Figure 940-16.)

940.09 Interchange Plans

Figure 940-17 is a sample showing the general format and data required for interchange design plans.

Compass directions (W-S Ramp) or crossroad names (E-C Street) may be used for ramp designation to realize the most clarity for each particular interchange configuration and circumstance.

Include the following as applicable:

• Classes of highway and design speeds for main line and crossroads (Chapter 440).
• Curve data on main line, ramps, and crossroads.
• Numbers of lanes and widths of lanes and shoulders on main line, crossroads, and ramps.
• Superelevation diagrams for the main line, the crossroad, and all ramps (may be submitted on separate sheets).
• Channelization (Chapter 910).
• Stationing of ramp connections and channelization.
• Proposed right of way and access control treatment (Chapter 1420).
• Delineation of all crossroads, existing and realigned (Chapter 910).
• Traffic data necessary to justify the proposed design. Include all movements.

Prepare a preliminary contour grading plan for each completed interchange. Show the desired contours of the completed interchange including details of basic land formation, slopes, graded areas or other special features. Coordinate the contour grading with the drainage design and the roadside development plan.

Alternative designs considered, studied, and rejected may be shown as reduced scale diagrams with a brief explanation of the advantages and disadvantages of the alternative designs, including the recommended design.

940.10 Documentation

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

- Interchange plan
- Access Point Decision Report (Chapter 1425)
- On-connection type justification
- Off-connection type justification
- Justification for ramp metering main line speed reduction
- Weaving analysis and design
- Alternative discussion and analysis
Basic Interchange Patterns
Figure 940-4
L = Minimum distance in feet from nose to nose. The nose is the beginning of the unpaved area within the gore for an exit and the ending of the unpaved area for an entrance.

A Between two interchanges connected to a freeway, a system interchange\(^2\) and a service interchange\(^3\).

B Between two interchanges connected to a C-D road, a system interchange\(^2\) and a service interchange\(^3\).

C Between two interchanges connected to a freeway, both service interchanges\(^3\).

D Between two interchanges connected to a C-D road, both service interchanges\(^3\).

Notes:
These recommendations are based on operational experience, need for flexibility, and adequate signing. Check them in accordance with Figure 940-15 and the procedures outlined in the Highway Capacity Manual and use the larger value.

1 With justification, these values may be reduced for cloverleaf ramps.

2 A system interchange is a freeway to freeway interchange.

3 A service interchange is a freeway to local road interchange.

Minimum Ramp Terminal Spacing
Figure 940-5
Lane Balance

*Number of lanes, F, may be more by one lane only, provided the lane dropped is an auxiliary lane between closely spaced entrance and exit ramps.
Lane Balance
Figure 940-6b

UNDESIRABLE  Lane balance but no compliance with basic number of lanes.

UNDESIRABLE  No lane balance but compliance with basic number of lanes.

DESIRABLE  Compliance with both lane balance and number of lanes.
Main Line Lane Reduction Alternatives

Figure 940-7
### Acceleration Lane Length

**Highway Design Speed (mph)**

<table>
<thead>
<tr>
<th>Highway Design Speed (mph)</th>
<th>Ramp Design Speed (mph)</th>
</tr>
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<tbody>
<tr>
<td></td>
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<tr>
<td>30</td>
<td>180</td>
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<tr>
<td>70</td>
<td>1495</td>
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<td>80</td>
<td>1885</td>
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**Minimum Acceleration Lane Length (ft)**

<table>
<thead>
<tr>
<th>Highway Design Speed (mph)</th>
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<th>Up Grade</th>
<th>Down Grade</th>
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</thead>
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<td></td>
<td></td>
<td>20</td>
<td>30</td>
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<tr>
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<td>1.5</td>
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<tr>
<td>50</td>
<td>or more</td>
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<td>60</td>
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<td>1.9</td>
</tr>
<tr>
<td>70</td>
<td>or more</td>
<td>2.0</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**Adjustment Factors for Grades Greater than 3%**

**Acceleration Lane Length**

*Figure 940-8*
On-Connection (Single-Lane, Taper Type)

Figure 940-9a

Notes:

(1) See Figure 940-8 for acceleration lane length $L_A$.

(2) Point A is the PT of the last curve designed at the ramp design speed.

(3) A transition curve with a minimum radius of 3,000 ft is desirable. The desirable length is 300 ft. When the main line is on a curve to the left, the transition may vary from a 3,000 ft radius to tangent to the main line.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.
Notes:

1. See Figure 940-8 for acceleration lane length $L_A$.
2. Point $A$ is the PT of the last curve designed at the ramp design speed.
3. A transition curve with a minimum radius of 3,000 ft is desirable. The desirable length is 300 ft. When the main line is on a curve to the left, the transition may vary from a 3,000 ft radius to tangent to the main line.
4. $L_g$ is the gap acceptance length. It is desirable that 300 ft be provided from the ramp PT to the end of the on-connection lane.
5. For striping, see the Standard Plans.
6. For ramp lane and shoulder widths, see Figure 940-3.
Notes:

(1) See Figure 940-8 for acceleration lane length $L_A$.

(2) Point $A$ is the PT of the last curve designed at the ramp design speed.

(3) A transition curve with a minimum radius of 3,000 ft is desirable. The desirable length is 300 ft. When the main line is on a curve to the left, the transition may vary from a 3,000 ft radius to tangent to the main line.

(4) $L_g$ is the gap acceptance length. It is desirable that 300 ft be provided from the ramp PT to the end of the on-connection lane.

(5) Added lane or 1,500 ft auxiliary lane, plus 600 ft taper.

(6) For striping, see the Standard Plans

(7) For ramp lane and shoulder widths, see Figure 940-3.
Notes:

(1) See Figure 940-8 for acceleration lane length $L_A$.

(2) Point $A$ is the PT of the last curve designed at the ramp design speed.

(3) A transition curve with a minimum radius of 3,000 ft is desirable. The desirable length is 300 ft. When the main line is on a curve to the left, the transition may vary from a 3,000 ft radius to tangent to the main line.

(4) Added lane or 1,500 ft auxiliary lane, plus 600 ft taper.

(5) For striping, see the Standard Plans

(6) For ramp lane and shoulder widths, see Figure 940-3.
Deceleration Lane length

**Figure 940-10**

<table>
<thead>
<tr>
<th>Highway Design Speed (mph)</th>
<th>Ramp Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>30</td>
<td>235</td>
</tr>
<tr>
<td>40</td>
<td>335</td>
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<tr>
<td>50</td>
<td>425</td>
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<td>60</td>
<td>530</td>
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<tr>
<td>70</td>
<td>605</td>
</tr>
<tr>
<td>80</td>
<td>710</td>
</tr>
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</table>

**Minimum Deceleration Length (ft)**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Up Grade</th>
<th>Down Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>3% to less than 5%</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>5% or more</td>
<td>0.8</td>
<td>1.35</td>
</tr>
</tbody>
</table>

**Adjustment Factors for Grades Greater than 3%**
W = The sum of the main line shoulder width and the ramp shoulder width, but not less than 10 ft
Notes:

(1) See Figure 940-10 for deceleration lane length \( L_D \).
(2) Point \( A \) is the PC of the first curve designed at the ramp design speed.
(3) For striping, see the Standard Plans.
(4) For ramp lane and shoulder widths, see Figure 940-3.

For striping details, see the Standard Plans.
Notes:
(1) See Figure 940-10 for deceleration lane length $L_D$.
(2) Point $A$ is the PC of the first curve designed at the ramp design speed.
(3) For striping, see the Standard Plans.
(4) For ramp lane and shoulder widths, see Figure 940-3.
Notes:

(1) See Figure 940-10 for deceleration lane length $L_D$.

(2) Point $A$ is the PC of the first curve designed at the ramp design speed.

(3) Auxiliary lane between closely spaced interchanges to be dropped.

(4) For striping, see the Standard Plans.

(5) For ramp lane and shoulder widths, see Figure 940-3.

**Desirable Minimum**

<table>
<thead>
<tr>
<th>T (mph)</th>
<th>min L (ft)</th>
<th>in’ (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>620</td>
<td>2.52</td>
</tr>
<tr>
<td>15</td>
<td>465</td>
<td>3.49</td>
</tr>
</tbody>
</table>

Off-Connection (Single-Lane, One-Lane Reduction)

Figure 940-12c
Notes:

(1) See Figure 940-10 for deceleration lane length $L_D$.
(2) Point A is the PC of the first curve designed at the ramp design speed.
(3) Lane to be dropped or auxiliary lane with a minimum length of 1,500 ft with a 300 ft taper.
(4) For striping, see the Standard Plans.
(5) For ramp lane and shoulder widths, see Figure 940-3.

Off-Connection (Two-Lane, Taper Type)

Figure 940-12d
Notes:
(1) See Figure 940-10 for deceleration lane length $L_D$.
(2) Point $A$ is the PC of the first curve designed at the ramp design speed.
(3) Lane to be dropped or auxiliary lane with a minimum length of 1,300 ft with a 300 ft taper.
(4) For striping, see the Standard Plans.
(5) For ramp lane and shoulder widths, see Figure 940-3.
Drainage as required, both sides of the barrier.

Concrete barrier (Single Slope shown)

* min 2%
max 10%

10 ft Shoulder
6 ft min
6 ft min
2 ft
15 ft min
8 ft Shoulder

**Design A**

10 ft Shoulder
2 ft
15 ft min Collector Distributor Road
8 ft Shoulder

**Design B: For Facilities With Speeds of 40 mph or Less Only**

Edge of thru-lane

With justification, the concrete barrier may be placed with 2 ft shy distance from the edge of either shoulder to the face of barrier. The minimum width between the edge of through-lane and the edge of C-D road will be reduced to 18 ft, and the radius at the nose will be reduced to 3 ft.

**Collector Distributor (Outer Separations)**

*Figure 940-13a*
Notes:

(1) See Figure 940-10 for deceleration lane length $L_D$.

(2) Point $A$ is the PC of the first curve designed at the ramp design speed.

(3) For striping, see the Standard Plans.

Collector Distributor (Off-Connections)

Figure 940-13b
Notes:

(1) See Figure 940-8 for acceleration lane length $L_A$.

(2) Point $A$ is the PT of the last curve designed at the ramp design speed.

(3) A transition curve with a minimum radius of 3,000 ft is desirable. The desirable length is 300 ft. When the main line is on a curve to the left, the transition may vary from a 3,000 ft radius to tangent to the main line.

(4) For striping, see the Standard Plans.

Collector Distributor (On-Connections)

Figure 940-13c
Note:
See Figure 940-15 for required minimum weaving length.

**Loop Ramps Connections**

*Figure 940-14*
Length of Weaving Sections

Figure 940-15
Temporary Ramps

Figure 940-16

Standard on connection

Standard off connection

Future lanes

200 ft Taper

500 ft

8 ft min

6 ft min

4 ft
In other urban areas and in rural areas, crossovers may be necessary to a law enforcement plan.

A crossover that is primarily for governmental service vehicles may be justified on the basis that access through interchanges or intersections is not practical. In urban areas where there are 3 or more miles between access points, providing an unobtrusive crossover may improve emergency service or improve efficiency for traffic service and maintenance forces.

Locate rural crossovers 3 or more miles from an interchange.

Where crossovers are justified and used for winter maintenance operations such as snow and ice removal, the interchange or intersection spacing rule does not apply and the distance from the ramp merge or diverge points may be decreased to a 500-ft minimum with 1,000 ft the desirable minimum.

Minimize visibility of the crossover to the traveling public.

960.03 Design

Consider the following design criteria for all median crossovers. However, taking into consideration the intended vehicle usage, some of the criteria may not apply to crossovers intended primarily for enforcement.

- Adequate median width at the crossover location is required to allow the design vehicle to complete a U-turn maneuver without encroaching within 8 ft of the traffic lanes, and without backing. The common design vehicles for this determination are a passenger car and a single unit truck depending upon the intended use of the crossover. Generally the minimum recommended median width is 40 ft.

- Use grades and radii that are suitable for all authorized user vehicles.

- Provide adequate inside shoulders to allow vehicle deceleration and acceleration to occur off the traffic lanes. Ten-foot inside
shoulders are adequate for most cases. Provide full 10-foot shoulders for a distance of 450 ft upstream of the crossover area to accommodate deceleration, and extend downstream of the crossover area for a distance of 600 ft to allow acceleration prior to entering the traffic lane.

- 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 traffic lanes, use conservative values for stopping sight distance. (See the Roadside Classification Plan.)

- Use side slopes of the crossing no steeper than 10H:1V. Grade for a relatively flat and gently contoured appearance that is inconspicuous to the public.

- Do not use curbs or pavement markings.

- Flexible guide posts may be provided for night reference. (See 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-ft year-round maximum height is recommended for this purpose. (See Chapter 1300).

- In locations where vegetation cannot be used to minimize visibility and there is a high incidence of unauthorized use, appropriate signing (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. Other urban crossovers may be paved if unauthorized use is minimized. Rural crossovers are not usually paved in order to be inconspicuous.

960.04 Approval

All existing and planned crossover locations will be designated on a corridor or regional 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 Olympia Service Center Access Engineer and the FHWA Safety and Operations Engineer or equivalents will be responsible for establishing and updating this plan yearly with proposed new crossings and removal of crossings that are no longer necessary.

Regional Administrators are responsible for the design and construction of median crossovers. Prior to construction of the opening, submit the documentation of crossover and the design data (together with a right-of-way print showing the opening in red) to the State Design Engineer for right of way or limited access plan approval. Construction should not proceed until approval is received.

After notification of approval, the Olympic Service Center (OSC) 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

☐ Applicable Master Plan for Median Crossovers

☐ Right of way or limited access plans showing approved median crossovers and supporting documents

P65:DP/DM9
1010 Auxiliary Lanes

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.

See the Traffic Manual and the MUTCD for signing of auxiliary lanes.

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.

See the following chapters for additional information:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>910</td>
<td>Turn lanes</td>
</tr>
<tr>
<td>910</td>
<td>Speed change lanes at intersections</td>
</tr>
<tr>
<td>940</td>
<td>Speed change lanes at interchanges</td>
</tr>
<tr>
<td>940</td>
<td>Collector distributor roads</td>
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<td>940</td>
<td>Weaving lanes</td>
</tr>
<tr>
<td>1050</td>
<td>High occupancy vehicle lanes</td>
</tr>
</tbody>
</table>

1010.02 References
Revised Code of Washington (RCW) 46.61, Rules of the Road.

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

Traffic Manual, M 51-02, WSDOT.

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 1994

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.

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.

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. A divided highway has two or more roadways.

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 turnouts  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.

1010.04 Climbing Lanes
(1) General
Normally, climbing lanes 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 is based on a typical heavy truck.

The maximum allowable entrance speed, as reflected on the graphs, is 55 mph. Note that this is the maximum value to be used regardless of the posted speed of the highway. When the posted speed is above 55 mph, use 55 mph in place of the posted speed. Examine the profile at least \( \frac{1}{4} \) mi 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 15 mph speed reduction below the posted speed limit for typical heavy 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 up-grade traffic volume exceeds 200 VPH and the up-grade truck volume exceeds 20 VPH. 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 and 300 ft beyond for 2-lane highways. Consider extending the auxiliary lane over the crest to improve vehicle acceleration and the 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 shoulders at standard width for the class of highway. However, on two-way two-lane highways, the shoulder may be reduced to 4 ft 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 if 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 mi can cause the driver to lose the sense that the highway is basically a two-lane facility.
Passing lanes are preferably four-lane sections. A three-lane section may be used, however. 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 ft. 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, by RCW 46.61.427, to turn off the through lane wherever a safe turnout exists, in order to permit the following vehicles 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 ft provides adequate storage, since additional storage is provided within the tapers and shoulders. The maximum length is ½ mi including tapers. Surface turnouts with a stable unyielding material such as BST or ACP with adequate structural strength to support the heavier traffic.

Locate slow vehicle turnouts where at least Design Stopping Sight Distance (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 location and why it was selected.

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 are 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 (Chapter 700)

(2) Design
When designing a shoulder for shoulder driving, use a minimum length of 600 ft. The minimum shoulder width is 8 ft with 10 ft preferred. When barrier is present, the minimum width is 10 ft with 12 ft preferred. 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 are one of 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 ft 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 a smooth, coarse, 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 benefits of gravity to the rolling resistance. However, successful arrester beds have been built on a level or descending grade.

(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 grade, or before a stop. It is desirable that the ramp leave the roadway on a tangent at least 3 mi 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 ft. 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 is documented.

<table>
<thead>
<tr>
<th>Material</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway</td>
<td>1</td>
</tr>
<tr>
<td>Loose crushed aggregate</td>
<td>5</td>
</tr>
<tr>
<td>Loose noncrushed gravel</td>
<td>10</td>
</tr>
<tr>
<td>Sand</td>
<td>15</td>
</tr>
<tr>
<td>Pea gravel</td>
<td>25</td>
</tr>
</tbody>
</table>

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 ft and the minimum width is 26 ft.

(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 in at the entry to a full depth of 18 to 30 in in not less than 100 ft.

- 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 wrecker and maintenance vehicles to remove vehicles and make repairs to the arrester bed. Anchors are desirable at 300 ft 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 Area

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

- Documentation that climbing lane warrant 1 has been met
- Documentation that climbing lane warrant 2 has been met
- Justification for waiving climbing lane warrant 1 or 2
- Justification for passing lanes
- Slow moving vehicle turnout documentation
- Emergency escape ramp documentation
Performance For Heavy Truck

Figure 1010-2a
Given: A 2-lane highway meeting the level of service warrant, with the above profile, and a 55 mph posted speed.

Determine: Is the climbing lane warranted and, if so, how long?

Solution:

1. Follow the 4% grade deceleration curve from a speed of 55 mph to a speed of 40 mph at 1,400 ft. The speed reduction warrant is met and a climbing lane is needed.

2. Continue on the 4% grade deceleration curve to 4,000 ft. Note that the speed at the end of the 4% grade is 25 mph.

3. Follow the 1% grade acceleration curve from a speed of 25 mph for 1,000 ft. Note that the speed at the end of the 1% grade is 34 mph.

4. Follow the -2% grade acceleration curve from a speed of 34 mph to a speed of 40 mph, ending the speed reduction warrant. Note the distance required is 400 ft.

5. The total auxiliary lane length is (4,000-1,400)+1,00+400+300=4,300 ft. 300 ft is added to the speed reduction warrant for a 2-lane highway, see the text and Figure 1010-4.

**Speed Reduction Example**

*Figure 1010-2b*
Level of Service — Multilane

Figure 1010-3

Example
2% grade for 2 km
10% trucks
12 ft lanes
lateral clearance ≥ 6 ft
4 lane, divided
DDHV = 2000
From the chart, climbing lane is recommended.
Auxiliary Climbing Lane

Figure 1010-4
Warrant For Passing Lanes

*Figure 1010-5*

**EXAMPLE**
For a Minor Arterial Given:
- DHV=400 VPH
- 10% Trucks
- 50% No Passing Zones
- Rolling Terrain from the Chart

Passing Lane NOT required.
4-Lane Design

3-Lane Design

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.
Facilities for Nonmotorized Transportation

1020.01 General
1020.02 Definitions
1020.03 Bicycle Facilities
1020.04 Pedestrian Facilities (Walkways)
1020.05 Equestrian and Watercraft Facilities

1020.01 GENERAL

Nonmotorized transportation includes travel by bicyclists, pedestrians, equestrians, and watercraft. Provisions for these travel modes are considered during the project development stage and included where there is demonstrated need. If sufficient funding is available, provisions for nonmotorized transportation may be included where there is the likelihood of substantial use.

These guidelines apply to normal situations encountered during project development. Unique design problems are resolved on a project-by-project basis using other relevant publications or appropriate methods.

State law (46.61.710 RCW) prohibits the operation of mopeds on facilities specifically designed for bicyclists, pedestrians, and equestrians. Mopeds are not considered in the design process for the purposes of this chapter.

1020.02 DEFINITIONS

Bikeway Any trail, path, part of a highway or shoulder, sidewalk, or any other travelway specifically signed and/or marked for bicycle travel.

Class I Bikeway (Bike Path) A separate trail for the principal use of bicycles.

Class II Bikeway (Bike Lane) A portion of a highway that is designated by signs and/or pavement markings for preferential bicycle use.

Class III Bikeway (Bike Route) A highway that is designated with signs as a bicycle route and is shared with other transportation modes.

Class IV Bikeway (Shared Roadway With No Designation) A publicly maintained facility that is not designated with signs and/or pavement markings as a bikeway, but is accessible to bicyclists.

Equestrian Trail Any designated trail on which horses are permitted to travel.

Pedestrian Walkway A continuous way designated for pedestrians and separated from the through lanes for motor vehicles by a physical barrier or space.

Water Trail A water-oriented trail which provides a designated route to, on, or along fresh and/or salt water in which the water is the primary point of interest.

1020.03 BICYCLE FACILITIES

(1) General

Normally, bikeways are shared with other transportation modes, although they may be provided exclusively for bicycle use. Bicycle facilities are designed to the standards for low speed roadways.

Properly designed facilities can accommodate bicyclists of all levels of skill, whereas an improperly designed facility will frequently be avoided by bicyclists.

In the development of shoulder widening projects along existing highways with short areas of restricted width, such as bridges, cuts, or fills, the widening can be quite costly. However, the presence of these short areas does not diminish the importance of widening the adjoining shoulder sections.

(2) Planning

Bikeway planning is an effort to provide for safe and efficient bicycle travel. An effective program recognizes that most highways can be upgraded to accommodate shared use by bicyclists and motorists.

The important consideration in an effort to enhance bicycle travel is the upgrading of existing networks of roads that are used regularly by bicyclists, regardless of whether bikeways are designated. The upgrading includes improving the width and quality of the surface and maintaining the right-hand portion in a condition suitable for bicycle riding. Consideration of bicycle needs is also important in the design of major construction projects and normal safety and operational improvements.

Bikeway planning is an integral part of the planning for other transportation modes and land use development. The location criteria and miscellaneous bikeway criteria that follow are to be used for long-term planning and project development as applicable.

(3) Selection of the Type of Facility

The type of facility to select in meeting the bicycle need is dependent on many factors, but the following applications are the most common for each type:

(a) Class I Bikeway (Bike Path). Generally, bike paths are used to serve corridors not served by streets and highways or where wide rights of way exist, permitting such facilities to be constructed away from the influence of parallel streets. Bike paths should offer opportunities not provided by the road system. They can either provide a recreational opportunity or, in some instances, can serve as direct high-speed commute routes, if cross-flow by motor vehicles can be
minimized. The most common applications are along rivers, ocean fronts, canals, utility rights of way, abandoned railroad rights of way, within college campuses, or within and between parks. There may also be situations where such facilities can be provided as part of planned developments. Another common application of Class I facilities is to close gaps to bicycle travel caused by construction of freeways, or because of the existence of natural barriers (rivers, mountains, etc.).

(b) Class II Bikeway (Bike Lane). Bike lanes are established along streets in corridors where there is significant bicycle demand, and where there are distinct needs that can be served by them. The purpose is to improve conditions for bicyclists in the corridors. Bike lanes are intended to delineate the rights of way assigned to bicyclists and motorists and to provide for more predictable movements by each. An important reason for constructing bike lanes is to better accommodate bicyclists through corridors where insufficient room exists for safe bicycling on existing streets. This can be accomplished by reducing the number of lanes, or prohibiting parking on given streets in order to delineate bike lanes. The number of vehicular traffic lanes may be reduced only if it does not reduce the highway's level of service below that appropriate for the highway class. Also, parking may be prohibited if it can be demonstrated that sufficient alternative parking is available to serve the needs of the motorized traffic. In addition, other things can be done on bike lane streets to improve the situation for bicyclists, that might not be possible on all streets (e.g., improvements to the surface; augmented sweeping programs, special signal facilities, etc.). Generally, stripes alone will not measurably enhance bicycling.

When selecting appropriate streets for bike lanes, refer to the location criteria discussed in 1020.03(4) for factors to be considered.

(c) Class III Bikeway (Bike Route). Bike routes are shared facilities that serve either to provide continuity to other bicycle facilities (Class II bikeways), or to designate preferred routes through high bicycle-demand corridors. As with bike lanes, designation of bike routes is an indication to bicyclists that there are particular advantages to using these routes as compared with alternative routes. This means that responsible agencies have taken action to assure that these routes are suitable as shared routes and will be maintained in a manner consistent with the needs of bicyclists. Normally, bike routes are shared with motor vehicles. The use of sidewalks as Class II or III bikeways is strongly discouraged.

(d) Class IV, Shared Roadway (Shared Roadway With No Bikeway Designation). In some instances, entire street systems are fully adequate for safe and efficient bicycle travel, and signage and striping for bicycle use would be unnecessary. In other cases, routes are inherently unsafe for bicycle travel and it would be inappropriate to encourage additional bicycle travel by designating the routes as bikeways. Finally, if the routes are not along high bicycle-demand corridors, it would be inappropriate to designate bikeways regardless of roadway conditions (e.g., on minor residential streets).

Many rural highways are used by experienced bicyclists for intercity and recreational travel. The development and maintenance of 4-foot paved roadway shoulders with a standard edge stripe can significantly improve the safety and convenience for bicyclists and motorists along such routes. This should be a goal to work towards. However, in most cases, it would be inappropriate to designate the highways as bikeways because of the limited use and the lack of continuity with other bike routes.

It is emphasized that the designation of bikeways as Class I, II, III, and IV should not be construed as a hierarchy of bikeways - that one is better than the other. Each class of bikeway has its appropriate application.

In selecting the proper facility, an overriding concern is to assure that the proposed facility will not encourage or require bicyclists or motorists to operate in a manner that is inconsistent with the rules of the road.

An important consideration in selecting the type of facility is continuity. Alternating segments of Class I and Class II (or Class III) bikeways along a route are generally incompatible, as street crossings by bicyclists are required when the route changes character. Also, wrong-way bicycle travel will occur on the street beyond the ends of bike paths because of the inconvenience of having to cross the street.

(4) Location Criteria

Among the factors to consider in determining proper location of a Class I, II, or III bikeway are the following:

(a) Potential Use. Locate bikeways along corridors where use is or can be maximized. Along highways with high vehicular traffic, a close parallel street or road should be used unless there is adequate width to develop a separate bikeway. However, to be attractive to commuting bicyclists, the street must offer through route conditions.

(b) Directness. Locate facilities along a direct line and in such a way that they connect traffic generators for the convenience of the users.

(c) Access. When locating a Bike Path (Class I bikeway), consideration should be given to providing adequate access points. The more frequent and convenient the access points, the more the facility
(d) **Available Width.** For an on-street bikeway (Class II or III bikeway), the overall roadway width must meet or exceed the highway minimum design criteria (Chapters 430 and 440).

(e) **On-Street Motor Vehicle Parking.** Consider the density of on-street parking and the safety implications, such as opening car doors. If possible, select a route where on-street parking is light or where it can be prohibited.

(f) **Delays.** Bicyclists have a strong desire to maintain momentum. If bicyclists are required to make frequent stops they may tend to avoid the route.

(g) **Traffic Volumes and Speeds.** For an on-street bikeway the speed and volume of auto traffic, along with the available width, are factors in determining the best location. Commuting bicyclists generally ride on arterial streets to minimize delay and because they are normally the only streets offering continuity for trips of several miles.

(h) **Truck and Bus Traffic.** High-speed truck, bus, and recreational vehicle traffic can cause problems along a Class II or III bikeway because of aerodynamic effects and vehicle widths.

(i) **Existing Barriers.** In some areas there are physical barriers to bicycle travel, caused by topographical features such as rivers, limited access highways, or other impediments. In such cases, developing a bikeway crossing of an existing barrier can provide access opportunities for bicyclists.

(j) **Accident History.** It is important to check the accident experiences at a prospective bicycle route to determine its relative safety compared to other candidate routes. This involves careful analysis of the accident types to determine which of them might be reduced. (See 1020.03(4)(o).) Also, the potential for introducing new accident problems needs to be considered.

(k) **Grades.** Steep grades on bikeways are to be avoided if possible. Refer to 1020.03(6) for specific criteria.

(l) **Pavement Surface Quality.** An on-street Class II or III bikeway should be established only where pavement can be brought to a reasonable standard. Dense graded asphalt concrete surfaces are preferable to open-graded or seal-coated surfaces. Refer to 1020.03(5) for additional guidance.

(m) **Maintenance.** Ease of maintenance is an important consideration in locating and developing a bikeway. The main factor to consider is the ease of entry and exit of maintenance vehicles. An improperly maintained bikeway will often be shunned by bicyclists in favor of a parallel roadway.

(n) **Environmental Compatibility.** Scenic value, erosion stability, and compatibility with the surrounding terrain are important for a bikeway whether serving as a recreational facility or for business commuting.

(o) **Use Conflicts.** On-street Class II or III bikeways primarily involve potential conflicts with motor vehicles. Bike paths and Class I bikeways usually involve conflicts with other bicyclists, with pedestrians on the path, and with motor vehicles at street intersections.

(p) **Security.** The potential for criminal acts against bicyclists, especially along remote bicycle paths, and the possibility of theft or vandalism at parking locations, need to be considered.

(q) **Cost/Funding.** Location selection will normally involve a cost comparison analysis of alternatives. Funding availability will often limit the alternatives; however, it is important that a lack of funds not result in a poorly designed or constructed facility. It is usually more desirable not to construct a bicycle facility than to construct a poorly planned or designed facility.

**5 Miscellaneous Bikeway Criteria**

The following miscellaneous bikeway criteria are to be followed, as pertinent, for Class I, II, and III bikeways. Some, by their very nature, will not apply to all classes of bikeway. Many of the criteria are important to consider on any highway where bicycle travel is expected, regardless of whether designated bikeways are established.

(a) **Bridges.** Bikeways on highway bridges must be carefully coordinated with approach bikeways. Bicycle traffic is best accommodated by continuing the approach bikeway across the structure. For a one-way Class I bikeway, refer to 1020.03(6)(a)4.

Where a two-way bike path, Class I bikeway, is carried across one side of a bridge, the following criteria apply:

- Design the bikeway approach to the bridge on a separate two-way facility.
- Provide a physical separation if needed. For criteria regarding when a physical separation is needed, see 1020.03(6)(a)4.

The clear width on structures between railings must not be less than 10 feet for two-way Class I bikeways and 6 feet for one-way Class I bikeways. It is desirable that the clear width on structures be equal to that of the approaching path including the 2 to 3 feet graded areas. The minimum vertical clearance to obstructions across the clear width of the path is 8 feet.

(b) **Maintenance.** Bikeway surfaces should be maintained in a good condition, generally free of potholes, corrugations, gravel, broken glass, and other debris.
(c) Surface Quality. The surface to be used by bicyclists should be smooth and the pavement edge uniform.

(d) Drainage Grates and Manhole Covers. Design the drainage inlet grates, manhole covers, etc. on bikeways in a manner that provides a smooth surface for bicyclists. Grates and manhole covers are to be maintained 0.5 inch below the surface.

Drainage inlet grates on bikeways must have openings narrow enough and short enough to ensure that bicycle tires will not drop into the grates. Where it is not immediately feasible to replace existing grates with standard designs for bicycles or where grate clogging could be a problem, steel cross straps may be installed onto the grates at a spacing of 6 inches to 8 inches on centers, to adequately reduce the size of the openings.

(e) At-Grade Railroad Crossings and Cattle Guards. Whenever a bikeway crosses railroad tracks, the crossing should be at least as wide as the approaches of the bikeway. Wherever possible, the crossing is at right angles to the rails.

For on-street bikeways, Class II or III bikeway, where a skew is unavoidable the shoulder (or bike lane) is widened to permit bicyclists to cross at right angles. If this is not possible, special construction and materials should be considered to keep the flangeway depth and width to a minimum.

Where hazards to bicyclists cannot be avoided, appropriate signs and markings should be installed in accordance with the MUTCD.

(f) Lighting. Proper illumination of bicycle facilities is necessary for provision of minimum levels of safety, security, and visibility. The level of illumination required on a bicycle facility is dependent upon the amount of nighttime use that is expected and the nature of the area the facility is expected to pass. Usually existing roadway illumination should be adequate to provide for safe bicycle travel. Refer to Chapter 840 for additional guidance concerning illumination of bikeways.

(g) Support Facilities. Where bicycles are used extensively for utility trips or commuting, adequate parking and/or storage at common destinations, such as park and ride lots, transit terminals, schools, shopping centers, etc., is desirable. This can be defined by doing a survey of the bicyclists using a particular route.

(6) Design Criteria By Bikeway Class

(a) Class I Bikeway (Bike Path). Class I bike paths are facilities with exclusive rights of way for the principal use of bicycles.

1. Widths. The geometric guidelines for bike paths are shown in Figures 1020-1a and 1020-1b. The paved width for a two-way bike path is 8 feet minimum and 10 feet desirable minimum. A minimum 2-foot wide graded area shall be provided adjacent to the pavement. Where the paved width is wider than the minimum required, the graded area may be reduced accordingly. If the bike path has an embankment height equal to or greater than 10 feet, a 3-foot wide graded area shall be provided adjacent to the pavement.

Where heavy bicycle volumes, adult tricycle traffic, or significant pedestrian traffic is expected, the paved width of a two-way path should be at least 10 feet. A count of 60 bicycles per hour during the peak hour taken on a nice day, constitutes a heavy bicycle volume. Twenty pedestrians per hour in the peak hour conditions described above constitute a significant pedestrian traffic. Contact the district Bicycle Coordinator for bicycle use information.

However, when maintenance vehicles are expected to use the bike path as an access road to utilities, etc., a 12-foot minimum paved width is recommended. Experience has shown that paved paths less than 12 feet wide sometimes break up along the edge as a result of loads from maintenance vehicles.

The minimum paved width for a one-way bike path is 5 feet. The development of a one-way bike path should be undertaken only after careful consideration due to the problems of enforcing one-way operation and the difficulties in maintaining a path of restricted width.

2. Clearance to Obstructions. The minimum horizontal clearance from the edge of pavement to an obstruction is 2 feet. Where minimum clearances to obstructions cannot be obtained, signs and pavement markings are installed to warn bicyclists of the condition.

3. Intersections with Highways. Intersections are a prime consideration in bike path design. At grade crossings occur at existing intersections or existing pedestrian crossings where motorists can be expected to stop. If alternate intersection locations for a bike path are available, the one with the most sight distance should be selected.

Whenever possible, a crossing is placed away from the influence of an intersection, to eliminate conflicts.

4. Outer Separations Between Class I Bikeways and Highways. Separation is recommended between Class I bikeways and adjacent highways. Class I bikeways closer than 5 feet to the edge of
a roadway must include a physical divider for posted highway speeds above 35 mph to prevent bicyclists from encroaching onto the highway. A suitable divider will include a concrete barrier Type 4, chain link fence, or a hedge. The physical separation should be at least 4.5 feet high, in order to minimize the likelihood of bicyclists falling over. Standard bridge railings which are lower than 4.5 feet can be retrofitted with additional railings or with chain link fence, suitable to restrain bicyclists. (Refer to Figure 1020-1c.) Vertical concrete surfaces adjacent to bicyclists or pedestrian facilities should be smooth to avoid snagging of clothing or abrasive injuries from contact with the surface. Where bicyclists use facilities located behind guardrail, the protruding bolts on the guardrail should be cut off.

5. Bike Paths in the Median of Highways. Bike paths in the median of highways are not recommended.

6. Design Speed. The proper design speed for a bike path is dependent on the expected conditions of use and on the terrain.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Min. Design Speed MPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Country (level or undulating);</td>
<td>20</td>
</tr>
<tr>
<td>Separate Bike Path in Urban Areas</td>
<td></td>
</tr>
<tr>
<td>Long Down Grades (steeper than 4% and longer than 500 feet)</td>
<td>30</td>
</tr>
</tbody>
</table>

Speed bumps or other similar surface obstructions intended to cause bicyclists to slow down in advance of intersections are not to be used.

7. Horizontal Alignment and Superelevation. Minimum recommended curve radii and superelevations for various design speeds are shown in Figure 1020-2. Superelevation transitions for bikeways are the same as those specified for ramp curves prorated for W/L = 10 feet (refer to Chapter 640). When minimum curve radii are selected, increased pavement width of up to 4 feet on the inside of the curve is recommended to compensate for bicyclist lean (see Figure 1020-3). In sharp curve conditions, consider center line striping for Class I bikeways.

A straight 2 percent cross slope is recommended on tangent. The maximum superelevation is 5 percent. Superelevation greater than 5 percent will slow bicyclists and adult tricyclists may have maneuvering difficulties (see Figure 1020-2).

8. Stopping Sight Distance. Figure 1020-4 indicates the minimum stopping sight distances for various design speeds and grades. The descending direction controls the design for two-way bike paths. Design speeds for both directions combined need to be considered. Passing sight distance is not considered due to the relatively low speed of bicyclists.

9. Length of Crest Vertical Curves. Figure 1020-5, Sight Distance For Crest Vertical Curves, indicates the minimum lengths of crest vertical curves for varying design speeds.

10. Lateral Clearance on Horizontal Curves. Figure 1020-6 indicates the minimum clearances to line-of-sight obstructions for horizontal curves. The lateral clearance is obtained by entering on the chart the stopping sight distance from Figure 1020-4 and the proposed horizontal curve radius. Where minimum clearances cannot be obtained, appropriate signs and pavement markings are installed to warn bicyclists of the condition.

11. Grades. Bicyclists who are not physically in condition, are less skilled, or are riding poorly maintained bikes will be unable to negotiate long, steep uphill grades. Long downgrades can also cause problems. For these reasons, bike paths with long, steep grades will generally receive very little use. The maximum grade rate recommended for bike paths is 5 percent. It is desirable that sustained grades be limited to 2 percent if a wide range of riders is to be accommodated.

Steep grades of 5 to 10 percent can be tolerated for short segments up to about 500 feet. Where the steeper grades are necessary, the design speed is increased and additional width of 3 feet is provided for maneuverability.

12. Structural Section. Design the structural section of a bike path in the same manner as a highway, giving consideration to the quality of the subgrade and the anticipated loads the bikeway will experience. Principal loads will normally be from maintenance and emergency vehicles.

Unless otherwise justified, Asphalt Concrete Pavement (ACP) is used in the construction of a bicycle facility. Asphalt concrete pavement 0.20-feet thick will not need surfacing material when the subgrade R value is more than 65. But if the R value is between 40 to 65, the depth of the surfacing material should be a minimum of 0.15 feet. If the subgrade R value is less than 40, the depth of the surfacing material should be a minimum 0.35 feet.

13. Drainage. For proper drainage, the surface of a bike path has a cross-slope of 2 percent. Sloping in one direction usually simplifies longitudinal drainage design and surface construction and is the preferred practice. Ordinarily, surface...
drainage from the path will be adequately dissipated as it flows down the gently sloping shoulder. However, a bike path constructed on the side of a hill, may require a drainage ditch of suitable dimensions on the uphill side to intercept the hillside drainage. Where necessary, catch basins with drains are provided to carry intercepted water under the path. Refer to Chapter 1210 for other drainage criteria.

14. Barrier Posts. Barrier posts may be installed at entrances to bike paths to prevent motor vehicles from entering. A barrier post is used only if operational problems demand it; for instance, if there is a policing problem at the site under consideration. When locating such installations, ensure that barriers are well-marked and visible to bicyclists, day or night (e.g., by installing reflectors or reflectorized tape). The barriers must be at least 30 inches in height.

Where more than one post is necessary, a 5-foot spacing is used to permit passage of bicycle-towed trailers and adult tricycles and to ensure adequate room for safe bicycle passage without dismounting. Design barrier post installations so they are removable, to permit entrance by emergency and service vehicles, and breakaway when in the lateral clearance area.

15. Signing and Striping. Refer to MUTCD for guidance and directions for signing and striping of bikeways. A yellow center line stripe is beneficial to separate opposing directions of travel where there is heavy use, on curves where there is restricted sight distance, and where the path is unlighted and nighttime riding is expected.

(b) Class II Bikeway (Bike Lane). Class II bikeways (bike lanes) for preferential use by bicycles are established within the paved area of highways. Bike lane stripes are intended to promote an orderly flow of traffic, by establishing specific lines of demarcation between areas reserved for bicycles and lanes to be occupied by other vehicles. This effect is supported by bike lane signs and pavement markings. Bike lanes are one-way facilities. Two-way bike lanes are not permitted, as such facilities have proved unsatisfactory.

1. Widths. Some typical Class II bikeway configurations are illustrated in Figure 1020-7 and are described below:

Figure 1020-7, Design A, depicts bike lanes on an urban-type curbed street where parking stalls (or continuous parking stripes) are marked. Bike lanes are located between the parking area and the traffic lanes. Minimum widths are shown.

Bike lanes are not placed between the parking area and the curb. Such facilities create hazards for bicyclists, with opening car doors and poor visibility at intersections. Also, they prevent bicyclists from leaving the bike lane to turn left, and cannot be effectively maintained.

Figure 1020-7, Design B, depicts bike lanes on an urban-type curbed street, where parking is permitted. Bike lanes are established in conjunction with the parking areas. As indicated, 12 feet is the minimum width of the bike lane where parking is permitted. This type of lane is satisfactory where parking is not extensive and where turnover of parked cars is infrequent. However, if parking is substantial or turnover of parked cars is high, additional width of 1 to 2 feet is recommended.

Figure 1020-7, Design C, depicts bike lanes along the outer portions of an urban-type curbed street, where parking is prohibited. This is generally the most desirable configuration for bike lanes, as it eliminates potential conflicts resulting from auto parking (e.g., opening car doors). Minimum widths are shown. Both minimum widths shown must be achieved. With a normal 2-foot gutter, the minimum bike lane width is 5 feet.

Figure 1020-7, Design D, depicts bike lanes on a highway without curbs and gutters. Minimum widths are shown. Additional width is desirable, particularly where motor vehicle speeds exceed 40 mph.

Bike lanes are not advisable on long, steep downgrades, where bicycle speeds greater than 30 mph are expected. As grades increase, downhill bicycle speeds will increase, which increases the danger of riding near the edge of the roadway. In such situations, bicycle speeds can approach those of motor vehicles, and experienced bicyclists will generally move into the motor vehicle lanes to increase sight distance and maneuverability.

If the bike lanes are to be located on one-way streets, they are placed on the right side of the street. Bike lanes on the left side would cause potentially hazardous weaving maneuvers between bicyclists and motorists making left turns onto a two-way street.

2. Intersection and Signal Design. Most auto/bicycle accidents occur at intersections. For this reason, bikeway design at intersections is to be accomplished in a manner that will minimize confusion by motorists and bicyclists and will permit both to operate in accordance with the normal rules of the road.

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Figure 1020-8 illustrates a typical intersection of multilane streets, with bike lanes on all approaches. Some common movements of motor vehicles and bicycles are shown. At intersections where there are bike lanes and traffic signals, installation of bicycle-sensitive loop detectors within the bike lane (well in advance of intersections) is desirable. It is also important that loop detectors in left-turn lanes be sensitive enough to detect bicycles. The use of push button actuators at bikeway intersections are not preferred by bicyclists as they must stop to actuate the signal.

Figures 1020-9 and 1020-10 illustrate recommended striping patterns for bike lanes crossing a motorist right-turn-only lane, or freeway off- and on-ramps. When confronted with such intersections, bicyclists will have to merge with right-turning motorists. Since bicyclists are typically traveling at speeds less than motorists, they could signal and merge where there is a sufficient gap in right-turning traffic, rather than at any predetermined location. For this reason, it is recommended that either all delineations are dropped at the approach of the right turn lane (or off-ramp), or that a single, dashed bike lane line be extended at a flat angle across the right turn lane. A pair of parallel lines (delineating a bike lane crossing) to channel the bike merge is not recommended, as bicyclists will be encouraged to cross at a predetermined location, rather than when there is a safe gap in right-turning traffic. Also, some bicyclists are apt to assume they have the right of way and neglect to check for right-turning traffic.

A dashed line across the right-turn-only lane (or off-ramp) is not recommended on extremely long lanes, or where there are double right-turn-only lanes. For these types of intersections, all striping is dropped to permit judgment by the bicyclists to prevail. Bike lanes crossing on-ramps do not present the same problems, as bicyclists normally have a good view of traffic entering the roadway, and will adjust their path to cross ramp traffic. A bike crossing sign is intended for use on highways to warn motorists of the potential for bicyclists crossing the roadway.

For additional guidance on signal design at intersections involving Class II bikeways, refer to Chapter 850.

3. Signing and Striping. Use the general guidelines for signing and striping in the MUTCD, Part IX, for acceptable signing and striping criteria. Additional guidelines are shown on Figure 1020-7.

(c) Class III Bikeways (Bike Routes). Bike routes are intended to provide continuity to the bikeway system. Bike routes are established along through routes not served by bike paths or bike lanes (Class I or II bikeways), or to connect discontinuous segments of bikeways. Bike routes are shared facilities, normally with motor vehicles on the street, or occasionally with pedestrians on sidewalks; in either case, bicycle usage is secondary.

Bike routes are established by placing the MUTCD Bike Route sign along highways. Since bicyclists are permitted on all highways (except prohibited portions of limited access highways), the decision to sign the route is based on the following factors:

1. On-Street Bike Route Criteria:
   - The route offers a higher degree of service than alternative streets.
   - It provides for through and direct travel in bicycle-demand corridors.
   - It connects discontinuous segments of bikeways.
   - An effort has been made to adjust traffic control devices for bicyclists.
   - Street parking is restricted for improved safety where lane width is critical.
   - Surface hazards to bicyclists have been corrected.
   - Maintenance of the route is to a higher standard than comparable streets, such as more frequent street sweeping and repair.

2. Sidewalks. Generally, the designated use of sidewalks for bicycle travel is unsatisfactory, for the following reasons:
   - Sidewalks tend to be used in both directions, despite any signing to the contrary.
   - At approaches to intersections, parked cars interfere with the visual relationships between motorists and bicyclists. At driveways, sight distances are often impaired by property, fences, shrubs, etc.
   - At intersections, motorists are not looking for bicyclists entering the crosswalk area, particularly when motorists are making a turn.
   - Sidewalks are typically designed for pedestrian speeds, and are not safe for higher-speed use. Conflicts between bicyclists and pedestrians (leaving stores, parked cars, etc.) are common, as are conflicts with fixed objects such as parking meters, utility poles, sign posts, bus shelters, benches, trees, hydrants, and mail boxes. Also, bicyclists
riding on the curb side of sidewalks may accidentally drop off the sidewalk into the path of motor vehicle traffic.

The development of extremely wide sidewalks does not necessarily add to the safety of sidewalk bicycle travel, as wide sidewalks will encourage higher speed bicycle use and can increase potential for conflicts with motor vehicles at intersections as well as with pedestrians and fixed objects.

Sidewalk bike routes are considered only under special circumstances, such as to provide bike-way continuity along high-speed or heavily traveled roadways having inadequate space for bicyclists, and uninterrupted by driveways and intersections for long distances or on long, narrow bridges. Even then, the preferred solution is to widen the roadway width itself and/or decrease the sidewalk width to provide room on the roadway for bicycles.

However, whenever sidewalk bike routes are necessary, a special effort should be made to remove obstacles that will be hazardous to bicycle travel. Ramps are installed at the sidewalk approaches. If approach bikeways are two-way, sidewalk facilities are also two-way. Whenever bicyclists are directed to sidewalks, curb cuts are required at each intersection. Curb cuts are flush with the street to ensure that bicyclists are not subjected to the hazards of a vertical lip crossed at a flat angle, and are as wide as the approach bike trail. For information regarding the design of sidewalks on highway structures, refer to 1020.04(6).

In residential areas, sidewalk riding by recreational adult bicyclists and children too inexperienced to ride in the street is common. However, it is inappropriate to sign these facilities as bikeways.

(d) Class IV Bikeway (Shared Roadway With No Designation). Most bicycle travel now occurs on streets and highways without bikeway designations. In most instances, the street or highway systems are adequate for safe and efficient bicycle travel, and bikeway signing and striping is unnecessary. Also, in some cases, the street or highway systems are not located along bicycle-demand corridors and it is inappropriate to designate them as bikeways regardless of roadway conditions (e.g., minor residential streets).

The State Operations and Maintenance Engineer is responsible for determining the sections of state highways from which bicycle traffic would be prohibited.

Many rural highways are used by touring bicyclists for intercity and recreational travel. In most cases, it would be inappropriate to designate the highways as bikeways because of the limited use and the lack of continuity with other bike routes. However, the development and maintenance of at least 4 feet of paved shoulders with a standard edge stripe can significantly improve safety and convenience for bicyclists and motorists along such routes. This should be the goal to work towards. Where rumble strips are used on shoulders, the outside 3 feet should be left clear for bicycles.

1020.04 PEDESTRIAN FACILITIES (WALKWAYS)

(1) General

Walkways may be sidewalks, pedestrian grade separations, hiking trails, or walking trails. Sidewalks are parallel and immediately adjacent to streets and highways, and are normally used for utility purposes. Walking and hiking trails are independently aligned and generally serve recreational activities (Figure 1020-11).

Walkways are considered during project development, along with the other highway design components. The type of walkway provided is based on the roadside environment, pedestrian volumes, user age group, safety-economic analysis, and continuity of local walkways along or across WSDOT right of way. The type of walkway also depends on the access control of the highway as follows:

(a) Full Access Control. Walking and hiking trails may be located within the highway right of way to connect trails outside the right of way, with the approval of the Assistant Secretary for Highways. Crossing of the highway will be by grade separation for both the trails and sidewalks.

(b) Partial Access and Modified Access Control. Walking and hiking trails may be located between access points (interchanges or intersections) using full access control or modified access control guidelines. (Refer to Chapter 1420.) Sidewalks or trails may cross the highway at grade with an intersecting cross road or by a grade separation.

(c) No Access Control. Sidewalks can be provided along both sides of urban area highways that are used for pedestrian access to schools, parks, shopping areas, commercial areas, and transit stops. In urban residential areas, a sidewalk is to be provided on at least one side of the highway. The sidewalk(s) is located close to the right of way line.

In rural areas, sidewalks would be needed only at points of community development such as schools, businesses, industrial plants, and transit stops. The cost of sidewalks are justified by a study of the local conditions. Walking trails may be used to connect some of these areas.
Crossings are permitted on uncontrolled access highways at intersections and where significant foot traffic is generated. In business districts, marked crosswalks are normally provided at intersections and, although not recommended, may be provided mid-block where pedestrian traffic volumes require. In residential and rural areas, marked crosswalks are normally unnecessary. In the vicinity of schools, convalescent centers, local parks, or community centers, marked crosswalks may be justified through a study of local conditions.

Design standards for marked crosswalks and warrants for pedestrian signals are provided in the MUTCD.

(2) **Sidewalks**

In urban and residential areas sidewalks are usually raised. In suburban areas foot traffic uses the highway shoulder, although raised sidewalks are provided in the vicinity of pedestrian traffic generators (see guidelines for traffic islands in Chapter 910). In either case, sidewalks are parallel and adjacent to a highway, and follow the same alignment.

(a) Standards for raised sidewalks, including curb cuts, are shown in the standard plans. The minimum width of sidewalks is 1.2 meters (4 feet) when separated from the traveled way by a planting strip. Planting strips shall be a minimum of 1 meter (3 feet) in width when used to separate sidewalks from the traveled way.

When a sidewalk is less than 1525 mm (5 feet) in width and separated from the traveled way by a planting strip, an unobstructed passing and turning space not less than 1525 mm (5 feet) by 1525 mm (5 feet) shall be provided at intervals of not more than 60 meters (200 feet) (see Figure 1020-13).

Where a sidewalk is separated from the traveled way with a curb only, the minimum sidewalk width shall be 1.8 meters (6 feet).

Sidewalks in areas of high pedestrian traffic such as at schools, businesses, industrial areas, and transit stops are wider than the minimum and paved to the curb in most cases. The cross slope on the sidewalk is toward the roadway at the rate of 2 percent.

Provide raised sidewalks on highway bridges when raised sidewalks exist on both ends of the bridge. (See Figure 1020-12.) A ramp with a slope of 1:20 or flatter is required to treat all abrupt raised sidewalk ends that are exposed to traffic.

(b) In rural areas, most pedestrians use the highway shoulders for walkways. These are usually not marked or signed for pedestrian traffic. In an area of heavy pedestrian use, an additional pavement width of up to 1.2 meters (4 feet) is added to the roadway to obtain a maximum shoulder width of 3 meters (10 feet).

(Refer to Chapter 440 for the roadway shoulder width for each particular highway classification.) A 200 mm (8-inch) solid white stripe is used to mark the edge of traveled way in these areas.

(c) Consider separating pedestrians from vehicular traffic with a traffic barrier when the posted speed is 70 km/h (45 mph) or greater and there is no other separation (such as a planting strip). Consider the following:

- volume and type of pedestrian traffic
- horizontal and vertical alignment
- impact on other forms of transportation (such as bicyclists)
- treatment of the ends of the barrier

Document in the design file the decision to install or not install a barrier in these instances.

In some cases, barrier separation may be considered at speeds less than 70 km/h (45 mph) depending on the volume and type of traffic.

Where pedestrian use facilities are located behind guardrail, cut the protruding guardrail bolts or install a rub rail to prevent snagging on the bolts. Provide a smooth finish to vertical concrete surfaces adjacent to the pedestrian facility to prevent snagging or abrasive injuries from contact with the surface.

(3) **Curb Cut Ramps**

Design for curb cut ramps for the handicapped are included in the standard plans.

A curb cut ramp will be located between the crosswalk lines at each sidewalk-crosswalk junction. Curb cuts and crosswalks have the same clear width as the sidewalks. The actual location is determined by considering user convenience, crosswalk location, and curb drainage characteristics. In some instances it may be proper to locate one curb cut in the center of the curb return to serve perpendicular crosswalks.

(4) **Walking and Hiking Trails**

Walking and hiking trails are a supplemental feature and are considered on a project by project basis.

These often have a natural surface and usually are provided on highway right of way to connect existing trails. Trails may be paved in the vicinity of rest areas and roadside points of interest, or where bicycle traffic is expected, and in urban areas.

The clear area around walking and hiking trails is 2.4 meters (8 feet) laterally and 3.0 meters (10 feet) vertically (see Figure 1020-11). Any trees or brush removed from this area is cut close to the ground, and intruding branches are trimmed flush with the tree trunk.

(a) Walking trails are a minimum of 1.2 meters (4 feet) wide and have a maximum grade of 10 percent. The
alignment of the trail is independent and beyond the clear zone (recovery area) of a parallel highway.

(b) Hiking trails have a minimum surface width of 0.6 meter (2 feet) and maximum sustained grade of 10 percent. The grade may be up to 20 percent maximum for a short distance.

All voids in hiking trails constructed on riprap, talus slide, or other rock slope are filled at least 0.6 meter (2 feet) below the rock surface. Place 75 mm (3 inches) of cover with soil or small rock over the filled surface.

(5) Pedestrian Grade Separations

In areas where highway crossing opportunities are infrequent and heavy pedestrian traffic is indicated, pedestrian grade separations may be appropriate, provided the following requirements are fulfilled:

(a) The following must be satisfied on all highways: The conditions that require the crossing are permanent. There is no possibility that the replanning of bus routes or school districts in the near future will eliminate the need for such a structure in the vicinity of a school or other heavily used facility.

(b) The following, plus the above, must be satisfied on fully controlled access highways: The estimated volume for the proposed structure is greater than 200 pedestrians per hour for two hours each day, and the additional average walking distance for 85 percent of the pedestrians having the shortest walking distance would exceed 800 meters (½ mile) if there were no structure.

(c) Either one of the following, plus the listing under (a) must be satisfied on partially controlled and non-controlled access highways:

1. An economic analysis indicates that the yearly cost of the separation structure is less than the yearly cost of installing and maintaining the required signal and appurtenances (signs, crosswalk painting, fencing, etc.). Before making this comparison, additional average walking distance for 85 percent of the pedestrians having the shortest walking distance must exceed 800 meters (½ mile) if there were no structure.

2. The vehicular and pedestrian traffic is so great that a traffic signal could not handle both without being overloaded during peak hour traffic.

Pedestrian grade separation bridges or tunnels are designed on a project by project basis.

Railings 1370 mm (4 feet 6 inches) high are provided on pedestrian bridges. The bridge rail is designed so that a 150 mm (6-inch) sphere cannot pass through. In addition, 760 mm (2 feet 6 inch) to 860 mm (2 feet 10 inch) high handrail is provided for slopes greater than 5 percent. Overhead fencing is advisable in areas where lots of young children are anticipated. This is to discourage the tossing of objects or people jumping onto lower roadways.

The clear width and overhead clearance are 2.4 m (8 feet) and 3.0 m (10 feet) respectively. For bridges, the vertical clearance to the roadway below is 5.334 m (17 feet 6 inches) minimum.

Ramps with landings are used for the pedestrian grade separation approaches. A ramp has a maximum grade of 8.33 percent with a maximum rise of 750 mm (30 inches) between landings. When an approach ramp changes directions between two successive landings, the inside radius of the ramp should be 9 m (30 feet) or greater. Landings are a minimum of 1525 mm (5 feet) in length except at the bottom where they are 1830 mm (6 feet) in length. They are of sufficient width to allow wheelchairs to maneuver and at least as wide as the ramp run leading to them. If ramps change direction at intermediate landings, the minimum landing size is 1525 mm (5 feet) by 1525 mm (5 feet). Stairways, when provided, are designed in accordance with the specifications in the standard plans.

Pedestrian tunnels are aligned with the approaching walkways to provide continuous vision throughout, and are illuminated.

(6) Illumination

Design guidance for illumination is in Chapter 840.

(7) Signing

Design guidance for signing is in Chapter 820, and in the MUTCD.

1020.05 EQUESTRIAN AND WATERCRAFT FACILITIES

In some areas it may be appropriate to incorporate equestrian or watercraft trails within the right of way. It is anticipated that there will be only occasional need for these facilities; consequently, specific design criteria are not presented. These facilities will be designed on an individual basis, considering safety, access control, and conflict with other travel modes.

V:DM10
TWO-WAY BIKE PATH ON SEPARATED RIGHT OF WAY

Figure 1020-1a
(Metric)
TYPICAL CROSS SECTION BIKE PATH ALONG HIGHWAY

Concrete Barrier Type 4
Highway

2.4 m MIN
2% 0.6 m Graded area MIN
Rounding required for
slopes steeper than 1:4

0.6 m MIN
Paved width

2% 0.6 m

1.5 m MIN
Bike Path

TWO-WAY BIKE PATH ALONG HIGHWAY

Figure 1020-1b
(Metric)
Bicyclists use the shoulder between the edge of travelled way and bridge rail.

Edge of travelled way

UNSEPARATED (Class II, III, and IV Bikeways)

Edge of bikeway

When the edge of bikeway is closer than 1.5 meters to the edge of the nearest travelled lane, a railing is also provided on the inner barrier.

SEPARATED (Class I Bikeways Only)

BIKEWAYS ON HIGHWAY BRIDGES

Figure 1020-1c
(Metric)
Figure at left is plot of:

\[
\frac{V^2}{gR} = \frac{\tan \theta + f}{1 - f \tan \theta}
\]

where:

- \(V\) = velocity, m/sec
- \(g\) = acceleration due to gravity, m/sec\(^2\)
- \(R\) = radius of curvature, m
- \(f\) = coefficient of friction on dry pavement = 0.4
  (based on max. 20° lean)
- \(\tan \theta\) = superelevation rate, m/m

**CURVE RADIi & SUPERELEVATIONS**

Figure 1020-2
(Metric)
BIKEWAY CURVE WIDENING FOR VARIOUS RADII

Figure 1020-3
(Metric)
STOPPING SIGHT DISTANCE
Figure 1020-4
(Metric)

where: $S = \text{Stopping Sight Distance, m}$
$V = \text{Velocity, km/h}$
$f = \text{Coefficient of Friction (use 0.25)}$
$G = \text{Grade (rise/run)}$

$$S = \frac{V^2}{255(f \pm G)} + 0.694 \, V$$

Descend (-G) \_____
Ascend (+G) \_____

1020-16
L = \frac{AS^2}{100(\sqrt{2h_1} + \sqrt{2h_2})^2} \quad \text{when } S < L

L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A} \quad \text{when } S > L

where: S = \text{Stopping sight distance}
A = \text{Algebraic difference in grade}
h_1 = 1.4 \text{ m (eye height of cyclist)}
h_2 = 0 \text{ m (height of object)}
L^{\text{MIN}} = 0.375 \text{ vertical curve length}

SIGHT DISTANCES FOR CREST VERTICAL CURVES

Figure 1020-5
(Metric)
S = Sight distance in meters
R = Radius of curve in meters
M = Distance from curve inside lane in meters
V = Design speed for S in km/h

Angle is expressed in degrees

\[ M = R \left( \frac{28.655}{R} \right) = R \left( 1 - \cos \frac{28.655}{R} \right) \]

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

(For a one-way facility)

Formula applies only when S is equal to or less than length of curve.

\[ S = S_{V1} + S_{V2} \] (for a two-way facility)
where \( S_{V1} \) = sight distance for vehicle 1
\( S_{V2} \) = sight distance for vehicle 2

**LATERAL CLEARANCES ON HORIZONTAL CURVES**

Figure 1020-6
(Metric)
* The optional solid white stripe may be advisable where stalls are unnecessary (because parking is light) but there is concern that motorists may misconstrue the bike lane to be a traffic lane.

DESIGN A  STRIPED PARKING

** 3.9 m - 4.2 m is recommended where there is substantial parking or turnover of parked cars is high (e.g., commercial areas).

DESIGN B  PARKING PERMITTED WITHOUT PARKING STRIPE OR STALL

DESIGN C  PARKING PROHIBITED

DESIGN D  TYPICAL ROADWAY IN RURAL AREAS

TYPICAL BIKE LANE CROSS SECTIONS

Figure 1020-7
(Metric)
TYPICAL BICYCLE/AUTO MOVEMENTS AT INTERSECTION OF MULTILANE STREETS

Figure 1020-8
BIKE LANE RAMP CROSSING

Figure 1020-9
(Metric)

Note:
If a minimum 1.2 m bike lane cannot be striped outside the traffic lane, the bike lane should not be striped between the ramps.

Also, if the vehicular traffic volume on the ramp is high, the bike lane should not be striped between the ramps.
BIKE LAINES APPROACHING MOTORISTS' RIGHT-TURN-ONLY LANES

Figure 1020-10
(Metric)
Clear generally as high as axe will reach, and 0.3 m beyond each extended arm.

Cut stumps close to ground.

Trim branches rather than cut tree to exclude sunlight and prevent growth. Cut branches flush with trunk, using pruning saw.

Rubble Rock or Talus Slides

600 mm

75 mm Cover of soil or small rock

All voids filled for 600 mm Minimum

Width 0.6 m Minimum tread
Grade 20% Maximum short, 10% Maximum sustained
Alignment Independent and located beyond 9.0 m safety zone
Clearances 3.0 m Vertical, 2.4 m Lateral
Surface Gravel or natural material
Access Control As required (see text)

GUIDELINES FOR HIKING TRAILS

Figure 1020-11
(Metric)
WALKWAYS ON HIGHWAY BRIDGES

Figure 1020-12
(Metric)
HANDICAP PASSING AND TURNING SPACE FOR SIDEWALKS

Figure 1020-13
(Metric)
TYPICAL CROSS SECTION

TWO-WAY BIKE PATH ON SEPARATED RIGHT OF WAY
Figure 1020-1a
TYPICAL CROSS SECTION BIKE PATH ALONG HIGHWAY

Concrete Barrier Type 4
Highway

2' (min.)
8' (min.)
2' (min.)
Paved width

2' Graded area (min.)
Rounding required for slopes steeper than 4:1

TWO-WAY BIKE PATH ALONG HIGHWAY
Figure 1020-1b
Bicyclists use the shoulder between the edge of travelled way and the bridge rail.

Edge of travelled way.

UNSEPARATED (Class II, III, & IV Bikeways)

Edge of bikeway

When the edge of bikeway is closer than five (5) feet to the edge of the nearest travelled lane, a railing is also provided on the inner barrier.

SEPARATED (Class I Bikeways Only)

BIKEWAYS ON HIGHWAY BRIDGES

Figure 1020-1c
Figure at left is plot of:

\[ \frac{V^2}{gR} = \tan \theta + f \]

\[ g = \text{acceleration due to gravity ft./sec}^2 \]

\[ R = \text{radius of curvature, ft.} \]

\[ f = \text{coefficient of friction on dry pavement} = 0.4 \]

(based on max. 20° lean)

\[ \tan \theta = \text{superelevation rate, ft./ft.} \]

**CURVE RADII & SUPERELEVATIONS**

Figure 1020-2
BIKEWAY CURVE WIDENING FOR VARIOUS RADII

Figure 1020-3

<table>
<thead>
<tr>
<th>Radius (feet)</th>
<th>Additional Pavement Width (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25</td>
<td>4</td>
</tr>
<tr>
<td>25 - 50</td>
<td>3</td>
</tr>
<tr>
<td>50 - 75</td>
<td>2</td>
</tr>
<tr>
<td>75 - 100</td>
<td>1</td>
</tr>
<tr>
<td>100+</td>
<td>0</td>
</tr>
</tbody>
</table>
Stopping Sight Distance - ft.
(based on 2.5 seconds reaction time.)

\[ S = \frac{V^2}{30(f + G)} + 3.67 \cdot V \]

where: 
- \( S \) = Stopping Sight Distance, ft.
- \( V \) = Velocity, mph
- \( f \) = Coefficient of Friction (use 0.25)
- \( G \) = Grade Ft./Ft. (rise/run)

**STOPPING SIGHT DISTANCE**
Figure 1020-4
SIGHT DISTANCES FOR CREST VERTICAL CURVES

Figure 1020-5

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1020-33
S = Sight distance in feet
R = Radius of curve inside lane in feet
m = Distance from curve inside lane in feet
V = Design speed for S in M.P.H.

Angle is expressed in degrees

\[ m = R \left( \frac{28.655}{R} \right) = R \left( 1 - \cos \frac{28.655}{R} \right) \]

\[ S = \frac{R}{28.65} \left( \cos \left( \frac{R-m}{R} \right) \right) \]

(For a one-way facility)

Formula applies only when S is equal to or less than length of curve.

\[ S = S_{V1} + S_{V2} \]  
(For a two-way facility)

where \( S_{V1} \) = Sight distance for vehicle 1
\( S_{V2} \) = Sight distance for vehicle 2

LATERAL CLEARANCES ON HORIZONTAL CURVES

Figure 1020-6

1020-34

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* The optional solid white stripe may be advisable where stalls are unnecessary (because parking is light) but there is concern that motorists may misconstrue the bike lane to be a traffic lane.

**DESIGN A  STRIPED PARKING**

**DESIGN B  PARKING PERMITTED WITHOUT PARKING STRIPE OR STALL**

**DESIGN C  PARKING PROHIBITED**

**DESIGN D  TYPICAL ROADWAY IN RURAL AREAS**

**TYPICAL BIKE LANE CROSS SECTIONS**

Figure 1020-7
BIKE LANE RAMP CROSSING
Figure 1020-9

* Note:
If a minimum 4' bike lane cannot be striped outside the traffic lane, the bike lane should not be striped between the ramps.
Also, if the vehicular traffic volume on the ramp is high, the bike lane should not be striped between the ramps.
BIKE LANE APPROACHING MOTORISTS' RIGHT-TURN-ONLY LANES

Figure 1020-10

Design Manual
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Guidelines for Hiking Trails

Figure 1020-11

Width: 2' Minimum tread
Grade: 20% Maximum short, 10% Maximum sustained
Alignment: Independent and located beyond 30' safety zone
Clearances: 10' Vertical, 8' Lateral
Surface: Gravel or natural material
Access Control: As required (see text)
WALKWAYS ON HIGHWAY BRIDGES
Figure 1020-12

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1020-39
Figure 1020-13

HANDICAP PASSING AND TURNING SPACE FOR SIDEWALKS

- Passing & Turning Space
- Sidewalk
- Planting Strip
- Face of Curb
- Direction of Travel
- Centerline

Dimensions:
- 5' MIN
- 200' MAX
- 5' MIN
- 5' MIN
- 5' MIN
1030 **Safety Rest Areas and Traveler Services**

1030.01 General

The Washington State Department of Transportation (WSDOT) has developed a statewide system of traveler services on Interstate highways and state routes. This system includes safety rest areas, roadside parks, points of interest, and traveler information centers. These traveler services provide the opportunity for rest and orientation. Benefits include improved safety, reduced driver fatigue, refuge from adverse driving conditions, and increased tourism.

Traveler services are planned and designed by the Safety Rest Area Team a WSDOT working group representing various divisions, regions, service centers, and offices responsible for safety rest area planning, programming, design, construction, maintenance, and operation. The team assists the Heritage Corridors Program in the development of short and long term plans and budgets.

Safety rest areas and roadside parks are spaced approximately every 60 miles on the National Highway System and on Scenic and Recreational Highways. Use the Safety Rest Area and Roadside Park Master Plan as a guide to site location. Provide appropriate site amenities such as rest rooms, telephones, plaza areas, kiosks, visitor information areas, picnic areas, pet walk areas, recreational trails, and vegetation.

See the Roadside Manual, Division 6, for detailed information on planning, design, construction, and maintenance of safety rest areas and other traveler services.

1030.02 References

42 USC Section 12101 et seq. Americans with Disabilities Act of 1990

23 CFR 752 Landscape and roadside development (Code Federal Regulations [CFR])

Revised Code of Washington (RCW) 46.16.063 Additional fee for recreational vehicles.

RCW 46.68.170 RV account — Use for sanitary disposal systems.

RCW 47.06.040 State-wide multimodal transportation plan.

RCW 47.28.030 Contracts — State Forces

RCW 47.38 Roadside Areas — Safety Rest Areas

RCW 47.39 Scenic and Recreational Highway Act of 1967

WAC 51-40 Uniform Building Code Requirements for Barrier-Free Accessibility

Roadside Manual, M 25-30, WSDOT

Highway Runoff Manual, M 31-16, WSDOT

Highway System Plan, WSDOT

Hydraulics Manual, M 23-03, WSDOT

Maintenance Manual, M 51-01, WSDOT

Right of Way Manual, M 26-01, WSDOT

Roadside Classification Plan, M 25-31, WSDOT

Traffic Manual, M 51-02, WSDOT

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


1030.03 Documentation

When locating a new traveler service, document:

- Conformance with the Safety Rest Area and Roadside Park Master Plan.
- Availability of utilities, including rights to well water where applicable.
- Site conditions and anticipated impacts.
- Mitigation measures where necessary.

Refer to Roadside Manual Division 4.
• Adjacent land use.

• Traffic calculations and projections from the Transportation Data Office. This applies to such things as rest room capacity design, on-site sewage capacity, and parking area design.

• Public participation process and public input.

• Design decisions for ingress and egress.

• Compliance with local building codes and the Americans with Disabilities Act (ADA) requirements.

When projects involve construction in an existing traveler service, document:

• New construction on plans.

• Impacts (if applicable).

• Mitigation measures where necessary.

• Compliance with local building codes and ADA regulations.

See the Roadside Manual for further information. The Highways and Local Roadways Division and the Heritage Corridors Program are an integral part of safety rest area planning and design and can provide assistance and information.
RESTROOM
Typical Location

* Note:
If exit ramp is tangent or has curve radii greater than 1000', this width may be reduced to 14'.

Typical Truck Storage
Figure 1030-1
Typical Single RV Dump Station Layout

Figure 1030-2
Typical Two RV Dump Station Layout

Figure 1030-3

NOTE:
Include an 18' lane for each additional RV Dump Station installed.
1040
Weigh Stations

1040.01 General
1040.02 Planning and Development
1040.03 Permanent Facilities
1040.04 Portable Facilities
1040.05 Agencies Responsibilities
1040.06 Design Report
1040.07 Federal Aid Participation

1040.01 GENERAL

Truck weighing facilities are needed to provide protection to state highways from overweight vehicles, to provide for vehicle safety inspection, and/or to provide a source of data for planning and research. The development and construction of these facilities is a cooperative effort between the Washington State Department of Transportation (WSDOT) and the Washington State Patrol (WSP).

1040.02 PLANNING AND DEVELOPMENT

To provide guidance for planning and development of weighing and inspection facilities, a biennial meeting of WSDOT and WSP representatives will be held to determine those needs. The headquarters Project Development Office will organize and conduct the meeting. (See Directive D 22-21, Truck Weigh Station and Vehicle Inspection Facilities on State Highways.)

The district will provide the headquarters Project Development Office a list of sites under consideration. The type of site, type of work, costs, scheduling, and other supporting data, as necessary, should also be included.

These sites should be determined as a result of contacts made with the WSP, as recommended by the WSP Enforcement Plan, or as a result of a highway project in the vicinity of an existing facility. This information should be forwarded well in advance of the scheduled meeting.

1040.03 PERMANENT FACILITIES

(1) Site Locations

The exact location of truck weighing facilities is generally controlled by topography, highway alignment and geometric. It is also desirable to select these sites in locations where adequate right of way is already available. The most economical site should be selected to minimize site preparation, expense, or impact on the environmental quality of the highway. Water, electricity availability, and sewage treatment and disposal are other considerations for site selection.

The location should be such that the operation of the weigh station will not hinder the operation of the highway or other related features such as intersections or interchanges.

The possibility of truck traffic circumventing the facility and the type and amount of truck traffic using the highway should be considered in locating the site of the truck weighing facility.

(2) Design Features

All connections to permanent weigh stations shall be constructed to the established highway standards. On multilane limited access highways, standard acceleration and deceleration lanes, as shown in Chapter 940, shall be used. Figure 1040-1a is intended as a guide for the minimal design of weigh stations on multilane controlled access highways.

Weigh stations to be constructed along two-lane highways should be designed to best fit the existing conditions, with particular consideration given to the matter of proper access to and from the site. Figure 1040-1b is intended as a guide for the design of weigh stations on two-lane highways. The following special design features shall apply:

- Portland cement concrete approach slabs having minimum dimensions of 100 feet in length by 14 feet in width and 0.75 foot in thickness shall be constructed at both ends of the scales.

- Asphalt approach slabs will be allowed only when adequate soil conditions exist, projected truck volume is light, and cost analysis warrants the use of asphalt based on the small percentage of time the scales will be in operation.

- The approach slab shall be level and in the same plane as the scale.

- Parking and storage space at each individual site shall be carefully studied and the area required agreed upon by the WSDOT District Administrator and the WSP. The storage area should be adequate to ensure that trucks do not impede the through traffic.

- An electronically controlled "open" and "closed" message sign that can be operated from the scalehouse will be installed at weigh stations on multilane divided highways.

- The need for a vehicle safety inspection facility at any site shall be identified by the WSP. Space at each individual site shall be carefully studied and the area required agreed upon by the WSDOT District Administrator and the WSP. Figure 1040-1c is intended as a guide for a site plan for a single bay vehicle inspection facility. Additional bays and site adaptation will be on a site by site basis.

- The need for some form of approach protective treatment for the scalehouse or a protective fence between
the scale and roadway shall be identified by the WSP and agreed upon by the WSDOT District Administrator and the WSP. The need for the device is to protect the scale-house from errant vehicles.

- The need for “Weigh in Motion” facilities will be identified by the WSP. The design will be agreed upon by the WSDOT District Administrator and the WSP. The design of the in-place facilities should take into account the ability to notify the driver whether to continue on or to stop for further investigation.

1040.04 PORTABLE FACILITIES

(1) Site Locations

Portable truck weighing facilities located on two-lane and multilane roadways should be designed to best fit the existing conditions. Sites where shoulder widening is utilized, as shown on Figure 1040-1d, are for use on roadways with two-way traffic. Minor portable scale sites, as shown on Figure 1040-1e, are for use on multilane highways with low traffic volumes, while major portable scale sites, Figure 1040-1f, are for use on expressway and freeway roadways.

The location should be such that the operation of the weighing facility will not hinder the operation of the highway or other related features such as an intersection. The storage area should be adequate to ensure that trucks do not impede the through traffic.

(2) Design Features

All connections to portable truck weighing facilities shall be constructed in accordance with Figures 1040-1d through 1f.

Asphalt concrete pavement is acceptable for use on the ramp and storage areas. The constructed depth shall be in accordance with the soils report by the headquarters Materials Engineer.

In order to optimize portable scale efficiency, the storage area should be flat; however, to facilitate drainage, the slope could be a maximum of 0.02 ft/ft.

Illumination is to be provided if the facility is to be operated during the hours of darkness. See Chapter 840.

1040.05 AGENCY RESPONSIBILITIES

The division of responsibility between the WSP and WSDOT for performance of the work, including maintenance of the facility, is as follows:

The WSP will initiate the action for the addition of a new weigh station or expansion of an existing weigh station. The WSDOT will initiate action for the relocation of an existing facility necessary because of the relocation of a highway facility or expansion of an existing highway facility. Either agency may initiate an action to correct an operational or safety deficiency.

WSDOT is responsible for the construction and maintenance of the facility acceleration and deceleration lanes, all ramps, pits, and any other facility appurtenances except the scale, scalehouse, or safety inspection facility. The designer should coordinate the pit design with the WSP.

The WSP will perform the preliminary engineering, design, and PS&E for the scale, scalehouse (including the utilities and sewage facilities), and safety inspection facility, as well as construct, operate, and maintain the facilities. WSDOT may be requested by the WSP to perform the preliminary engineering or construction or maintenance of a facility. An agreement will be necessary for WSDOT to perform work which is the responsibility of the WSP.

At portable scale sites, it is the WSP’s responsibility for the signing as it is their intent to utilize portable signs. The signing will be agreed upon by the WSDOT District Administrator and WSP during the design stage and documented in the design report.

For further details, refer to Directive D 22-21, Truck Weigh Stations and Vehicle Inspection Facilities on State Highways.

1040.06 DESIGN REPORT

Each weighing facility under consideration must be addressed in a design report. See Chapter 330.

1040.07 FEDERAL AID PARTICIPATION

Federal aid highway funds appropriate to the system being improved may be used for the acquisition of right of way and the construction of truck weighing facilities and/or vehicle inspection facilities. This includes but is not limited to on and off ramps, deceleration and acceleration lanes, passing lanes, driveways, parking areas, scale approach slabs, vehicle inspection facilities, roadway illumination, and signing.
TRUCK WEIGHING STATION INSTALLATIONS FOR MULTILANE LIMITED ACCESS HIGHWAYS

Figure 1040-1a (Metric)

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1040-3
TRUCK WEIGH STATION INSTALLATIONS FOR TWO LANE HIGHWAYS

Figure 1040-1b
(Metric)
Single bay building shown. Additional 6 m bays may be added as required.

VEHICLE INSPECTION INSTALLATION
Figure 1040-1c
(Metric)
PORTABLE SCALE SITE
Shoulder Widening

Figure 1040-1d
(Metric)
MINOR PORTABLE SCALE SITE
One Way Traffic
Figure 1040-1c
(Metric)
MAJOR PORTABLE SCALE SITE
One Way Traffic
Figure 1040-1f
(Metric)
TRUCK WEIGH STATION INSTALLATIONS FOR TWO LANE HIGHWAYS

Figure 1040-1b

Cement Concrete Approach Slabs 100' MIN x 14' x 0.75'

STD Deceleration Lane
(See Chapter 940)
A.P.

300' MIN

300' MIN

STD Acceleration Lane
(See Chapter 940)
A.P.

SECTION A-A

SECTION B-B

0.02'/Ft. MAX

0.00% GRADE

100' MIN SCALE

100' MIN
SINGLE BAY BUILDING SHOWN. ADDITIONAL 20' BAYS MAY BE ADDED AS REQUIRED.

VEHICLE INSPECTION INSTALLATION

Figure 1040-1c

Design Manual
March 1994
PORTABLE SCALE SITE
Shoulder Widening
Figure 1040-1d
MINOR PORTABLE SCALE SITE
One Way Traffic
Figure 1040-1e
MAJOR PORTABLE SCALE SITE
One Way Traffic
Figure 1040-1f
1050 High Occupancy Vehicle Facilities

1050.01 General
The high occupancy vehicle (HOV) is a transit vehicle, van, car, or any other vehicle that meets the occupancy requirements of a particular facility. Motorcycles and buses (with a capacity of 20 or more) can legally travel in an HOV lane regardless of occupancy level. Vehicles with a gross vehicle weight over 4500kg (10,000 lbs.) are not allowed in HOV lanes.

The specific objectives for the HOV system are:
- Improve the capability of congested freeway corridors to move more people by increasing the number of persons per vehicle.
- Provide travel time savings and a more reliable trip time to HOVs that use the facilities.
- Provide safe travel options for HOVs without unduly affecting the safety of the freeway general-purpose lanes.

HOV facilities should be designed and constructed to ensure intermodal linkages, with consideration given to future highway system capacity needs. Whenever possible, HOV facilities should be designed so that the level of service for the general-purpose lanes will not decrease.

In those urban corridors that do not currently have planned or existing HOV facilities, a thorough analysis of the need for HOV facilities should be completed before proceeding with any projects for additional new general-purpose lanes. In those corridors where both HOV and general-purpose facilities are planned, the HOV facility should be constructed before or simultaneously with the construction of new general-purpose lanes.

1050.02 Definitions

arterial HOV  
a priority treatment(s) for buses, carpools, and vanpools on nonlimited access roadways

buffer-separated HOV facility  
an HOV lane(s) that is separated from adjacent general-purpose freeway lanes by a designated buffer width 0.6 to 1.2 m (2 to 4 ft) or greater than 2.4 m (8 ft)

concurrent flow lane  
a buffer or nonseparated lane on which HOVs operate in the same direction as the normal traffic flow

contraflow lane  
a lane on which HOVs operate in a direction opposite to that of the normal flow of traffic

direct access ramp  
a grade-separated on or off ramp that provides local access from a street or transit support facility to the freeway HOV facility

enforcement area  
a place where vehicles may be stopped for ticketing by law enforcement. It also may be used as an observation point and for emergency refuge

enforcement observation point  
a place where an officer may park and observe traffic

flyover ramp  
a grade-separated usually high-speed facility that provides ingress and egress over a freeway HOV main line facility to a local arterial street, another freeway, or another HOV support facility

high occupancy vehicle (HOV)  
a transit vehicle, van, car or any other vehicle that meets the occupancy requirements of a particular facility
level of service  a descriptive measure of the quantity and quality of transportation service provided the user that incorporates finite measures of quantifiable characteristics such as travel time, travel cost, number of transfers, etc.

line enforcement  enforcement by means of travel in the HOV lane or in the adjacent general-purpose lane

occupancy designation  the minimum number of occupants for a vehicle to use the facility

separated HOV facility  an HOV lane that is physically separated from adjacent general-purpose freeway lanes

shy distance  the width between the outside edge of the shoulder and the traffic barrier or other obstruction

single occupant vehicle (SOV)  motor vehicles other than a motorcycle carrying one occupant

stationary enforcement  enforcement by vehicles parked in enforcement areas, on and off ramps, and at locations with high violation rates. The officer can wave the violator over, and ideally, pursuit is not necessary.

violation rate  the total number of violators divided by the total number of vehicles on an HOV facility

1050.03 References

Guide for the Design of High Occupancy Vehicle Facilities, American Association of State Highway and Transportation Officials

Manual on Uniform Traffic Control Devices for Streets and Highways, M 24-01, U.S. Department of Transportation, Federal Highway Administration

Design Features of High Occupancy Vehicle Lanes, Institute of Traffic Engineers

Washington State Freeway HOV System Policy, Washington State Department of Transportation

Standard Plans for Road, Bridge and Municipal Construction, M 21-01, Washington State Department of Transportation

Traffic Manual, M 51-02, Washington State Department of Transportation


1050.04 Preliminary Design and Planning

(1) Planning Elements for Design

In order to determine the appropriate design options for an HOV facility, the travel demand and capacity must first be established. Suitable corridors must be identified, the HOV facility location and length evaluated, and the HOV demand must be estimated. A viable HOV facility will satisfy the following criteria:

- Part of an overall transportation plan.
- Have the support of the community and public.
- In response to demonstrated congestion or near-term anticipated congestion (Level of Service E or F for at least one hour of peak period, traffic approaching a capacity of 1,700 to 2,000 vehicles per hour per lane, and/or average speeds less than 50 km/h (30 mph) during peak periods over an extended distance).
- Except for a bypass of a local bottleneck, HOV facilities will be of sufficient length to provide a travel time saving of at least 5 minutes during the peak periods.
- Sufficient number of HOV users for a cost-effective facility and to avoid the perception of under utilization. (HOV volumes of 400 to 500 vehicles per hour on concurrent flow lane and 600 to 800 on separated facilities.)
- A design that provides for safe, efficient, and enforceable operation.

A queue bypass treatment does not need to justify all of the above to be effective. Isolated bypasses may be warranted when there is localized, recurring traffic congestion, and such treatment will provide a travel time saving to an adequate number of HOV users.
Particular attention must be given to the ingress and the egress to the facility. The efficiency of the HOV facility can be greatly affected by the access provisions. Direct access to and from the HOV facility would be the most desirable, but it is also an expensive alternative. Direct access options are discussed in 1050.04(3)(d). The termination of an HOV lane should be safe and efficient. See the discussion in 1050.06(6).

The design report should address the need for the facility and how the facility will meet those needs in accordance with the above criteria.

(2) HOV Facility Type

A determination must be made as to the type of HOV facility. For freeways, the three major choices are separated roadway, concurrent flow, and buffer separated.

(a) Separated Roadway. The separated roadway can be either a one-way reversible or a two-way operation. The directional split in the peak periods, space available, and operating logistics are factors to be considered. A separated HOV may be located in the median of the freeway, next to the freeway, along the side, or on an independent alignment. Separated HOV facilities are more effective for:

- Large HOV volumes.
- Large merging and weaving volumes that can compromise efficiency of the HOV lane.
- Long-haul HOV travel.

Reversible, separated roadways operate effectively where there are major directional splits during peak periods. Consideration should be given to potential changes in this traffic pattern in the future and designing the facility to accommodate possible conversion to two-way operation in the future. The separated roadway is normally the more efficient, provides for the higher level of safety, and is more easily enforced. However, it is generally the most expensive type of HOV facility to implement.

(b) Concurrent Flow. Concurrent flow lanes are an alternate for two-way operation. Concurrent flow HOV lanes operate in the direction of the freeway lanes immediately adjacent to the general-purpose lanes. They are located either to the inside or outside of the general-purpose lanes. Refer to Figure 1050-1. This type of facility is normally less costly, is easier to implement, and provides more opportunity for frequent access. However, the ease of access also can create more problems for enforcement and higher potential for conflicts, particularly considering the speed differential between the HOV lane and the mixed traffic lanes. These operational shortcomings can be alleviated somewhat by the use of a buffer between the HOV lane and the general-purpose lanes.

(c) Buffer Separated. The buffer separated HOV facility is similar to the concurrent flow HOV, but with a 0.6- to 1.2-m (2- to 4-ft) buffer (or greater than 2.4 m [8 ft]) between the HOV lane and the general-purpose lanes. The addition of a buffer provides better delineation between the lanes and an improved operation, considering the speed differential between the lanes.

(3) Operational Alternatives

In addition to the HOV facility, a full range of operational alternates must be considered before preparing a project prospectus. For limited access facilities, the operational alternates include:

- Inside or outside HOV lane.
- Lane conversion.
- Use of existing shoulder.
- Direct access.
- Queue bypasses.
- Transit flyer stops.

When evaluating alternates, it must be realized that a combination of alternates may provide the best solution for the corridor. Also, flexibility must be incorporated into the design in order not to preclude potential changes in operation, such as outside-to-inside lane and reversible to two-way operations. Access, freeway-to-freeway connections, and enforcement would have to be accommodated for such changes.
(a) **Inside Versus Outside HOV Lane.**
System continuity and consistency of HOV lane placement along a corridor are important and influence facility development decisions. Issues that should be considered include land use, trip patterns, transit vehicle service, HOV main line and ramp volumes, main line congestion levels, safety, enforcement, and direct access to facilities.

The inside HOV lane (left lane) is most appropriate for a corridor with long distance trip patterns, such as a freeway providing mobility to and from the central business district or a large activity center. These trips are characterized by long haul commuters and express transit vehicle service. Maximum capacity for an effective inside HOV lane is approximately 1,500 vehicles per hour. When HOV volumes exceed 1,500 vehicles per hour, the HOVs weaving across the general-purpose lanes may cause severe congestion. In these situations consideration should be given to implementing direct access HOV ramps, physically separated HOV roadways, or providing a higher occupancy designation.

The outside HOV lane (right lane) is most appropriate for a corridor with shorter, widely dispersed trip patterns such as a freeway that encircles the central business district and provides mobility for the suburb-to-suburb commuters. These trip patterns are characterized by transit vehicle routes that exit and enter at nearly every interchange. The maximum capacity for an effective outside HOV lane is approximately 1,100 vehicles per hour. Capacity is reduced and potential conflicts are increased by heavy main line congestion and large entering and exiting general-purpose volumes since they must cross through the HOV lane.

(b) **Conversion of a General-Purpose Lane.**
Conversion of a general-purpose lane to an HOV lane may be justified when the conversion provides greater people-moving capability on the roadway. Given sufficient existing capacity, converting a general-purpose lane to an HOV lane will provide for greater people moving capability in the future without significantly affecting the existing roadway operations. From an engineering standpoint, the fastest and least expensive method for providing an HOV lane is through conversion of a general-purpose lane. Striping and signing are sometimes the only engineering features that need be implemented. Converting a general-purpose lane to HOV use would likely have long-term environmental benefits. This method, however, is controversial from a public acceptance standpoint. Public support may be gained through an effective public involvement program. See Chapter 210, Public Involvement and Hearings.

Lane conversion of a general-purpose lane to an HOV lane must enhance the corridor’s people moving capacity. It is critical that an analysis be conducted. This analysis shall address:

- Public acceptance of the lane conversion.
- Present and long-term traffic impacts on the adjacent general-purpose lanes and the HOV lane.
- Impacts to the neighboring streets and arterials.
- Legal, environmental, and safety impacts.

The analysis must reflect an overall increase in people moving capacity, and this analysis must be included in the design report.

(c) **Use of Existing Shoulder.** When considering the alternatives in order to provide additional width for an HOV lane, the use of the existing shoulder is not a preferred option. To use the existing shoulder is a design deviation and approval is required.

Shoulder conversion to an HOV lane should only be used when traffic volumes are heavy and the conversion is a temporary measure. Another alternative would be to use the shoulder as a permanent measure to serve as a transit-only lane during peak hours and then reverted to a shoulder in off-peak hours. The use of the shoulder creates special signing, operational, and enforcement problems. An agreement must be executed with the transit agency to ensure that transit vehicles will only use the shoulder during peak hours. The use of the shoulder must be clearly defined by signs which include the words TRANSIT ONLY and SHOULDER. Special operations should be instituted to ensure the shoulder is
clear and available for the designated hours. These operational alternatives must be documented in the design report.

The existing shoulder pavement is often not designed to carry heavy volumes of HOVs, especially transit vehicles. As a result, repaving and reconstruction of the shoulder may be required.

(d) **Direct Access.** To maximize the efficiency of the HOV system, exclusive HOV access ramps for an inside HOV lane are recommended. Direct access eliminates the HOV user crossing the general-purpose lanes since most of the main line ingress and egress movements are from the outside (right side). Also, transit vehicles will be able to use the HOV lane and provide service to frequently spaced interchanges.

Providing the HOV user access to the inside HOV lane without mixing with the general-purpose traffic saves the user additional travel time and aids in safety and enforcement, incident handling, and overall operation of the HOV facility.

Key locations for direct access ramps include park and ride lots and flyer stop interchanges. Coordination with the local transit agencies will result in the identification of these key locations. Priority should be given to locations that serve the greatest number of transit vehicles and other HOVs. Transit agencies may provide funding for the construction of a direct access ramp that serves transit vehicles.

Direct access of any type is usually very expensive due to the structural and right of way requirements. If direct access ramps are not included in the initial project, provisions should be made so that they can be added later or at least the design should not preclude their addition at a later date.

(e) **Queue Bypass Lanes.** The type of congestion, the HOV demand, or the physical roadway characteristics may warrant a short, preferential treatment that allows HOVs to save time by avoiding congestion at an isolated bottleneck. The bottleneck may be operational due to capacity restrictions or artificially introduced by metering. An acceptable range of time savings for queue bypasses are one to three minutes, although much larger time savings may be experienced, particularly at metering sites. Typical locations for queue bypasses are at ramp meters, signalized intersections, toll plaza or ferry approaches, and parallel facilities in conjunction with isolated main line congestion. By far the most common use is with ramp metering. This type of treatment can be accomplished along with a corridor HOV facility or independently. In most cases, these treatments are relatively low cost and can be readily implemented. HOV bypasses should be included on all ramp metering sites or provisions made for the future accommodation, unless specific location conditions dictate otherwise.

(f) **Transit Flyer Stops.** A variation of direct access is to provide a flyer stop (also known as express transit stations) where transit vehicles traveling on the freeway stop alongside the freeway on a special ramp constructed for transit vehicle use only. Pedestrians access the flyer stop by way of stairs, wheelchair accessible ramps, and elevators. Ideally, the flyer stop is separated by barriers from the rest of the freeway.

**1050.05 Operations**

(1) **Vehicle Occupancy Designation**

The vehicle occupancy designation should provide for the maximum movement of people in a corridor, provide free-flow HOV operations, reduce the empty lane perception, provide for the ability to accommodate future HOV growth within a corridor, and be consistent with the regional transportation plan and the policies adopted by the metropolitan planning organization (MPO).

An initial occupancy designation must be established, but it is not critical that this initial occupancy level be based on detailed traffic projections and usage for the design year since the requirements can be changed as operational conditions warrant in the future. It is WSDOT policy to use the 2+ designation as the initial occupancy designation. The 2+ carpools are easier to establish and will provide the higher vehicle utilization. A 3+ occupancy designation...
should be considered if it is anticipated during initial operation that the volumes will be 1,500 vehicles per hour for a left side HOV lane, or 1,200 vehicles per hour for a right-side HOV lane, or that a 70 km/h (45 mph) operating speed cannot be maintained for more than 90 percent of the peak hour.

In air quality nonattainment areas where transportation sources are a significant cause of pollution, a change in the vehicle occupancy designation is subject to analysis by the MPO. A possible option is a variable 2+/3+ occupancy designation providing access to the HOV lane for the 3+ HOV users during the peak hours and 2+ HOV users in the nonpeak hours. A variable definition alleviates the under utilization of an HOV lane and allows for a reliable level of service during peak hours. The use of a combination of both fixed and changeable message signing should be considered to indicate a variable carpool designation. Adequate signing and accommodation of enforcement needs must be included in this decision. Coordination with the enforcement agency(s) and an evaluation of the consistency with regional plans and policies is required before implementing this option.

(2) Hours of Operation

WSDOT policy is to provide 24 hours a day HOV designation on freeway HOV lanes. There may be special situations where part time operation during the peak period is appropriate. This involves more complicated signing and enforcement considerations. Additionally, if it involves a shoulder or parking lane that reverts back to its normal usage, special operations should be instituted to ensure the shoulder or lane is clear and available for the designated hours. These operational alternatives must be documented in the design report.

(3) Enforcement

Enforcement is essential to the success of an HOV facility. It shapes public attitudes and maintains the integrity of the facility. Coordination with the Washington State Patrol is critical when the operational characteristics and design alternatives are being established. This involvement ensures that the project is enforceable and will receive their support.

Any high-speed HOV facility shall provide both enforcement areas and observation points. Ramp facilities also need enforcement areas although the design requirements will be different due to their location and reduced speeds.

Barrier-separated facilities, because of the limited access to SOV violators, are the easiest facilities to enforce. Shoulders provided to accommodate breakdowns may also be used for enforcement. Reversible barrier-separated facilities have dead ramps for the reverse direction that may be used for enforcement. Breaks in the barrier may be needed so emergency responders can access barrier separated HOV lanes and back up to the accident.

Buffer-separated and concurrent flow facilities allow violators to enter and exit the HOV lane at will. For this reason, providing strategically located enforcement areas and observation points is essential.

Consider the impact on safety and visibility for the overall facility during the planning and design of enforcement areas and observation points. Where HOV facilities do not have enforcement areas, or where officers perceive that the enforcement areas are inadequate, enforcement on the facility will be difficult and less effective.

(4) SC&DI

The objective of the Surveillance, Control and Driver Information (SC&DI) system is to make more efficient use of our transportation network. This is done by collecting data, managing traffic, and relaying information to the motoring public.

It is important that an SC&DI system is incorporated into the HOV project and that the HOV facility fully utilize the SC&DI features available. This includes providing a strategy of incident management since vehicle breakdowns and accidents have a significant impact on the efficient operation of both the HOV facilities and the general-purpose lanes.
1050.06 Design Criteria

(1) Design Procedures

HOV projects that add or reconstruct HOV facilities are to be considered as new construction. A design report is required for all HOV projects (including lane conversion alternatives). Refer to Chapter 330, Design Reports, for design report procedures.

(2) Design Considerations

For freeway facilities, the design elements such as horizontal and vertical alignment, vertical clearance, cut and fill slopes for both sides of the freeway, sight distance, weave areas within interchanges, and superelevation shall conform to the criteria in Division 6, Geometrics, and Division 9, Interchanges and Intersections. The roadside safety principles in Division 7 are also applicable.

The design vehicle for HOV facilities should include passenger vehicles, vans, and single unit and articulated buses. Turning roadway widths for HOV on and off ramps shall conform to Figure 1050-2. The design speeds, as a minimum, should be comparable to the general-purpose facilities. The design criteria for paving sections, vehicle characteristics and intersection radii should conform to Chapter 1060, Transit Benefit Facilities.

(3) Adding an HOV Lane

The options for adding an HOV lane are reconstruction, restriping, combined reconstruction and restriping, and possibly lane conversion.

Reconstruction involves creating additional traffic lanes by widening to the inside (left side), the outside (right side), or both. Additional right of way may be required. Restriping involves reallocating the existing paved roadway to create enough space to provide an additional HOV lane. Restriping of lane widths to less than 3.6 m (12 ft) is a design deviation and approval is required.

Reconstruction and restriping can be combined to maximize use of the available right of way. For example, a new lane can be created through a combination of median reconstruction, shoulder reconstruction, and lane restriping. Each project will be handled on a case by case basis. Generally the following reductions should be considered in order of preference:

(a) Reduction of the inside shoulder width, provided the enforcement and safety mitigation issues are addressed. (Consideration shall be given not to preclude future direct access by over reduction of the available median width.)

(b) Reduction of the interior general-purpose lane width to not less than 3.3 m (11 ft).

(c) Reduction of the outside general-purpose lane width to not less than 3.3 m (11 ft).

(d) Reduction of the HOV lane to not less than 3.3 m (11 ft).

(e) Reduction of the outside shoulder width from 3.0 to 2.4 m (10 ft to 8 ft).

If lane width adjustments are necessary, old lane markings must be thoroughly eradicated. It is desirable that longitudinal joints (new or existing) not conflict with tire track lines. If they do, then consideration should be given to overlaying the roadway before restriping.

(4) Design Criteria for Types of HOV Facilities

(a) Barrier-Separated HOV Facilities. The separated HOV facility can be single lane or multilane and directional or reversible. A single lane roadway shall have a minimum cross section of 7.9 m (26 ft) (Figure 1050-3a). A two-lane roadway shall have a minimum width of 11.4 m (38 ft) (Figure 1050-3b).

(b) Concurrent Flow HOV Lanes. Concurrent flow HOV lanes are lanes that operate in the same direction as the adjacent freeway lanes and are located either on the outside or inside of the general-purpose lanes (Figure 1050-1).

For both inside and outside HOV lanes, the standard lane width is 3.6 m (12 ft) and the standard shoulder width is 3.0 m (10 ft). Approval of a design deviation is required for lane widths less than 3.6 m (12 ft) and shoulder widths less than 3.0 m (10 ft).
When it is proposed that the inside shoulder be less than 3.0 m (10 ft) for distances exceeding 2.5 km (1.5 mi), enforcement and observation areas must be provided at 1.5- to 3-km (1- to 2-mi) intervals. See Figures 1050-7a and 7b.

Where inside shoulders of less than 2.4 m (8 ft) are proposed for lengths of roadway exceeding 0.8 km (0.5 mi), safety refuge areas must be provided at 0.8- to 1.6-km (0.5- to 1-mi) intervals. These can be in addition to or in conjunction with the enforcement areas. Dedicated incident response teams, contracted towing, or private assistance patrols located along the corridor or in the immediate vicinity are operational mitigations which can be used along with greater spacing between refuge areas. These measures are to provide for the efficient operation and free flow capabilities of the corridor.

A buffer separated HOV facility is a variation of the concurrent flow lanes in which a buffer is provided between the faster moving HOV traffic and the general-purpose traffic to increase safety and driver confidence. The design standards are the same as for the concurrent flow HOV lanes, except for a buffer 0.6 to 1.2 m (2 to 4 ft) in width or greater than 2.4 m (8 ft) in width. Buffer widths between 1.2 and 2.4 m (4 and 8 ft) are not considered desirable since they may be mistak- enly used as a refuge area for which they would be inadequate.

(c) **HOV Ramp Bypass.** The HOV bypass may be created by widening an existing ramp, construction of a new ramp where right of way is available, or reallocation of the existing pavement width provided the shoulders are full depth.

Ramp meter bypass lanes are located on the left or right of metered lane(s). Typically, bypass lanes are located on the left side of the ramp. Consult with local transit agencies and the region’s Traffic Office for direction on which side (left or right) to place the HOV bypass. The design of the ramp meter should be determined by the existing conditions at each location. See Figure 1050-4a for the typical single lane ramp meter with HOV bypass and Figure 1050-4b for the typical two lane ramp meter with HOV bypass.

Both Figures, 1050-4a and 4b, show the required 4.2-m (14-ft) wide observation point/enforce- ment area. Any other design must be treated as a design exception and documented accordingly. One alternative (a design exception) is to provide a 3.0-m (10-ft) outside shoulder from the stop bar to the main line.

(5) **Direct Access Connections**

Direct access ramps, such as Figure 1050-5a and 5b, provide access between the inside HOV facilities (barrier separated or concurrent flow) to another freeway, a local arterial street, or a park and ride facility, by way of an elevated structure.

The design for a single-lane on ramp located on the left side of the main line is shown on Figure 1050-5c.

A less expensive alternative to a flyover ramp is a slip ramp (Figure 1050-6). Slip ramps provide access to and from the barrier separated facility from the inside main line lane. As a result of the operational problems associated with a left-hand slip ramp, a thorough operational analysis should be conducted and adequate signing should be provided.

(6) **HOV Lane Termination**

The beginning and end of an HOV facility should be at logical points and should typically avoid existing freeway ramps. There should be adequate sight distance at the terminals, and adequate signing and pavement markings must be provided.

For the termination of an HOV lane, the principles that apply to merge or diverge maneuvers should be used. When the HOV lane is on the inside of the freeway, the desirable or higher values should be used since the interface is with the “fast” lane.

The preferred method is to provide a straight-through move into a mixed-flow lane and drop a general-purpose lane. However, volumes for both the HOV lanes and general-purpose lanes, and
the geometric conditions should be analyzed so that the operational performance of the general-purpose lanes is not compromised.

(7) Enforcement Areas

Enforcement of the inside concurrent flow HOV lane can be done with a minimum 3.0-m (10-ft) inside shoulder. For continuous lengths of barrier exceeding 3 km (2 mi), a 3.0-m (10-ft) shoulder with a 0.6-m (2-ft) shy distance is recommended.

For inside shoulders less than 3.0 m (10 ft), enforcement and observation areas shall be located at 1.5- to 3-km (1- to 2-mi) intervals or based on the recommendations of the Washington State Patrol. These areas can also serve as safety refuge areas for disabled vehicles. Refer to Figure 1050-7a and 7b.

Observation points should be constructed approximately 400 m (1300 ft) before enforcement areas. They can be designed to serve both patrol cars and motorcycles or motorcycles only. Coordination with Washington State Patrol is essential during the design stage to provide effective placement and to ensure utilization of the observation points. Median openings give motorcycle officers the added advantage of being able to quickly respond to emergencies in the opposing lanes. See Figure 1050-7c. The ideal observation point places the motorcycle officer a meter or more in elevation above the HOV lane and outside the shoulder so the officer can look down into a vehicle.

The enforcement pad should be located on the right side for queue bypasses and downstream from the stop bar so the officer can be an effective deterrent (Figures 1050-4a and 4b).

An optional one-section signal head with a 200 mm (8 in) red lens (signal status indicator for enforcement) may be placed at HOV lane installations that are metered. The signal head faces the enforcement pad so that Washington State Patrol can determine if vehicles are violating the ramp meter. The signal head allows Washington State Patrol to simultaneously enforce two areas, the meter and the HOV lane. Consult with Washington State Patrol for use at all locations.

Document in the design report the decision regarding the installation of the signal head. Refer to the Traffic Manual regarding HOV metered bypasses for additional information on enforcement signal heads.

(8) Signs and Pavement Markings

The MUTCD has established pavement markings and signs for preferential lane-use control. Guidance for use of these items is provided in the Traffic Manual.

(a) Signs. Restricted use HOV signs should be post mounted next to the HOV lane. The sign wording must be clear and precise, stating which lane is restricted, the type of HOVs allowed and the HOV vehicle occupancy designation approved for that section of road. The sign size, location, and spacing is dependent upon the conditions under which the sign is used and should be consistently applied. Refer to the Traffic Manual for additional guidance on signing of HOV facilities. Roadside signs can also be used to convey other HOV information such as the HERO program, carpool information telephone numbers, and violation fines. Some situations may call for the use of variable message signs.

Overhead signs should be placed directly over the HOV lane to provide maximum visibility. A sequence of overhead signs shall be used at the beginning and end of all HOV freeway facilities. Overhead signs can also be used in conjunction with roadside signs along the roadway.


(c) Interchanges. In the vicinity of interchange on and off connections where merging or exiting traffic crosses an HOV lane, make provisions for general-purpose traffic using the HOV lane. These provisions include signing and striping that clearly show the changes in HOV versus general traffic restrictions. Refer to the Standard Plans for pavement markings and signing.
1050.07 Arterial HOV

There are a variety of HOV treatments available for use on arterials. Some of these treatments are site specific or have limited applications. HOV lanes on arterials are increasingly being considered. Arterial HOV lanes differ from freeway HOV lanes in slower speeds, little access control (turning traffic can result in right angle conflicts), traffic signals, and reduced geometric standards. Arterial HOV lanes are occasionally designated for transit vehicles only, especially in major cities with a large concentration of transit vehicles.

Often, arterial HOV lanes are constructed in relatively short lengths to give an advantage to HOVs approaching a signalized intersection. Arterial HOV lanes are usually located on the outside (right) lane of the roadway because the loading and unloading of transit vehicles usually takes place there. If business and cross streets are present, then SOV traffic should be allowed access to the HOV lane to turn.

Turns across and through the arterial HOV lane can create conflicts. Minimizing access points that create these conflict locations, such as by providing well-delineated driveways, is recommended. Adequate signs and pavement markings are important.

The outside of the HOV lane should have either curb or an edge stripe.

Signal priority treatments which alter the sequence or duration of a traffic signal are techniques for providing preferential treatment for transit vehicles and emergency vehicles. The priority treatments can range from timing and phasing adjustments to signal preemption. The priority treatments may require changes in signal controller equipment and provisions for on-board transit vehicle equipment or special detectors to identify transit vehicles. However, the overall impact on traffic must be considered. Preemption would normally not be an appropriate treatment where traffic signal timing and coordination are being utilized or where there are high volumes on the cross streets.

These priority treatments can significantly improve effectiveness and safety of an arterial HOV facility. Modification of the signal system can provide a low cost priority treatment for transit vehicles. The use of these priority treatments must be coordinated with the local transit agencies and approved by the State Traffic Engineer. For further guidance for the use of signal priority treatments, refer to the Traffic Manual.
Typical Concurrent Flow Lanes

Figure 1050-1
(Metric)

*For continuous lengths of barrier, a 3.0 m shoulder with a 0.6 m shy distance is recommended to provide an enforceable corridor.
### Roadway Widths for Three-Lane HOV On and Off Ramps

*Figure 1050-2 (Metric)*

<table>
<thead>
<tr>
<th>RADIUS OF TWO-LANE RAMP $R$ (m)</th>
<th>DESIGN WIDTH OF THIRD LANE* $W$ (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>301 to TANGENT</td>
<td>3.6</td>
</tr>
<tr>
<td>300</td>
<td>3.9</td>
</tr>
<tr>
<td>180</td>
<td>3.9</td>
</tr>
<tr>
<td>150</td>
<td>3.9</td>
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<tr>
<td>120</td>
<td>4.2</td>
</tr>
<tr>
<td>105</td>
<td>4.2</td>
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</tr>
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<td>30</td>
<td>5.1</td>
</tr>
</tbody>
</table>

*NOTE:* Apply additional width to 2-lane ramp widths. See Chapter 640 for turning roadway widths.
*See Chapter 640 for turning roadway widths.

**The use of a 2.4 m shoulder will require a design deviation.

**Separated Roadway Single-Lane, One-Way or Reversible**

*Figure 1050-3a*  
(Metric)
Separated Roadway Multi-Lane, One-Way or Reversible

* See Chapter 640 for turning roadway widths.
NOTES
2. This distance must equal or exceed the "acceleration lane length" tabulated in Chapter 940.
3. See Chapter 640 for roadway widths.
4. Use of radii less than 900 m must be justified in the design report.

Single-Lane Ramp Meter With HOV Bypass

Figure 1050-4a
(Metric)
Two-Lane Ramp Meter With HOV Bypass

Figure 1050-4b
(Metric)
Typical HOV Flyover

Figure 1050-5a
(Metric)

Section A-A

*See Chapter 640 for turning roadway widths.
Section A-A

*See Chapter 640 for turning roadway widths.

Typical Inside Lane On Ramp

*Figure 1050-5b*

(Metric)
Inside Single-Lane On Ramp

Figure 1050-5c
(Metric)
Typical Slip Ramp

* For standard acceleration and deceleration tapers see Chapter 940.
Enforcement Area (One Direction Only)

Figure 1050-7a
(Metric)
Median Enforcement Area

Figure 1050-7b
(Metric)

*Refer to Standard Plans for warning marker details.*
Bidirectional Observation Point

Figure 1050-7c
(Metric)
Concurrent flow HOV lanes with outside HOV lanes

Concurrent flow HOV lanes with median HOV lanes

*For continuous lengths of barrier, a 10' shoulder with a 2' shy distance is recommended to provide an enforceable corridor.

Typical Concurrent Flow Lanes
Figure 1050-1
### Roadway Widths for Three-Lane HOV On and Off Ramps

**Figure 1050-2**

<table>
<thead>
<tr>
<th>RADIUS OF TWO-LANE RAMP R (ft)</th>
<th>DESIGN WIDTH OF THIRD LANE* W (ft)</th>
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<tr>
<td>1001 to TANGENT</td>
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</tbody>
</table>

*NOTE: Apply additional width to 2-lane ramp widths. See Chapter 640 for turning roadway widths.*
*See Chapter 640 for turning roadway widths.
**The use of an 8' shoulder will require a design deviation.

Separated Roadway Single-Lane, One-Way or Reversible

*Figure 1050-3a*
* See Chapter 640 for turning roadway widths.

Separated Roadway Multi-Lane, One-Way or Reversible
*Figure 1050-3b*
Single-Lane Ramp Meter With HOV Bypass

Figure 1050-4a

NOTES
2. This distance must equal or exceed the "Acceleration Lane Length" tabulated in Chapter 940.
3. See Chapter 640 for roadway widths.
4. Use of radii less than 3000' must be justified in the design report.

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Design Manual
June 1995
Two-Lane Ramp Meter With HOV Bypass

*Figure 1050-4b*
Typical HOV Flyover

Section A-A

For standard acceleration and deceleration tapers see Chapter 940.

To local street support facility or another HOV facility

*See Chapter 640 for turning roadway widths.
Section A-A

*See Chapter 640 for turning roadway widths.

Typical Inside Lane On Ramp

Figure 1050-5b
Inside Single-Lane On Ramp

Figure 1050-5c
Typical Slip Ramp  
*For standard acceleration and deceleration tapers see Chapter 940.*
Enforcement Area (One Direction Only)

Figure 1050-7a
Median Enforcement Area

Figure 1050-7b

*Refer to Standard Plans for warning marker details.
Bidirectional Observation Point

Figure 1050-7c
1060
TRANSIT BENEFIT FACILITIES

1060.01 Introduction
1060.02 Definitions
1060.03 Park and Ride Lots
1060.04 Transfer/Transit Centers
1060.05 Bus Stops and Pullouts
1060.06 Passenger Amenities
1060.07 Roadway and Vehicle Design Criteria Characteristics
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1060.01 INTRODUCTION

(1) Purpose of Chapter
The purpose of this chapter is to provide operational guidance and information for designing transit benefit facilities for WSDOT, local agencies, and developers on public or private property within Washington.

The design criteria presented represent recognized principles based mainly upon criteria developed by AASHTO. The information presented should not substitute for sound engineering judgment. It must be recognized that some situations encountered will be beyond the scope of this section, since it is not a comprehensive textbook on public transportation engineering.

Private development, which incorporates transit benefit facilities into its design, should use this section as a guide at the direction of staff from the appropriate public jurisdiction.

Coordination between agencies in the location and design of transit benefit facilities has often been “catch-as-catch-can” at best. Where transit benefit facilities have been required as a condition of development, there has been some confusion as to what design criteria apply. This chapter, along with the referenced “A Guide to Land Use and Public Transportation,” provides guidance for the design and location of transit benefit facilities.

The design information which follows can help WSDOT, local jurisdictions, and developers assure that transit provides efficient and cost effective service to the public and the community.

1060.02 DEFINITIONS

articulated bus  a two-section bus that is permanently connected at a joint. An articulated bus is 50 percent longer than a standard bus, has three axles, and can bend around corners.

bus pull-out  a dedicated parking area for in-service coaches on specified routes, where coaches do not have independent pull-in and pull-out areas.

bus shelter  a facility which provides seating and protection from the weather for passengers waiting for a bus.

bus stop  a place where passengers wait to board a bus.

car/vanpool  a group of people who share the use and cost of a car or van for transportation, on a regular basis.

feeder service  bus service providing connections with other bus or rail services.

high occupancy vehicle (HOV)  a vehicle which carries a specified minimum number of persons (Chapter 1050).

kiss and ride  when patrons of a park and ride lot are dropped off or picked up by private auto or taxi. These are sometimes called drop and ride.

public transportation  passenger transportation services available to the public, including buses, ferries, rideshare, and rail transit.

sawtooth berth  a series of bays that are off-set from one another by connecting curblines. They are constructed at an angle from the bus bays. This configuration minimizes the amount of space needed for vehicle pull-in and pull-out.

standard bus  a bus that is approximately 40 feet in length.

transit  a general term applied to passenger rail and bus service used by the public.

transit benefit facility  capital facilities, along with the necessary design considerations, which improve the efficiency of public transportation or encourage the use of public transportation and other HOVs.

1060.03 PARK AND RIDE lots

(1) General
Park and ride lots provide parking for people who wish to transfer from private vehicles to public transit or carpools/vanpools. These lots are intended to increase highway efficiency, reduce energy demands, and increase highway safety by reducing traffic congestion. Most park and ride lots located within urban areas are served by transit; however, the smaller lots may only have local transit service. Smaller leased lots, usually at churches or shopping centers, may have no bus service, and only serve carpools and vanpools. Park and ride lots, located in rural areas not served by buses, also serve carpools and vanpools.

Early and continuous coordination with the local transit authority and local government agencies is critical. When a memorandum of understanding (MOU) exists, which
outlines design, funding, maintenance and operations of the lot program, it must be checked for requirements for new lots. If the requirements cannot be met, the MOU must be renegotiated.

(2) Site Selection

Present and future needs are the main considerations in determining the location of a park and ride lot. Public input is a valuable tool. The demand for and the size of a park and ride lot is dependent on a number of factors. Many of these factors vary with the state of the economy, energy availability and cost, perceived congestion, and public attitude, and are somewhat difficult to predict. Therefore, consider sizing the facility to allow for a conservative first-stage construction with expansion possibilities. As a rule of thumb, one acre can accommodate approximately 90 vehicles in a park and ride lot. This allows about 40 percent of the area for borders, landscaping, passenger amenities, bus facilities for larger lots, and future expansion.

Primary concerns during the design stage include:
- Safe and efficient traffic flows, both on and adjacent to the site, for all modes: transit, carpools, vanpools, pedestrians, and bicycles.
- Adequate lighting and good visibility to enhance security and surveillance of the facility to reduce criminal activity.
- Adequate number of parking spaces.
- Comfortable and attractive facilities.
- Facilities that accommodate use by elderly and disabled users and meet state barrier free design codes.

Local transit authority input is critical because, in some cases, the need for a park and ride lot and its location may already have been determined in the development of their comprehensive transit plan. Failure to obtain transit input could result in a site which does not work well for transit vehicle access.

A list of potential sites should be developed. This can be simplified by the use of existing aerial photos, detailed land use maps, or property maps. The goal is to identify properties which can most readily be developed for parking and which have suitable access.

Factors influencing site selection and design of a park and ride facility include:
- Local transit authority master plan.
- Regional transportation plan.
- Local public input.
- Need.
- Traffic.
- Commuter distance.
- Local government zoning.
- Economic, social, and environmental impacts.
- Cost and cost effectiveness.
- Access by all modes of travel.
- Security and appearance.
- Maintenance.
- Available utilities.
- Existing right of way or sundry site.
- Capability for future expansion.

Purchasing or leasing property increases costs substantially. Therefore, state-owned right of way should be the first choice, assuming the other selection criteria are favorable. The use of city or county-owned right of way should also receive prime consideration. The site selected should not jeopardize the present and future integrity of the highway facility.

Each potential site should be further investigated in the field. The field survey serves to confirm or revise impressions gained from the office review. Consider the following when making the review:
- Physical characteristics of the site.
- Current use of surrounding area (zoning).
- Whether the site is visible from adjacent street(s) to enhance security and surveillance of the facility.
- Potential for additional expansion.
- Accessibility for motorists and other modes of travel including transit.
- Proximity of any existing parking facilities, such as church or shopping center parking lots, that are underutilized during the day.
- Potential for joint use of facilities with businesses or land uses compatible with park and ride patrons, such as day care centers or dry cleaners.
- Congestion problems and other design considerations.

After establishing the best potential sites, public meetings and environmental procedures should be completed prior to preparing the design report. Follow environmental procedures as outlined in Chapter 220.

The design report should address the public meetings and environmental processes completed, as well as the preferred and alternate sites considered.

(3) Design

A design report (Chapter 330) is required for all federally funded projects and for WSDOT facilities that are to be paved.

Design features must be in compliance with applicable design standards, specifications, and operating procedures and with any local requirements that may apply. In some cases, variances to local design standards may be necessary to ensure the safety and security of facility users.
Design components may include:
• Geometric design of access points.
• Internal and external circulation.
• Parking space layout.
• Pavements.
• Shelters.
• Exclusive High Occupancy Vehicle (HOV) facilities.
• Bicycle facilities.
• Motorcycle facilities.
• Traffic control devices, including signs, signals, and permanent markings.
• Illumination.
• Drainage and erosion control.
• Security of facility users and vehicles.
• Environmental mitigation.
• Landscape preservation and development.
• Restroom facilities.
• Telephone booths.
• Trash receptacles.
• Traffic data.
• Barrier free design for the disabled.

The degree to which the desirable attributes of any component are sacrificed to obtain the benefits of another component can only be dealt with on a site specific basis. However, these guidelines present the optimum requirements of each factor.

Large park and ride lots use private automobiles as the primary collector distributor mode and transit buses as the line haul mode. The basic principles are also used in designing smaller park and ride lots used primarily for carpools and vanpools with limited or no bus service.

(a) Access. Six basic transportation modes are used to arrive at and depart from park and ride lots: walking, bicycle, motorcycle, private automobile including carpools, vanpools, and bus. All these modes should be provided for.

Access to a park and ride lot should not increase congestion on the facility it serves. For this reason, direct access by private automobiles to a freeway or ramp should be avoided. However, direct access for transit is often desirable as long as this access does not add a major conflict point. Often the most efficient access point to a park and ride lot will be on an intersecting collector or local street. If the intersection is already signalized, excellent access can often be provided. Entrances and exits should be located with regard to adjacent intersections, so that signal control at these intersections can be reasonably installed at a later time, if necessary. Storage for vehicles entering the lot and adequate storage for exiting vehicles should be planned. Ease of access will encourage use of the facility.

When it is necessary to provide direct access to an arterial, the location must be carefully considered. It should be located to avoid queues from nearby intersections. Field observation of traffic patterns and queuing at the site is recommended prior to establishing an access point.

The facility should be located to allow the most users possible to make a right turn into the lot, thus reducing the hazard of crossing opposing traffic.

Entrances and exits should be at least 150 feet apart and not closer than 150 feet to a public intersection, all measured curb to curb (minimum standard): 350 feet is desirable. Where the capacity of the parking area does not exceed 150 stalls, the above spacings may be reduced to 100 feet.

Park and ride lots located along one-way couplets should be located between the two one-way streets with access from both streets. When access cannot be provided directly to both streets, it may be necessary to provide additional signing to guide users to and from the facility.

When a park and ride lot has more than 300 parking stalls, at least two entrances and two exits should be provided. The volume per entrance or exit should not exceed 300 vehicles per hour. With lot sizes larger than 500 stalls, two lane exits with traffic signals should be considered for exits onto heavy volume two-way streets. It is desirable for park and ride lots with capacities greater than 1,000 parking stalls to have entrance and exit points to two or more adjacent streets in order to avoid congestion. Entrances should be located so that a vehicle approaching the site from any direction could miss one entrance and find a second one without circuitous routing.

Entrances and exits that will be used by buses should have a minimum width of 15 feet per lane. See Section 1060.08 for corner radii requirements for buses. See Chapter 920 and the standard plans for design of other access points.

All entrances and exits should conform to WSDOT design standards or other published design standards used by the local agency.

The transit route from the freeway or arterial to a park and ride lot, circulation patterns within the lot, and return route should be designed to minimize transit travel time. Exclusive ramp connections for buses and vanpools, both to and from the freeway or street, may be justified by time savings to riders and reduced transit costs. All transit routing should be coordinated with the transit authority.

(b) Internal Circulation. Major circulation routes within a park and ride lot should be located at the periphery of the parking area to minimize vehicle-pedestrian conflicts. Circulation within the lot should
accommodate all modes using that part of the facility. Care should be taken to see that an internal intersection is not placed too close to a street intersection. A separate loading area, with priority parking areas, should be considered for vanpools. Whenever possible, buses should not be mixed with cars. Bus circulation routes should be designed to provide for easy movement, with efficient terminal operations and convenient passenger transfers. A one-way roadway with two lanes to permit passing of stopped buses is desirable, with enough curb length and/or saw-tooth type loading areas to handle the number of buses that will be using the facility under peak conditions (see Section 1060.04). Close coordination with the local transit authority is critical in the design of internal circulation for buses and vanpools.

The passenger waiting area should be located either:

1. In a central location with parking for the various user modes surrounding the waiting area, or
2. Located near the end of the facility with parking for the various user modes extending radially from the waiting area.

Large lots may require more than one waiting area. In shared-type lots, such as shopping centers and churches, the waiting area should be located away from main building(s) so pedestrian and vehicle traffic from the lot will not interfere with the other facility activities.

In an undersized or odd-shaped lot, circulation may have to be compromised in order to maximize utilization of the lot. The general design for the individual user modes should be based on the priority sequence of pedestrians, bicycles, feeder buses, and park and ride area. Traffic circulation should be designed to minimize vehicular travel distances, conflicting movements, and number of turns. Vehicular movements within the parking area should be dispersed by strategic location of entrances, exits, and aisles. Aisles should be aligned to facilitate convenient pedestrian movement toward the bus loading zone.

Any of the internal layout that will be used by buses, including entrance and exit driveways, must be designed to the turning radius of the bus. Additional considerations for internal circulation are:

- All users (auto, pedestrian, bicycle, and bus) should be able to understand how the lot works.
- Drivers should not be confronted with more than one decision at a time.
- Adequate capacity should be provided at entrances and exits.
- Signing should be clear.
- Flexibility to adjust to changes in transit volume and operations should be provided.

(c) Stall Size. Internal circulation should be two-way with 90-degree parking. However, due to geometrics of smaller lots, one-way aisles with angled parking may be advantageous. Automobile stall dimensions should be 8.5 feet x 18 feet. When space for vehicle overhang is provided, some of the stalls may be 8.5 feet x 16 feet when parking at 90 degrees. When justified, some of the stalls may be designed for compact cars, 8 feet x 16 feet minimum. Include justification of the percentage of compact stalls.

For additional information on parking stall size requirements for the disabled, see Section 1060.09.

If possible, aisle lengths should not exceed 400 feet. The greatest efficiency can generally be obtained by placing aisles and rows of parking parallel to the long dimension of the site. All parking should be head-in only. Vehicles and other objects should be excluded from corners where it is necessary to provide adequate intersection sight distances. It is also desirable to have parking on both sides of the aisle. This provides the most efficient design in terms of land use.

(d) Pedestrian Movement. Pedestrian movement in parking areas is normally by way of the aisles. Additional provision for pedestrian movement by means of walkways is desirable and could be required in certain situations, as described below. A pedestrian path from any parking stall to the loading zone should be as direct as possible.

Pedestrian walkways should be provided to minimize pedestrian use of a circulation road or an aisle, and to minimize the number of points at which pedestrians cross a circulation road. Where pedestrians originate from an outlying part of a large parking lot and use aisles or circulation roads to approach the loading zone, they will have to travel along an irregular path for a considerable distance. In such cases, consideration should be given to the provision of a walkway which extends toward the loading zone in a straight line.

The maximum distance a pedestrian will have to walk from his car to a loading zone should be in the range of 600 to 800 feet. Longer walking distances require consideration of centrally located or additional loading zones.

Pedestrian crossings should have good visibility both for pedestrians and drivers. Pedestrian walkways and crossings shall be clearly marked.

Facilities for disabled patrons must also be included. All pedestrian walkways shall have curb cuts, built in accordance with the Standard Plans, at all curbs or other sudden elevation changes. The sidewalk grade should be 12:1 or less. For additional disabled accessibility information, see Section 1060.09.
Sidewalks intended for use by pedestrians should have a minimum width of 5 feet. When it is anticipated that both pedestrians and bicycles will use the sidewalks, the minimum width is 8 feet. They should be compatible with existing sidewalks in the area and follow local codes.

The minimum width of a sidewalk adjacent to a loading zone should be 12 feet or the adjacent sidewalk width plus 7 feet, whichever is greater. Pedestrian barriers should be provided where unusual hazards or unreasonable interference with vehicular traffic would result. The barriers may be railings, berms, fencing, walls, or landscaping. These barriers should be installed with sight distance in mind. Minimum horizontal clearance between a barrier and vehicle should be 2 feet. A good parking lot design will minimize the need for pedestrian barriers.

(e) Bicycle Facilities. Encouraging the bicycle commuter is important. Each bicycle used to commute to the park and ride lot potentially frees up one parking space. An evaluation should be made to determine if the lot is going to be used by bicyclists and, if bicycles are expected, bicycle lockers or locking racks should be provided. All paved lots that are accessible by bicycle and are served by public transit should have lockers or a rack for a minimum of three bicycles. The bike parking area should be located relatively close to the transit loading area, separated from motor vehicles by curbing or other physical barriers, and have a direct route from the feeding streets. The bicycle parking area should be designed to prevent pedestrians from inadvertently walking into it and tripping. For bicycles, the layout normally consists of stalls 2 feet x 6 feet, at 90 degrees to aisles, with a minimum aisle width of 5 feet. For additional information on bicycle facilities, see Chapter 1020.

(f) Motorcycle Facilities. Motorcycle stalls should be 4 feet x 7 feet. Motorcycle storage should be on a Portland cement concrete slab to prevent stands from sinking into the asphalt pavement. Motorcycle stalls should be located relatively close to the transit loading areas.

(g) Drainage. Ponding of water in a lot is undesirable both for vehicles and pedestrians. Therefore, adequate slope should be provided for surface drainage. This is particularly true in cold climates where freezing may create icy spots. Recommended grade is 2 percent (0.02 ft/ft). Curb, gutter, and surface drains and grates should be installed where needed. Drainage grates with short, narrow openings, placed perpendicular to traffic direction, should be used in traffic areas to allow safe passage over the grate. Drainage design should be coordinated with the local agency to ensure that appropriate codes are followed (Chapter 1210).

Raised islands shall be held to a minimum so as not to hinder cleaning and snow removal.

(h) Pavement Design. Pavement design shall conform to state design specification for each of the different uses and loadings that a particular portion of a lot or roadway is expected to handle. The surfacing type shall have the concurrence of the Materials Laboratory (Chapter 520).

(i) Traffic Control. Control of traffic movement can be greatly improved by proper pavement markings. Typically, reflectorized markings for center lines, lane lines, channelizing lines, and lane arrows will be necessary to guide or separate patron traffic and transit traffic. Signing and pavement markings shall conform to Chapters 820 and 830 and to the MUTCD. Park and Ride identification signs should be installed.

(j) Shelters. Pedestrian shelters should be considered in areas where the magnitude of transit service and environmental conditions warrant. Consider shelters when 50 or more riders per day are anticipated. Shelters may be individually designed or selected from a variety of commercially available designs to satisfy local needs. The following features should be considered in selecting shelter designs:

- Select open locations with good visibility to minimize potential for criminal activity.
- If enclosed, the open side should be away from nearby vehicle splashing.
- Doors are not recommended, unless need dictates otherwise, because of maintenance and vandalism potential.
- Allow for a small air space below side panels to permit air circulation and prevent the collection of debris.
- Optional features that may be provided are lighting, heat, telephone, travel information (schedules), and trash receptacles.
- Ease of field assembly and repair of components. Contact WSDOT's Architecture Office or local transit agency for shelter designs. Shelters are usually provided by the serving transit authority with the state providing only the shelter pad. Coordination with the local transit authority is essential in shelter design and placement.
- Design shelters to accommodate the disabled.
- See Section 1060.06, Passenger Amenities, for additional information on this subject.

(k) Illumination. Adequate lighting is important from a safety standpoint and as a deterrent to criminal activity in both the parking area and the shelters. Illumination should be considered for all park and ride lots (Chapter 840). Only security lighting is provided during hours of low usage. Locate poles so that vehicle movements and parking are not obstructed. If
raised islands are used to separate adjacent parking rows, place the poles on the islands. In determining the locations of luminaire poles, plan for future expansion of the facility.

(i) Landscape Preservation and Development. Selective preservation of existing vegetation is often a cost-effective means to provide a balanced environment for the park and ride lot user. Preservation may reduce environmental impacts and give "instant" results. Landscaping of park and ride lots is desirable for aesthetic as well as ecological reasons and should consist of plantings that will be compatible with the operation of the facility. Landscaping shall be cost-effective, comply with the local requirements, and satisfy the functional needs of the park and ride lot. The type of plantings and their placements should not interfere with:

- Adequate lighting for the area, thus resulting in a potential safety hazard to the patron.
- Adequate sight distance for cars and transit vehicles, especially at intersections and pedestrian crossings.
- The proper placement of the traffic control devices.
- The ability of pedestrians, bicyclists, and the disabled to use the facility.
- Security of patrons and their property.

Trees provide shade and visual interest, reduce glare, and are less costly to maintain than shrubs and ground cover. Therefore, trees should be the dominant plant material. Trees should be placed only where they will not block sight distance for cars or buses and proper clearances can be maintained as they mature. Landscaping should be designed in such a manner that hiding places for vandals are minimized. Landscaping can provide an effective means for establishing pedestrian paths and walking patterns within the site. In parking zones, sufficient setback must be provided for all plants so the front or rear overhang of cars does not damage them. Earth forms, such as berms, mounds, and swales are a good design tool to provide for low-cost screening, delineation, visual interest, and drainage. Landscaping should be designed so that security patrols can see into the lot from adjacent streets without entering. Landscape design shall keep maintenance requirements to a minimum.

It is desirable that one tree be planted per 12 parking stalls so that no parking stall is farther than 75 feet from a tree. These trees provide luminaire light diffusion for adjacent property owners.

Irrigation also needs to be addressed in the landscape design.

(m) Fencing. See Chapter 1460 for guidelines for fencing.

(n) Maintenance. A comprehensive maintenance plan should be developed as per established state policy either as part of a memorandum of understanding with the local authority or for use by state maintenance forces. Maintenance of park and ride lots outside state right of way shall be the responsibility of the local transit authority. It is encouraged that park and ride lots inside state right of way should also be maintained by the local transit authority. Agreements for maintenance by others shall be negotiated during the design phase and documented in the design report (Chapter 330).

Maintenance cost estimates, funding source, and legal responsibilities for accidents and security are to be addressed in the maintenance plan and documented in the design report. The location and type of site (new or existing), and method of performing maintenance, will generally determine the extent of the maintenance program.

The following maintenance activities should be considered:

- Periodic inspection.
- Pavement repair.
- Traffic control devices (signs and pavement markings).
- Lighting.
- Mowing.
- Cleaning of drainage structures.
- Sweeping/trash pickup.
- Landscaping.
- Shelters.
- Snow and ice control.

A sound maintenance program should be established well ahead of the date a park and ride lot is placed into operation.

1060.04 TRANSFER/TRANSIT CENTERS

(1) Introduction

Transfer centers are essentially large bus stops where buses on a number of routes converge to allow riders the opportunity to change buses. Transfer centers are of particular importance in many transit systems, since riders in many areas are served by a "feeder" route; to travel to area destinations not served by the feeder, residents must transfer.

Transit centers are frequently associated with a major activity center. In this case, the activity is beyond simply a transfer between buses but also involves the center as a destination point.

This section provides general design considerations of transfer and transit centers. The development of a particular center requires consideration of such features as
passenger volume, number of buses on site at one time, and local auto and pedestrian traffic levels. These factors will dictate the particular requirements of each center.

(2) Bus Berths

Where several transit routes converge and where buses congregate, multiple bus berths or spaces are sometimes required. Parallel and shallow sawtooth designs are the options available when considering multiple berths.

An important aspect in multiple bus berthing is proper signing and marking for the bus bays. Each bay should clearly delineate the route served. In addition, the pavement should be marked with striping to indicate correct stopping positions.

Consideration should be given to using Portland Cement Concrete Pavement where pedestrians will walk for ease of cleaning.

Where buses are equipped with a bicycle rack, the design should provide for loading and unloading of bicycles.

Figure 1060-1 shows typical parallel and sawtooth designs for parking standard 40-foot buses for loading and unloading passengers at a transfer center. The sawtooth design does not require buses to arrive or depart in any order. The parallel design shown requires that the buses either arrive or depart in order.

Where space is a consideration, the sawtooth design can be used for independent arrival but dependent departure. Figure 1060-2 is an example of a sawtooth transit center. In an in-line berthing design, space requirements are excessive if this same access is to be provided. More commonly, in an in-line design, buses pull into the forward-most available berth. Buses must then leave in the order of arrival. The local transit authority should be involved throughout the design process and must concur with the final design.

In the design of parallel bus berths, additional roadway width is required for swing-out maneuvers if shorter bus loading platforms are utilized. The roadway width and amount of lineal space at the bus loading platform are directly related where designs allow departing buses to pull out from the platform around a standing bus. For example, a 40-foot bus with a 16-foot forward clearance requires 22 feet of roadway width for its pull-out maneuver. This condition requires a roadway width of at least 24 feet and a total minimum berth length of 56 feet for each bus. Thus, five buses would require 264 feet of linear distance. The shorter the berth length allowed, the wider the roadway must be.

Considerable linear space is necessary in a parallel design to permit a bus to overtake and pull into a platform ahead of a parked bus. For example, a 40-foot bus requires approximately 92 feet to pull in, assuming the rear end of the bus is 1 foot out from the platform curb and 56 feet when a 5-foot “tailout” is permitted.

Parallel designs, even if signed properly, require strict parking enforcement, since they give the appearance of general curbside parking areas. Pavement marking is most critical for parallel design. Sawtooth designs offer the advantage of appearing more like a formal transit facility, which tends to discourage unauthorized parking.

(3) Flow/Movement Alternatives

Two primary alternatives for vehicle and passenger movement are possible for transfer centers, regardless of the type of bus berths used. As shown in Figure 1060-3, all buses may line up along one side of the transfer center. This type of arrangement is generally only suitable for a limited number of buses, due to walking distances required for transferring passengers. For a larger number of buses, an arrangement similar to Figure 1060-4 can minimize transfer time requirements by consolidating the buses in a smaller area.

1060.05 BUS STOPS AND PULLOUTS

(1) Introduction

The bus stop is the point of contact between the passenger and the transit services. The simplest bus stop is a location by the side of the road. The highest quality bus stop is an area that provides passenger amenities such as a bench and protection from the weather.

Bus pullouts allow the transit vehicle to pick up and discharge passengers in an area outside the traveled way. The interference between buses and other traffic can be reduced by providing bus pullouts.

(2) Bus Stops Designation and Location

The location of bus stops should be standardized within the system to avoid undue confusion. However, standardization should not be a substitute for sound judgement whenever conditions render standard practice inappropriate. It is imperative that bus stops be of adequate length and located so that the adverse effect on traffic (including pedestrians) is kept to a minimum.

The following should be considered when locating bus stops:

- Bus stop placement requires the consent of the jurisdiction having authority over the affected right of way and the local transit authority.
- The physical location of any bus zone should be primarily determined by the following considerations: maximizing safety, operational efficiency, minimizing adjacent property impacts, and user destination points.
- Public transportation agencies are typically responsible for maintenance of transit facilities within the public right of way.
These elements are discussed in the following subsections.

The proper spacing for bus stops represents a trade-off between passenger convenience and bus operating speed. Closer spacing reduces passenger walking distance, while longer spacing permits faster and less expensive bus operations. The proper spacing in any specific area depends on the nature and layout of adjoining land uses and the number of passengers expected. Bus stops should be as close as possible to passenger origins and destinations.

If activity along the bus route is uniform, the typical bus stop spacing should be about 1,000 feet. A general minimum spacing should be 500 to 600 feet within the central business district (every 2 to 3 blocks). In this range, stops should be provided where streets intersect or where walkways from the surrounding areas reach the main street. Evaluation of pedestrian walking distances as a design issue in subdivision layout may yield short walking distances to bus stops and encourage transit use.

In suburban areas (mostly single-family housing with pockets of open space and undeveloped land), bus stops should be located approximately every 1,250 feet (four per mile). Stops are generally not provided where residential density drops below four units per acre.

If commercial, residential, or industrial activity along the bus route is not clustered, bus stops need not be located uniformly along routes, but can be sited at the activity nodes. Greater spacings, 1,500 to 2,500 feet (approximately two to four per mile), may be possible in these circumstances.

In order to evaluate a new route and build ridership, placement of bus zones may initially depart from the above guidelines.

(3) Bus Stop Placement

Where traffic volume is low, on-street parking is prohibited, and a stopped bus will not impede traffic, the bus stop may simply be a designated location where the bus can pull up to the curb or to the edge of the roadway. The location will be dictated by patronage, the intersecting bus routes or transfer points, security of the rider, and the need for convenient service.

The specific bus stop location is influenced not only by convenience to patrons, but also by the design characteristics and operational considerations of the highway or street. Bus stops are usually located in the immediate vicinity of intersections. Where blocks are exceptionally long, or where bus patrons are concentrated well removed from intersections, midblock bus stops, along with midblock crosswalks, may be used.

Bus stop capacity of one bus will typically be adequate for up to 30 buses per hour.

Where on-street auto parking is permitted, a designated area where the bus can pull in, stop, and pull out must be provided. Figure 1060-5 illustrates several types of bus stops.

- Far-side, with a stop located just past an intersection;
- Near-side, with a stop located just prior to an intersection; and
- Mid-block, with a stop located away from any intersections.

In general, a far-side stop is preferred, however, examine each case separately and determine the most suitable location giving consideration to such things as service to patrons, efficiency of transit operations, and traffic operation in general. Near-side and mid-block bus stops may be suitable in certain situations. Bus stops should utilize sites which encourage a pedestrian crossing, offers proximity to activity centers, and satisfy the general spacing requirements discussed previously. Following are descriptions of the advantages and disadvantages of each type of site.

(a) Far-Side Bus Stops. Advantages:

- Right turns can be accommodated with less conflict.
- A minimum of interference is caused at locations where traffic is heavier on the approach side of the intersection.
- Will cause less interference where the cross street is one-way street from left to right.
- Stopped buses do not obstruct sight distance for vehicles entering or crossing from a side street.
- At a signalized intersection, buses can find a gap to enter the traffic stream without interference, except where there are heavy turning movements into the street with the bus route.
- Waiting passengers assemble at less-crowded sections of the sidewalk.
- Buses in the bus stop will not obscure traffic control devices or pedestrian movements at the intersection.

Disadvantages:

- Intersections may be blocked if other vehicles park illegally in the bus stop, or if the stop is too short for occasional heavy demand.
- Stops on a narrow street or within a traffic lane may block the intersection.

(b) Near-Side Bus Stops. Advantages:

- A minimum of interference is caused at locations where traffic is heavier on the leaving side than on the approach side of the intersection.
- Will cause less interference where the cross street is one-way from right to left.
- Passengers generally exit the bus close to crosswalk.
• There is less interference with traffic turning into the bus route street from a side street.

Disadvantages:
• Heavy vehicular right turns can cause conflicts, especially where a vehicle makes a right turn from the left of a stopped bus.
• Buses often obscure sight distance stop signs, traffic signals, or other control devices, as well as pedestrians crossing in front of the bus.
• Where the bus stop is too short for occasional heavy demand, the overflow will obstruct the traffic lane.

(c) Mid-Block Bus Stops. Advantages:
• Buses cause a minimum of interference with sight distance of both vehicles and pedestrians.
• Stops can be located adjacent to major bus passenger generators.
• Waiting passengers assemble at less-crowded sections of the sidewalk.

Disadvantages:
• Pedestrian jaywalking is more prevalent.
• Patrons from cross streets must walk farther.
• Buses may have difficulty re-entering the flow of traffic.

Some general guidelines for the location of bus stops are:
• At intersections controlled by signals, stop, or yield signs, when transit is critical but traffic and parking are not critical, a near-side stop is preferable.
• At intersections where heavy left or right turns occur, a far-side bus stop should be used. If a far-side bus stop is impractical, the stop should be moved to an adjacent intersection or to a mid-block location in advance of the intersection.
• It is important that the bus stop be clearly marked as a no parking zone with signs and/or curb painting.
• For safety and accessibility, all loading and unloading should be made from the curb, not in the street/traffic lane.
• At intersections where bus routes and heavy traffic movements diverge, a far-side stop can be used to advantage.

Mid-block stop areas are recommended under the following conditions: (1) where traffic or physical street characteristics prohibit a near or far-side adjacent to an intersection; or (2) where large factories, commercial establishments, or other large bus passenger generators exist. A mid-block stop should be located at the far-side of a pedestrian crosswalk (if one exists) so that standing buses will not block an approaching motorist's view of pedestrians in the crosswalk.

• Sight distance conditions generally favor far-side bus stops, especially at unsignalized intersections. A driver approaching a cross street on the through lanes can see any vehicles approaching from the right. With near-side stops the view to the right may be blocked by a stopped bus. Where the intersection is signalized, the bus may block the view of one of the signal heads.
• For security purposes the availability of adequate off-street lighting is an important consideration.

(4) Bus Pullouts

Bus pullouts are generally most appropriate when one or more of the following situations exits:
• Traffic in the curb lane exceeds 250 vehicles during the peak hour.
• Passenger volume at the stop exceeds 20 boardings an hour.
• Traffic speed is greater than 45 miles per hour.
• Accident patterns are recurrent.

The separation of transit and passenger vehicles is critical in cases of high bus or traffic volumes or high speeds. Bus stops in the travel lane may be unsafe or impede the free flow of traffic. Bus pullouts should also be considered at locations with high bus passenger loading volumes that cause traffic to back up behind the stopped bus.

To be fully effective, the pullout should incorporate a deceleration lane or taper, adequate staging area for all anticipated buses, and a merging lane or taper. As roadway operating speeds increase, the taper length should increase accordingly. Many times, high traffic volumes will not allow sufficient gaps for the bus operator to return the vehicle safely to the traffic stream. When this happens, the operator may opt not to use the turnout.

Figure 1060-6 illustrates the dimensions and design features of bus pullouts associated with near-side, far-side, and mid-block bus pullouts.

There are no absolute criteria for locating bus pullouts. Where a pullout is being considered, the transit agency must be involved. Factors controlling the appropriate location and eventual success of a pullout include:
• Operating speed.
• Traffic volume.
• Number of passenger boardings.
• Available right of way.
• Roadway geometrics (horizontal and vertical).
• Construction costs.
• Location of curb ramps.

Figure 1060-7 illustrates the dimension and design requirements of far-side bus zones and pullouts where buses will stop after making a right turn. Adherence to these designs should allow safe stopping of buses with minimal interference with legally parked vehicles.
It is important in the design of bus pullouts to consider the need to provide structurally adequate pavement for the bus pullout (Chapter 520), otherwise the surfacing may be damaged by the weight of the buses.

1060.06 PASSENGER AMENITIES

(1) Introduction

Providing an attractive, pleasant setting for the walk and wait are important elements in attracting bus users.

A passenger arriving at a bus stop desires a comfortable place to wait. Important elements of a bus stop are:

- Safety from passing traffic.
- Adequate lighting.
- Security.
- Paved surface.
- Protection from the environment.
- A seat (if the wait may be long).
- Information about the routes serving the stop.

Providing safety from passing traffic involves locating stops where there is adequate space, so passengers can wait away from the edge of the traveled roadway. The buffering distance required from the roadway increases with traffic speed and traffic volume. Three to 5 feet is adequate where vehicle speeds are 30 miles per hour. A heavy volume arterial with speeds of 45 miles per hour can require a distance of 8 to 10 feet for passenger comfort.

Passengers arriving at bus stops, especially infrequent riders, want information and reassurance. Information provided should include the numbers or names of routes serving the stop. Other important information may include a system route map, the hours and days of service, schedules, and a phone number for information. The information provided and format used is typically the responsibility of the local transit system.

At busier stops, including park and ride lots, a public telephone should be provided. For all paved park and ride lots, a desirable site for a public telephone should be selected and conduit provided whether or not a telephone is currently planned. Where shelters are not provided, a bus stop sign and, depending on weather conditions, passenger bench are desirable. The sign indicates to passengers where to wait and can provide some basic route information.

(2) Passenger Shelters

Passenger shelters should provide protection for waiting transit users. In accomplishing this task, the shelter itself must be located conveniently for users without creating hazards — such as blocking the line of sight of automobile drivers or blocking the sidewalk. Figure 1060-8 illustrates a clear sight triangle that will permit shelter sitting with minimal impact on sight distances at urban arterial intersections without traffic controls. The dimensions may vary by local jurisdiction — check local zoning ordinances or with appropriate officials.

State Motor Vehicle Funds cannot be used for design or construction of shelters, except for the concrete pad. Funding of shelters must be handled by the transit agency or some other local agency.

Adequate lighting is necessary to enhance passenger security. Lighting makes the shelter visible to passing traffic and allows waiting passengers to read information provided. General street lighting is usually adequate. Where street lights are not in place, additional street lights or transit shelter lights should be considered.

A properly drained, paved surface is necessary so that passengers will not traverse puddles and mud in wet weather. Protection from the environment is typically provided by a shelter that provides shade from the sun, protection from rain and snow, and a wind break. Shelters can range from simple to elaborate. The latter type may serve as an entrance landmark for a residential development or employment complex and be designed to carry through the architectural theme of the complex. If a nonpublic transportation entity shelter is provided, its design and siting must be approved by the local transit operator. The reasons for this approval requirement include safety, barrier-free design and long-term maintenance concerns.

Simple shelters, such as that illustrated in Figure 1060-9, may be designed and built by the transit agency or purchased from commercial vendors. The WSDOT Architecture Office may be contacted for more complex designs.

If resources permit, shelter placement should be considered at most bus stops in new commercial and office developments and in places where large numbers of elderly and disabled persons may wait, i.e., hospitals, senior centers, etc. In residential areas, shelters are placed only at the highest volume stops.

1060.07 ROADWAY AND VEHICLE DESIGN CRITERIA CHARACTERISTICS

(1) Paving Sections

The pavement design (type and thickness) of a transit benefit project, whether initiated by a public transportation agency or a private entity, must be coordinated with WSDOT or the local agency public works department depending on highway, street, or road jurisdiction. These agencies play a major role in determining the paving section for the particular project. Early and frequent coordination is required.
Paving section design is determined by the volume and type of traffic, design speed, soil characteristics, availability of materials, construction costs, and maintenance cost. Important characteristics of good pavement design are the ability to retain shape and dimensions, the ability to drain, and the ability to maintain adequate skid resistance.

See Chapter 510 "Investigation of Soils and Surfacing Materials" and Chapter 520 "Design of Pavement Structure" for guidance in the design of pavements.

(a) Grades. Roadway grades refer to the maximum desirable slope or grade, or the maximum slope based upon the minimum design speed that a standard 40-foot transit bus can negotiate safely. Guidance on roadway grades is in Chapter 440 or in the Local Agency Guidelines. Public transportation agencies or private developers should coordinate their needs with WSDOT or the appropriate local agency. Speed of buses on grades is directly related to the weight/horsepower ratio. Grades should be selected to permit uniform operation at an affordable cost. In cases where the roadway is steep, a climbing lane for buses and trucks may be needed. Abrupt changes in grade should be avoided due to bus overhangs and ground clearance requirements.

(b) Lane Widths. Roadway and lane widths are generally regulated by WSDOT or the Local Agency Guidelines, based upon the functional class of highway or road under their respective jurisdiction. Private developers should contact these agencies early in the design process to ensure that roadway and lane widths are consistent with applicable standards. Roadway capacity is directly affected by lane width. As lanes narrow, anticipated capacity is lowered. Controls determining adequate lane width include design speed, anticipated traffic volume, types of user vehicles, available right of way, and roadside obstructions, i.e., retaining walls, light poles, and street furniture.

For lanes to be used by High Occupancy Vehicles (HOV), buses, vanpools, and carpools, the recommended width is 12 feet. Lane widths should not be less than 12 feet when transit volumes are high. Chapter 1050 provides additional information on HOV facilities.

(2) Vehicle Characteristics/Specifications

Most transit agencies operate several types of buses within their system. Vehicle sizes range from the articulated bus to passenger vans operated for specialized transportation purposes and vanpooling.

Each manufacturer within each of the general classifications may vary dimensions such as wheelbase, height, and vehicle overhang. The total gross vehicle weight rating (GVWR) varies considerably among manufacturers for the type of general vehicle classification. Because of these differences, more specific design information should be obtained from the local transit authority.

The principal dimensions affecting design are the minimum turning radius, the tread width, the wheelbase, and the path of the inner rear tire. Effects of driver characteristics and the slip angle of the wheels are minimized by assuming that the speed of the vehicle for the minimum radius (sharpest) turn is less than 10 miles per hour.

(a) Large Transit Buses. These traditional urban transit service vehicles are typically 40 feet long and have a wheelbase of approximately 25 feet. Many agencies operate 35-foot buses which have a 19-foot wheelbase. Many of these vehicles are equipped with either front or rear door wheelchair lifts, or a front "kneeling" feature that reduces the step height for mobility impaired patrons.

(b) Articulated Transit Bus. Because articulated buses are hinged between two sections, these vehicles can turn on a relatively short radius. Articulated buses are typically 60 feet in length with a wheelbase of 19 feet from the front axle to mid-axle and 24 feet from the mid-axle to the rear axle.

(c) Small Transit Buses. Some of the smaller transit agencies operate 26 to 30-foot transit coaches which are designed for use in low volume situations. Modified vans are used for transportation of the elderly and disabled persons and shuttle services. Passenger vans are a third type of small bus, used for specialized transportation and vanpooling. Some of these vans have been modified to provide special seating arrangements. Since the vehicle specifications vary so widely within this category, consult the local transit authority or bus manufacturer for specifications of the particular vehicle in question.

1060.08 INTERSECTION RADII

A fundamental characteristic of transit accessible development is safe, convenient access and circulation for transit vehicles. It is important that radii at intersections be designed to accommodate turning buses. Adequate radii will reduce conflicts between automobiles and buses, reduce bus travel time, and provide maximum comfort for the passengers.

The following major factors should be taken into consideration in designing intersection radii:

- Right of way availability.
- Angle of intersection.
- Width and number of lanes on the intersecting streets.
- Design vehicle turning radius.
• Parking at the intersection.
• Allowable bus encroachment.
• Operating speed and speed reductions.
• Pedestrians.
• Bicycles.

Because of space limitations and generally lower operating speeds in urban areas, curve radii for turning movements may be smaller than those normally used in rural areas. It is assumed that buses making turns are traveling at speeds of less than 10 miles per hour. Figures 1060-10 and 11 illustrate the Turning Templates and design vehicle specifications for a standard 40-foot bus and an articulated bus.

Figure 1060-12 illustrates appropriate radii at intersections for four types of parking configurations which may be associated with an intersection. Radii less than minimum result in encroachment into adjoining lanes or curbs. As intersection radii increase, pedestrian crossing distances increase.

To ensure efficient transit operation on urban streets, it is desirable to provide corner radii of from 35 to 50 feet (based on the presence of curb parking on the streets) for right turns to and from the through lanes. Where there are curb parking lanes on both of the intersecting streets and parking is restricted for some distance from the corner, the extra width provided thereby serves to increase the usable radius.

Angle of intersection also influences the turning path of the design vehicle. Figure 1060-13 shows the effect of the angle of intersection on the turning path of the design vehicle on streets without parking. Figure 1060-13 also illustrates different cases; when a vehicle turns from proper lane and swings wide on the cross street, and when the turning vehicle swings equally wide on both streets.

1060.09 DISABLED ACCESSIBILITY

(1) Introduction

Public transportation providers have an obligation under both state and federal laws to create and operate capital facilities and vehicles that are usable by the wide variety of residents in the service area. A major need arising from this obligation is to provide transportation service to the transit dependent, among whom are disabled individuals.

According to the report titled “Persons of Disability in Washington State — A Statistical Profile 1970-1980” by the Washington State Employment Security Department, the percentage of persons with disabilities within the state in the working age years of 16 to 64 was 8.7 percent in 1980. The number of elderly people with disabilities that affect mobility is far higher.

Federal law requires all new or significantly rehabilitated buses to be accessible to the disabled. Transit agencies are also required to provide demand response service comparable with the fixed route service.

Barrier-free design means more than just accommodating wheelchairs. Care needs to be given not to create hazards or barriers for people who have vision or hearing impairments. The key is to design clear pathways without obstacles and signs that are simple with large print.

Transit Benefit facilities are designed for accessibility aspects under the Uniform Federal Accessibility Standards (UFAS) and/or, Chapter 51-10 WAC “Washington State Regulations for Barrier-Free Facilities” or local agency standards where applicable.

(2) Park and Ride Lots

Parking stalls for the disabled should be located in close proximity to the transit loading and unloading area. Stalls shall be at least 8 feet wide with a 5-foot adjacent loading aisle on each side with sidewalk curb cuts (see Standard Plans). Two accessible parking stalls may share a common access aisle. Provide disabled stalls according to the following table:

<table>
<thead>
<tr>
<th>Total Parking Stalls in Lot</th>
<th>Required Disabled Parking Stalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 25</td>
<td>1</td>
</tr>
<tr>
<td>26 to 50</td>
<td>2</td>
</tr>
<tr>
<td>51 to 75</td>
<td>3</td>
</tr>
<tr>
<td>76 to 100</td>
<td>4</td>
</tr>
<tr>
<td>101 to 150</td>
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<tr>
<td>151 to 200</td>
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</tr>
<tr>
<td>201 to 300</td>
<td>7</td>
</tr>
<tr>
<td>301 to 400</td>
<td>8</td>
</tr>
<tr>
<td>401 to 500</td>
<td>9</td>
</tr>
<tr>
<td>501 to 1,000</td>
<td>2% of total</td>
</tr>
<tr>
<td>1,001 and over</td>
<td>20 plus 1 for each</td>
</tr>
<tr>
<td></td>
<td>100 over 1,000</td>
</tr>
</tbody>
</table>

No more than two of these stalls need be striped and signed for disabled use at the time of initial operation. The remaining stalls may be striped for standard usage, but the curb cuts for wheelchair ramps should be provided for each future stall. Additional stalls shall be made available for use by disabled patrons when demand indicates the need.

A parking stall for disabled persons shall be signed according to the requirements of RCW 46.61.581.

Disabled facilities should be in accordance with the following:
• Disabled patrons should not have to cross access roads enroute to the bus loading zone.
• Disabled patrons should not be forced to travel behind parked cars (in their circulation path).
• Wheelchair ramps shall be provided to facilitate the movement of physically disabled patrons.

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• Parking stalls and access aisles shall be level with surface slopes not exceeding 2 percent.

**3) Bus Stops and Shelters**

In order to use buses which are accessible, bus stops must also be accessible to disabled persons. The nature and condition of streets, sidewalks, passenger loading pad, curb ramps, and other bus stop facilities can constitute major obstacles to mobility and accessibility. State, local, public and private agencies need to work closely with public transportation officials to enhance accessibility for people with disabilities. A significant component of bus stop accessibility is in the provision of “pads” for the deployment of wheelchair lifts. The terrain where a wheelchair pad is located should be level. The pad should be constructed of cement concrete, asphalt concrete pavement, or a similar impervious surface. The approach to the pad should not consist of grass, gravel, or any surface where a wheelchair might lose traction. The pad should have a minimum slope toward the curb sufficient for drainage purpose. The stop pad should measure at least 10 feet in length and 8 feet in width. When right of way or other limitations restrict the pad size, a smaller pad may be provided, but it must be able to accommodate a wheelchair.

The local public transit agency should be involved in the pad design to help ensure that lifts can actually be deployed at this site.

In order to access a bus stop, it is important that the path to these facilities also be accessible by the use of sidewalks with curb ramps. The Standard Plans contain design and construction information for cement concrete sidewalks and curb ramps. A continuous curb ramp is used for accessibility of disabled park and ride users as part of the accessible path to the bus stop and shelter.

In the design of bus stops and/or shelters the following should be considered:
• Inclusion of bus stop disabled access as a critical factor in the selection of locations for pedestrian improvements within the safety component of the state’s or local agency capital improvement program.
• Ensure that curb ramps are properly sloped and sized for safe wheelchair usage and that they have textured surfaces to warn blind persons (see the Standard Plans).
• Identification of places that require sidewalks.
• Encouragement that property owners keep existing sidewalks in a good state of repair.
• Encouragement and continued emphasis of standards requiring all new street construction or reconstruction to include sidewalk or pedestrian walkway and curb ramps.

• Bus stop should be identified with curb painting and/or bus stop signs. Both disabled and nondisabled persons will benefit from this.
• All bus stops that can be made accessible should be made accessible, whether or not the paths to them are accessible, as future improvements may make the paths accessible.
• All bus stop signs along a route served by accessible vehicles should be marked with the blue international accessibility symbol conforming to the requirements of RCW 70.92.120 for easier identification by users.
• Existing as well as future park and ride locations must, by state law, include reserved parking for disabled persons, marked with signs as outlined in RCW 46.61.581.

1060.10 REFERENCES


Manual on Uniform Traffic Control Devices for Streets and Highways, (MUTCD), FHWA.

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

Design Guidelines for Bus Facilities, Orange County Transit District, Garden Grove, California, November 1987.


VDM10

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1060-13
Parallel Design

NOT TO SCALE

Sawtooth Design

BUS BERTH DESIGNS
Figure 1060-1
(Metric)
TRANSIT CENTER
SAWTOOTH BUS BERTH
DESIGN EXAMPLE
Figure 1060-2
BUS TURNOUT TRANSFER CENTER

Figure 1060-3
(Metric)
OFF-STREET TRANSFER CENTER

Figure 1060-4
(Metric)
Minimum Lengths for Bus Curb Loading Zones (L)¹

<table>
<thead>
<tr>
<th>Approx. Bus Length (L)</th>
<th>Near Side²,³</th>
<th>Far Side²</th>
<th>Mid Block</th>
<th>Near Side²,³</th>
<th>Far Side²</th>
<th>Mid Block</th>
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<td>12</td>
<td>31.5</td>
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<td>18</td>
<td>37.5</td>
<td>30</td>
<td>48</td>
<td>57</td>
<td>48</td>
<td>66</td>
</tr>
</tbody>
</table>

¹Based on bus 0.3 m from curb. When bus is 0.15 m from curb, add 6.0 m near side, 4.5 m far side, and 6.0 m midblock. Based on streets 12.0 m wide, add 4.5 m when 10.5 m wide and 9.0 m when 9.6 m wide.

²Measured from extension of building line or established stop line. Add 4.5 m where buses make a right turn.

³Add 9.0 m where right turn volume is high for other vehicles.

MINIMUM BUS ZONE DIMENSIONS

Figure 1060-5
(Metric)
See Chapter 910 for right turn lane design.

* 15 m Bay is for one standard 12 m bus. Add 13.5 m for each additional standard bus. Articulated buses require 21 m bays, with 19.5 m for each additional.

**Bus Stop Pullouts, Arterial Streets**

*Figure 1060-6*
MINIMUM BUS ZONE AND PULLOUT AFTER RIGHT TURN DIMENSIONS

Figure 1060-7
(Metric)
SHELTER SITING
Figure 1060-8
(Metric)
TYPICAL BUS SHELTER DESIGN
Figure 1060-9
(Metric)

Note: Bench style can vary.
Design Vehicle Turning Movements

Figure 1060-10

(Metric)

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Turning Template for Articulated Bus

Figure 1060-11
(Metric)
INTERSECTION DESIGN
Figure 1060-12
(Metric)

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1060-25
<table>
<thead>
<tr>
<th>Design Vehicle</th>
<th>R = 4.5 m</th>
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<td>B</td>
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<td>7.5</td>
<td>9.6</td>
</tr>
</tbody>
</table>

**CASE A**

Vehicle turns from proper lane and swings wide on cross street.

**CASE B**

Turning vehicle swings equally wide on both streets.

**CROSS-STREET WIDTH OCCUPIED BY TURNING VEHICLE FOR VARIOUS ANGLES OF INTERSECTION AND CURB RADI**

Figure 1060-13

(Metric)
Parallel Design

NOT TO SCALE

Sawtooth Design

BUS BERTH DESIGNS
Figure 1060-1
BUS TURNOUT TRANSFER CENTER

Figure 1060-3

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March 1994
OFF-STREET TRANSFER CENTER
Figure 1060-4
Minimum Lengths for Bus Curb Loading Zones (L)\(^1\)

<table>
<thead>
<tr>
<th>Loading Zone Length (feet)</th>
<th>One Bus Stop</th>
<th>Two Bus Stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx. Bus Length(L)</td>
<td>Near Side(^2,3)</td>
<td>Far Side(^2)</td>
</tr>
<tr>
<td>25</td>
<td>90</td>
<td>65</td>
</tr>
<tr>
<td>30</td>
<td>95</td>
<td>70</td>
</tr>
<tr>
<td>35</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>40</td>
<td>105</td>
<td>80</td>
</tr>
<tr>
<td>60</td>
<td>125</td>
<td>100</td>
</tr>
</tbody>
</table>

\(^1\) Based on bus 1 foot from curb. When bus is 0.5 feet from curb, add 20 feet near side, 15 feet far side, and 20 feet midblock. Based on streets 40 feet wide, add 15 feet when 35 feet wide and 30 feet when 32 feet wide.

\(^2\) Measured from extension of building line or established stop line. Add 15 feet where buses make a right turn.

\(^3\) Add 30 feet where right turn volume is high for other vehicles.

MINIMUM BUS ZONE DIMENSIONS

Figure 1060-5
BUS STOP PULLOUTS, ARTERIAL STREETS

Figure 1060-6

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1060-31
MINIMUM BUS ZONE AND PULLOUT AFTER RIGHT TURN DIMENSIONS

Figure 1060-7

- Based on a standard 40' bus. Add 20' for articulated buses.
SHELTER SITING
Figure 1060-8
TYPICAL BUS SHELTER DESIGN
Figure 1060-9

Note: Bench style can vary.
Design Vehicle Turning Movements

Figure 1060-10
Turning Template for Articulated Bus

Figure 1060-11
INTERSECTION DESIGN
Figure 1060-12
### $d_2$ (ft) for Cases A and B Where:

<table>
<thead>
<tr>
<th>Design Vehicle</th>
<th>$R=15'$</th>
<th>$R=20'$</th>
<th>$R=25'$</th>
<th>$R=30'$</th>
<th>$R=40'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$30^\circ$</td>
<td>22</td>
<td>17</td>
<td>19</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>$60^\circ$</td>
<td>28</td>
<td>21</td>
<td>26</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>$90^\circ$</td>
<td>38</td>
<td>23</td>
<td>33</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>$120^\circ$</td>
<td>46</td>
<td>28</td>
<td>40</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>$150^\circ$</td>
<td>48</td>
<td>28</td>
<td>40</td>
<td>25</td>
<td>32</td>
</tr>
</tbody>
</table>

---

**CASE A**

Vehicle turns from proper lane and swings wide on cross street.

$d_2=12'$; $d_3$ is variable

---

**CASE B**

Turning vehicle swings equally wide on both streets.

$d_2=d_3$; both variable

---

**CROSS-STREET WIDTH OCCUPIED BY TURNING VEHICLE FOR VARIOUS ANGLES OF INTERSECTION AND CURB RADII**

Figure 1060-13
1110 Site Data for Structures

1110.01 General
The Olympia Service Center Bridge and Structures Office provides structural design services to the regions. This chapter describes the information required by the Bridge and Structures Office to perform this function.

1110.02 References
Bridge Design Manual, M 23-50, WSDOT
Plans Preparation Manual, M 22-31, WSDOT

1110.03 Required Data for All Structures
Submit the bridge site data to the Bridge and Structures Office. Provide a cover memo that gives general information on the project, describes the attachments, and transmits the forms and data included in the submittal. Submit site data as a CAD file, supplemental drawings, and a report. See Figure 1110-1 for items to include in a bridge site data submittal. Direct any questions relating to the preparation of bridge site data to the Bridge and Structures Office. The Bridge Design Manual shows examples of required WSDOT forms.

(1) CAD Files and Supplemental Drawings
The Bridge and Structures Office uses the GDS Computer-Aided Drafting (CAD) system. CAD files prepared for use as bridge site data will be accepted in standard DGN, DXF, or DWG format.

Prepare plan, profile, and section drawings for all structures. Include copies of the CAD site data and supplemental drawings in the reduced plan sheet format with the submittal.

Use a complete and separate CAD file for each structure. See the Plans Preparation Manual for information regarding drawing levels and use the Bridge and Structures format. The Bridge Design Manual contains examples of completed Bridge Preliminary Plans. These plans show examples of the line styles and drawing format for site data in CAD.

Include the following information in the CAD files or in the supplemental drawings:

(a) Plan
- Drawing scales for the bridge site plan:

<table>
<thead>
<tr>
<th>Length of Structure</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 ft to 100 ft</td>
<td>1”=10’</td>
</tr>
<tr>
<td>100 ft to 500 ft</td>
<td>1”=20’</td>
</tr>
<tr>
<td>500 ft to 800 ft</td>
<td>1”=30’</td>
</tr>
<tr>
<td>800 ft to 1,100 ft</td>
<td>1”=40’</td>
</tr>
<tr>
<td>more than 1,100 ft</td>
<td>1”=50’</td>
</tr>
</tbody>
</table>

The bridge site data is used to prepare the bridge layout plan which is used in the contract plans. The drawing scales shown are for the full-sized contract plan format and are a guide only. Consider the width and general alignment of the structure when selecting the scale. For structures on curved alignments or where the bridge width is nearly equal to or greater than the bridge length, consult the Bridge and Structures Office for an appropriate plan scale.

- Vertical and horizontal datum control. See Chapters 1440 and 1450.

- Contours of the existing ground surface. Use intervals of 1, 2, 5, or 10 ft depending on terrain and plan scale. The typical contour interval is 2 ft. Use 1 ft intervals for flat terrain. Use 5 ft or 10 ft
intervals for steep terrain or small scales. Show contours beneath an existing or proposed structure and beneath the water surface of any waterway.

- Alignment of the proposed highway and traffic channelization in the vicinity.
- Location by section, township, and range.
- Type, size, and location of all existing or proposed sewers, telephone and power lines, water lines, gas lines, traffic barriers, culverts, bridges, buildings, and walls.
- Location of right of way lines and easement lines.
- Distance and direction to nearest towns or interchanges along the main alignment in each direction.
- Location of all roads, streets, and detours.
- Stage construction plan and alignment.
- Type, size, and location of all existing and proposed sign structures, light standards, and associated conduits and junction boxes. Provide proposed signing and lighting items when the information becomes available.
- Location of existing and proposed drainage.
- Horizontal curve data. Include coordinates for all control points.

(b) Profile

- Profile view showing the grade line of the proposed or existing alignment and the existing ground line along the alignment line.
- Vertical curve data.
- Superelevation transition diagram.

(c) Section

- Roadway sections on the bridge and at the bridge approaches. Indicate the lane and shoulder widths, cross slopes and side slopes, ditch dimensions, and traffic barrier requirements.
- Stage construction roadway geometrics with the minimum lane and roadway widths specified.

(2) Report

Submit DOT Form 235-002, “Bridge Site Data-General.” Supplement the CAD drawings with the following items:

- Vicinity maps
- Class of highway
- Design speed
- Special requirements for replacing or relocating utility facilities
- ADT and DHV counts
- Truck traffic percentage
- Requirements for road or street maintenance during construction

(3) Video and Photographs

Submit a VHS video of the site. Show all the general features of the site and details of existing structures. Scan the area slowly, spending extra time showing existing bridge pier details and end slopes. A “voice over” narrative on the video is necessary for orientation.

Color photographs of the structure site are desirable. Include detailed photographs of existing abutments, piers, end slopes, and other pertinent details for widenings, bridge replacements, or sites with existing structures.

1110.04 Additional Data for Waterway Crossings

Coordinate with the Olympia Service Center (OSC) Hydraulics Branch and supplement the bridge site data for all waterway crossings with the DOT Form 235-001, “Bridge Site Data for Stream Crossings” and the following:

(a) Plan

- Show riprap or other slope protection requirements at the bridge site (type, plan limits, and cross section) as determined by the OSC Hydraulics Branch.

(b) Profile

- Show a profile of the waterway. The extent will be determined by the OSC Hydraulics Branch.
(c) Section

• Show cross sections of the waterway. The extent will be determined by the OSC Hydraulics Branch.

The requirements for waterway profile and cross sections may be less stringent if the Hydraulics Branch has sufficient documentation (FEMA reports, for example) to make a determination. Contact the Hydraulics Branch to verify the extent of the information needed. Coordinate any rechannelization of the waterway with the Hydraulics Branch.

Many waterway crossings require a permit from the U.S. Coast Guard. (See Chapter 240.) Generally, ocean tide influenced waterways and waterways used for commercial navigation require a Coast Guard permit. These structures require the following additional information:

• Names and addresses of the landowners adjacent to the bridge site.

• Quantity of new embankment material within the floodway. This quantity denotes, in cubic meters, the material below normal high water and the material above normal high water.

Some waterways may qualify for an exemption from Coast Guard permit requirements if certain conditions are met. See the Bridge Design Manual. If the waterway crossing appears to satisfy these conditions, then submit a statement explaining why this project is exempt from a Coast Guard permit. Attach this exemption statement to the Environmental Classification Summary prepared for the project and submit it to the OSC Project Development Branch for processing to FHWA.

The region is responsible for coordination with the Bridge and Structures Office, U. S. Army Corps of Engineers, and U. S. Coast Guard for waterways that may qualify for a permit exemption. The Bridge and Structures Office is responsible for coordination with the U.S. Coast Guard for waterways that require a permit.

1110.05 Additional Data for Grade Separations

(1) Highway-Railroad Separation

Supplement bridge site data for structures involving railroads with the following:

(a) Plan

• Alignment of all existing and proposed railroad tracks.

• Center-to-center spacing of all tracks.

• Angle, station, and coordinates of all intersections between the highway alignment and each track.

• Location of railroad right of way lines.

• Horizontal curve data. Include coordinates for all circular and spiral curve control points.

(b) Profile

• For proposed railroad tracks; profile, vertical curve, and superelevation data for each track.

• For existing railroad tracks, elevations accurate to 0.1 ft taken at 10-ft intervals along the top of the highest rail of each track. Provide elevations to 50 ft beyond the extreme outside limits of the existing or proposed structure. Tabulate elevations in a format acceptable to the Bridge and Structures Office.

(2) Highway-Highway Separation

Supplement bridge site data for structures involving other highways by the following:

(a) Plan

• Alignment of all existing and proposed highways, streets, and roads.

• Angle, station, and coordinates of all intersections between all crossing alignments.

• Horizontal curve data. Include coordinates for all curve control points.

(b) Profile

• For proposed highways; profile, vertical curve, and superelevation data for each.
- For existing highways; elevations accurate to 0.1 ft taken at intervals of 10 ft along the center line or crown line and each edge of shoulder, for each alignment, to define the existing roadway cross slopes. Provide elevations to 50 ft beyond the extreme outside limits of the existing or proposed structure. Tabulate elevations in a format acceptable to the Bridge and Structures Office format.

(c) Section
- Roadway sections of each undercrossing roadway indicating the lane and shoulder widths, cross slopes and side slopes, ditch dimensions, and traffic barrier requirements.
- Falsework or construction opening requirements. Specify minimum vertical clearances, lane widths, and shy distances.

1110.06 Additional Data for Widenings
Bridge rehabilitations and modifications that require new substructure are defined as bridge widenings.

Supplement bridge site data for structures involving bridge widenings by the following:
- Submit DOT Form 235-002A, “Supplemental Bridge Site Data-Rehabilitation/Modification.”

(a) Plan
- Stations for existing back of pavement seats, expansion joints, and pier center lines based on field measurement along the survey line and each curb line.
- Locations of existing bridge drains. Indicate whether these drains are to remain in use or be plugged.

(b) Profile
- Elevations accurate to 0.1 ft taken at intervals of 10 ft along the curb line of the side of the structure being widened. Pair these elevations with corresponding elevations (same station) taken along the crown line or an offset distance (minimum of 10 ft from the curb line). This information will be used to establish the cross slope of the existing bridge. Tabulate elevations in a format acceptable to the Bridge and Structures Office.

Take these elevations at the level of the concrete roadway deck. For bridges with latex modified or microsilica modified concrete overlay, elevations at the top of the overlay will be sufficient. For bridges with a nonstructural overlay, such as an asphalt concrete overlay, take elevations at the level of the concrete roadway deck. For skewed bridges, take elevations along the crown line or at an offset distance (10 ft minimum from the curb line) on the approach roadway for a sufficient distance to enable a cross slope to be established for the skewed corners of the bridge.

1110.07 Documentation
The following documents are to be preserved in the project file. See Chapter 330.

- DOT Form 235-002, “Bridge Site Data - General”
- DOT Form 235-001, Bridge Site Data for Stream Crossings”
- DOT Form 235-002A, “Supplemental Bridge Site Data - Rehabilitation/Modification”
- United States Coast Guard permit
- Environmental Classification Summary

P65:DP/DME
Review Chapter 1110 of the *Design Manual* for further information and description of the items listed below.

**PLAN (In CAD file.)**
- Survey Lines and Station Ticks
- Survey Line Intersection Angles
- Survey Line Intersection Stations
- Survey Line Bearings
- Roadway and Median Widths
- Lane and Shoulder Widths
- Sidewalk Width
- Connection/Widening for Traffic Barrier
- Profile Grade and Pivot Point
- Roadway Superelevation Rate (if constant)
- Lane Taper and Channelization Data
- Traffic Arrows
- Mileage to Towns Along Main Line
- Existing Drainage Structures
- Existing Utilities — Type/Size/Location
- New Utilities — Type/Size/Location
- Light standards, Junction boxes, Conduits
- Bridge Mounted Signs and Supports
- Contours
- Bottom of Ditches
- Test Holes (if available)
- Riprap Limits
- Stream Flow Arrow
- R/W Lines and/or Easement Lines
- Existing Bridge No. (to be removed, widened)
- Section, Township, Range
- City or Town
- North Arrow
- SR Number
- Scale

**TABLES (In tabular format in CAD file.)**
- Curb Line Elevations. at Top of Exist. Br. Deck
- Undercrossing Roadway Existing Elevations
- Undercrossing Railroad Existing Elevations
- Curve Data

**OTHER SITE DATA (May be in CAD or may be on supplemental sheets or drawings.)**
- Superelevation Diagrams
- End Slope Rate
- Profile Grade Vertical Curves
- Coast Guard Permit Status
- Railroad Agreement Status
- Highway Classification
- Design Speed
- ADT, DHV, and % T

**FORMS (Information noted on the form or attached on supplemental sheets or drawings.)**
- Bridge Site Data General
  - Slope Protection
  - Pedestrian Barrier/Pedestrian Rail Height Requirements
  - Construction/Falsework Openings
  - Stage Construction Channelization Plans
  - Bridge (before/with/after) Approach Fills Datum
  - Video of Site
  - Photographs of Site
  - Control Section
  - Project Number
  - Region Number
  - Highway Section

- Bridge Site Data for Stream Crossings
  - Water Surface Elevations and Flow Data
  - Riprap Cross Section Detail

- Supplemental Bridge Site Data-Rehabilitation/Modification

**BRIDGE, CROSSROAD, AND APPROACH ROADWAY CROSS SECTIONS**
(May be in CAD or separate drawings.)
- Bridge Roadway Width
- Lane and Shoulder Widths
- Profile Grade and Pivot Point
- Superelevation Rate
- Survey Line
- PB/Pedestrian Rail Dimensions
- Stage Construction Lane Orientations
- Locations of Temporary Barrier
- Conduits/Utilities in Bridge
- Location and Depth of Ditches
- Shoulder Widening for Barrier
- Side Slope Rate

---

**Bridge Site Data Check List**

*Figure 1110-1*
1120.01 General
A bridge is a structure having a clear span of 20 ft or more. Bridge design is the responsibility of the Bridge and Structures Office in Olympia. A project file is required for all bridge construction projects. The Bridge Office develops a preliminary bridge plan for a new or modified structure in collaboration with the region. This chapter provides basic design considerations for the development of this plan. Unique staging requirements, constructibility issues, and other considerations are addressed during the development of this plan. Contact the Bridge Office early in the planning stage on issues that might affect the planned project.

1120.02 References
*Bridge Design Manual, M 23-50, WSDOT*
*Local Agency Guidelines, M 36-63, WSDOT*
*Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT*

1120.03 Bridge Location
Bridges are located to conform to the alignment of the highway. Providing the following conditions can simplify design efforts, minimize construction activities, and reduce structure costs:
- A perpendicular crossing
- The minimum required horizontal and vertical clearances
- A constant bridge width (without tapered sections)
- A tangential approach alignment of sufficient length to not require superelevation on the bridge

1120.04 Bridge Site Design Elements

(1) Structural Capacity
The structural capacity of a bridge or culvert is a measure of the structure’s ability to carry vehicle loads. For new bridges, the bridge designer chooses the design load that determines the structural capacity. For existing bridges, the structural capacity is calculated to determine the “load rating” of the bridge. The load rating is used to determine whether or not a bridge is “posted” for legal weight vehicles or if the bridge is “restricted” for overweight permit vehicles.

a) New Structures. All new structures must be designed to HL-93 notional live load in accordance with AASHTO LRFD Bridge Design Specifications or HS-25 live loading in accordance with the AASHTO Standard Specifications for Highway Bridges.

b) Existing Structures. When the Structural Capacity column of a Design Matrix applies to the project, request a Structural Capacity Report from the Risk Reduction Engineer in the Bridge and Structures Office at mail stop 47341. The report will state:
- The structural capacity status of the structures within the project limits.
- What action, if any, is appropriate.
- Whether a deficient bridge is included in the six-year or 20 year plans for replacement or rehabilitation under the P2 program and, if so, in which biennium the P2 project is likely to be funded.

Include the Structural Capacity Report in the design file.
The considerations used to determine that the structural capacity of a bridge is adequate are as follows:

1. On National Highway System (NHS) routes (including Interstate routes):
   - Operating load rating is at least 40 tons (which is equal to HS-20).
   - The bridge is not permanently posted for legal weight vehicles.
   - The bridge is not permanently restricted for vehicles requiring overweight permits.
2. On non-NHS routes:
   - The bridge is not permanently posted for legal weight vehicles.
   - The bridge is not permanently restricted for vehicles requiring overweight permits.

(2) Bridge Widths for Structures

(a) New Structures. Full design level widths are provided on all new structures. See Chapter 440. All structures on city or county routes crossing over a state highway must conform to the Local Agency Guidelines. Use local city or county adopted and applied standards when their minimums exceed state criteria.

(b) Existing Structures. See the design matrices in Chapter 325 for guidance.

(3) Horizontal Clearance

Horizontal clearance for structures is the distance from the edge of the traveled way to bridge piers and abutments, bridge rail ends, or bridge end embankment slopes. Minimum distances for this clearance vary depending on the type of structure. The Bridge Design Manual provides guidance on horizontal clearance.

(4) Medians

For multilane highways, the minimum median widths for new bridges are as shown in Chapters 430 and 440. An open area between two bridges is undesirable when the two roadways are separated by a median width of 26 ft or less. The preferred treatment is to provide a new, single structure that spans the area between the roadways. When this is impractical, consider widening the two bridges on the median sides to reduce the open area to between 2 in and 6 in. When neither option is practical, consider installing netting or other elements to enclose the area between the bridges. Consideration and analysis of all site factors are necessary if installation of netting or other elements is proposed. Document this evaluation in the project file and obtain the approval of the State Design Engineer.

(5) Vertical Clearance

Vertical clearance for a bridge over a road is measured from the roadway surface, including the useable shoulders, to the bottom of the overhead structure. For a new bridge, the minimum vertical clearance is 16.5 ft. An approved deviation is required for the widening of an existing bridge that provides less than 16.5 ft vertical clearance. Generally, 15.5 ft is considered the minimum with a deviation for non-Interstate highways. The minimum with a deviation for the widening of an existing bridge over an Interstate highway is 16.0 ft.

The MTMCTEA has been given an inventory of vertical clearance deficiencies over the Interstate system in Washington State, as of January 1, 1998. Contact the MTMCTEA, through FHWA, if any of the following changes are proposed:

- A project would create a new deficiency of less than 16.0 ft vertical clearance over an Interstate highway.
- The vertical clearance over the Interstate is already deficient and a change (upgrade or degrade) to vertical clearance is proposed.
The coordination with MTMCTEA is required for these changes on all rural Interstate highways and for one Interstate route through urban areas.

A minimum vertical clearance of 14.5 ft is required for an existing bridge to remain in place. If an existing bridge has less than 14.5 ft, or a planned resurfacing project would result in less than 14.5 ft, consider pavement removal and replacement or roadway excavation and reconstruction (to lower the profile of the roadway) or provide a new bridge with the required vertical clearance. Reducing paving and surfacing depths under the bridge to avoid structure modification can cause accelerated deterioration of the roadway and is not allowed. Elimination of the surfacing in the immediate area of the bridge might be a short term solution if recommended by the regional Materials Engineer.

Low clearance warning signs are necessary when the vertical clearance of an existing bridge is less than 15 ft 3 in. When the useable vertical clearance is less than the legal vehicle height limit of 14 ft, place advance warning signs at the nearest intersecting road or other suitable location where trucks can detour or turn around to seek another route.

The minimum vertical clearance for a new bridge over a railroad track is 23.5 ft. See Figure 1120-1a. An existing bridge over a railroad track cannot have a vertical clearance of less than 22.5 ft. See Figure 1120-1b. Vertical clearance over a railroad track may be less than the above values if agreed upon by the railroad company and the Washington State Utilities and Transportation Commission.

(6) Bridge Approach Slab

The Materials Engineer makes recommendations as to when approach slabs are appropriate on bridges. Construction details for approach slabs are shown in the Standard Plans. When approach slabs are omitted, provide justification in the Final Foundation Report.

(7) Pedestrian and Bicycle Facilities

Accommodations for pedestrians and bicycles on bridges are addressed in Chapter 1020.

(8) Bridge Rail End Treatment

Plans for new bridge construction and bridge rail modifications include provisions for the connection of traffic barriers to the bridge rail. Indicate the preferred traffic barrier type and connection during the review of the bridge preliminary plan.

(9) Bridge Slope Protection

Slope protection provides a protective and aesthetic surface for exposed slopes under bridges. Slope protection is normally provided under:

- Structures over state highways
- Structures within an interchange
- Structures over other public roads unless requested otherwise by the public agency
- Railroad overcrossings, if requested by the railroad

Slope protection is usually not provided under pedestrian structures. The type of slope protection is selected at the bridge preliminary plan stage. Typical slope protection types are concrete slope protection, semi-open concrete masonry, and rubble stone.

(10) Slope Protection at Watercrossings

The Olympia Service Center (OSC) Hydraulics Branch determines the slope protection requirements for structures that cross waterways. The type, limits, and quantity of the slope protection are shown on the bridge preliminary plan.

(11) Protective Screening for Highway Structures

Protective screening may be necessary on some structures to prevent the throwing of objects from the structure. Analyze each location individually. In most cases, the installation of a protective screen can be postponed until such time as there are indications of need.
Consider installing screens at the following locations:

- On a structure near a school, a playground, or where frequently used by children not accompanied by adults.
- In urban areas, on a structure used by pedestrians where surveillance by local law enforcement personnel is not likely.
- On structures with walkways where experience on similar structures within a one mile radius indicates a need.
- On structures over private property that is subject to damage, such as buildings or power stations.
- On existing structures where there is a history of multiple incidents of objects being dropped or thrown and enforcement has not changed the situation.

Contact the regional Maintenance Engineer’s office and the Washington State Patrol for the history of reported incidents.

Submit all proposals to install protective screening on structures to the State Design Engineer for approval. Contact the Bridge and Structures Office for approval to attached screening to structures and for specific design and mounting details.

1120.05 Documentation

Include the following items in the project file. See Chapter 330.

- Structural Capacity Report
- Evaluation of need and approval for enclosing the area between bridges
- Correspondence involving the MTMCTEA
- Justification for eliminating an overlay in the vicinity of a bridge
- Final Foundation Report and justification for omitting recommended bridge approach slabs
- Analysis of need and approval for protective screening on highway structures
 Railroad Vertical Clearance New Bridge Construction

Figure 1120-1a

- Increase 1.5 inches for each degree of railway alignment curve.
Railroad Vertical Clearance Existing Bridge Modifications

Figure 1120-1b

* Increase 1.5 inches for each degree of railway alignment curve.
1130 Retaining Walls and Steep Reinforced Slopes

1130.01 References

Bridge Design Manual, M 23-50, WSDOT

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

Plans Preparation Manual, M 22-31, WSDOT

Roadside Manual, M 25-39, WSDOT

1130.02 General

The function of a retaining wall is to form a nearly vertical face through confinement and/or strengthening of a mass of earth or other bulk material. Likewise, the function of a reinforced slope is to strengthen the mass of earth or other bulk material such that a steep (up to 1H:2V) slope can be formed. In both cases, the purpose of constructing such structures is to make maximum use of limited right of way. The difference between the two is that a wall uses a structural facing whereas a steep reinforced slope does not require a structural facing. Reinforced slopes typically use a permanent erosion control matting with low vegetation as a slope cover to prevent erosion. See the Roadside Manual for more information.

To lay out and design a retaining wall or reinforced slope, consider the following items:

- Functional classification
- Highway geometry
- Design Clear Zone requirements (Chapter 700)
- The amount of excavation required
- Traffic characteristics
- Constructibility
- Impact to any adjacent environmentally sensitive areas
- Impact to adjacent structures
- Potential added lanes
- Length and height of wall
- Material to be retained
- Foundation support and potential for differential settlement
- Ground water
- Earthquake loads
- Right of way costs
- Need for construction easements
- Risk
- Overall cost
- Visual appearance

If the wall or toe of a reinforced slope is to be located adjacent to the right of way line, consider the space needed in front of the wall/slope to construct it.

(1) Retaining Wall Classifications

Retaining walls are generally classified as gravity, semigravity, nongravity cantilever, or anchored. Examples of the various types of walls are provided in Figures 1130-1a through 1c.

Gravity walls derive their capacity to resist lateral soil loads through a combination of dead weight and sliding resistance. Gravity walls can be further subdivided into rigid gravity walls, prefabricated modular gravity walls, and Mechanically Stabilized Earth (MSE) gravity walls.

Rigid gravity walls consist of a solid mass of concrete or mortared rubble and use the weight of the wall itself to resist lateral loads.
Prefabricated modular gravity walls consist of interlocking soil or rock filled concrete, steel, or wire modules or bins (gabions, for example). The combined weight of these modules or bins resist the lateral loads from the soil.

MSE gravity walls use strips, bars, or mats of steel or polymeric reinforcement to reinforce the soil and create a reinforced soil block behind the face. The reinforced soil block then acts as a unit and resists the lateral soil loads through the dead weight of the reinforced mass. MSE walls may be constructed as fill walls, with fill and reinforcement placed in alternate layers to create a reinforced mass, or reinforcement may be drilled into an existing soil/rock mass using grouted anchor technology to create a reinforced soil mass (soil nail walls).

Semigavity walls rely more on structural resistance through cantilevering action of the wall stem. Generally, the backfill for a semigavity wall rests on part of the wall footing. The backfill, in combination with the weight of the wall and footing, provides the dead weight for resistance. An example of a semigavity wall is the reinforced concrete wall provided in the Standard Plans.

Nongravity cantilever walls rely strictly on the structural resistance of the wall in which vertical elements of the wall are partially embedded in the soil or rock to provide fixity. These vertical elements may consist of piles (soldier piles or sheet piles, for example), caissons, or drilled shafts. The vertical elements may form the entire wall face or they may be spanned structurally using timber lagging or other materials to form the wall face.

Anchored walls derive their lateral capacity through anchors embedded in stable soil or rock below or behind all potential soil/rock failure surfaces. Anchored walls are similar to non-gravity cantilevered walls except that anchors embedded in the soil/rock are attached to the wall facing structure to provide lateral resistance. Anchors typically consist of deadmen or grouted soil/rock anchors.

Reinforced slopes are similar to MSE walls in that they also use fill and reinforcement placed in alternate layers to create a reinforced soil mass. However, the face is typically built at a 1.2H:1V to 1H:2V slope.

Rockeries (rock walls) behave to some extent like gravity walls. However, the primary function of a rockery is to prevent erosion of an oversteepened but technically stable slope. Rockeries consist of large well-fitted rocks stacked on top of one another to form a wall.

An example of a rockery and reinforced slope is provided in Figure 1130-1d. The various wall types and their classifications are summarized in Table 1(a-f).

### 1130.03 Design Principles

The design of a retaining wall or reinforced slope consists of seven principal activities:

- Developing wall/slope geometry
- Adequate subsurface investigation
- Evaluation of loads and pressures that will act on the structure
- Design of the structure to safely withstand the loads and pressures
- Design of the structure to meet aesthetic requirements
- Wall/slope constructibility
- Coordination with other design elements

The structure and adjacent soil mass must also be stable as a system, and the anticipated wall settlement must be within acceptable limits.

### 1130.04 Design Requirements

#### (1) Wall/Slope Geometry

Wall/slope geometry is developed considering the following:

- Geometry of the transportation facility itself
- Design Clear Zone requirements (Chapter 700)
- Flare rate and approach slope when inside the Design Clear Zone (Chapter 710)
• Right of way constraints
• Existing ground contours
• Existing and future utility locations
• Impact to adjacent structures
• Impact to environmentally sensitive areas
• For wall/slope geometry, also consider the foundation embedment and type anticipated, which requires coordination among the various design groups involved.

Retaining walls must not have anything (such as bridge columns, light fixtures, or sign supports) protruding in such a way as to present a potential for snagging vehicles.

Provide a traffic barrier shape at the base of a new retaining wall constructed 12 ft or less from the edge of the nearest traffic lane. The traffic barrier shape is optional at the base of the new portion when an existing vertical-faced wall is being extended (or the existing wall may be retrofitted for continuity). Standard Concrete Barrier Type 4 is recommended for both new and existing walls except when the barrier face can be cast as an integral part of a new wall. Deviations may be considered but require approval as prescribed in Chapter 330. For deviations from the above, deviation approval is not required where sidewalk exists in front of the wall or in other situations where the wall face is otherwise inaccessible to traffic.

(2) Investigation of Soils
All retaining wall and reinforced slope structures require an investigation of the underlying soil/rock that supports the structure. Chapter 510 provides guidance on how to complete this investigation. A soil investigation is critical for the design of any retaining wall or reinforced slope. The stability of the underlying soils, their potential to settle under the imposed loads, the usability of any existing excavated soils for wall/reinforced slope backfill, and the location of the ground water table are determined through the geotechnical investigation.

(3) Geotechnical and Structural Design
The structural elements of the wall or slope and the soil below, behind, and/or within the structure must be designed together as a system. The wall/slope system is designed for overall external stability as well as internal stability. Overall external stability includes stability of the slope of which the wall/reinforced slope is a part and the local external stability (overturning, sliding, and bearing capacity). Internal stability includes resistance of the structural members to load and, in the case of MSE walls and reinforced slopes, pullout capacity of the structural members or soil reinforcement from the soil.

(4) Drainage Design
One of the principal causes of retaining wall/slope failure is the additional hydrostatic load imposed by an increase in the water content in the material behind the wall or slope. This condition results in a substantial increase in the lateral loads behind the wall/slope since the material undergoes a possible increase in unit weight, water pressure is exerted on the back of the wall, and the soil shear strength undergoes a possible reduction. To alleviate this, adequate drainage for the retaining wall/slope must be considered in the design stage and reviewed by the Region Materials Engineer during construction. The drainage features shown in the Standard Plans are the minimum basic requirements. Underdrains behind the wall/slope must daylight at some point in order to adequately perform their drainage function. Provide positive drainage at periodic intervals to prevent entrapment of water.

Native soil may be used for retaining wall and reinforced slopes backfill if it meets the requirements for the particular wall/slope system. In general, use backfill that is free-draining and granular in nature. Exceptions to this can be made depending on the site conditions as determined by the Geotechnical Services Branch of the Olympia Service Center (OSC) Materials Laboratory.
A typical drainage detail for a gravity wall (in particular, an MSE wall) is shown in Figure 1130-2. Typical drainage details for a standard reinforced concrete cantilever wall are provided in the DETAILS.CEL library. Always include drainage details such as these with a wall unless otherwise recommended to be deleted by the region’s Materials Engineer or OSC Geotechnical Services Branch.

(5) Aesthetics
Retaining walls and slopes should have a pleasing appearance that is compatible with the surrounding terrain and other structures in the vicinity. To the extent possible within functional requirements and cost effectiveness criteria, this aesthetic goal should be met for all visible retaining walls and reinforced slopes.

Aesthetic requirements include consideration of the wall face material, the top profile, the terminals, and the surface finish (texture, color, and pattern). Where appropriate, provide planting areas and irrigation conduits. These will visually soften them and blend the them with adjacent areas. Avoid short sections of retaining wall or steep slope where possible.

In higher walls, variations in slope treatment are recommended for a pleasing appearance. High, continuous walls are generally not desirable from an aesthetic standpoint, as high, continuous walls can be quite imposing. Consider stepping high or long retaining walls in areas of high visibility. Plantings could be considered between wall steps.

Approval from the Principle Architect of the Bridge and Structures Office is required on all retaining wall aesthetics including finishes.

(6) Constructibility
Consider the potential effect site constraints may have on the constructibility of the specific wall/slope. Constraints to be considered include, but are not limited to, site geometry, access, time required to construct the wall, environmental issues, and impact on traffic flow and other construction activities.

(7) Coordination with Other Design Elements
Retaining wall and slope designs must be coordinated with other elements of the project that could interfere with or impact the design and/or construction of the wall/slope. Also consider drainage features, utilities, luminaire or sign structures, adjacent retaining walls or bridges, concrete traffic barriers, and beam guardrails. Locate these design elements in a manner that will minimize the impacts to the wall elements.

In general, locate obstructions within the wall backfill (such as guardrail posts, drainage features, and minor structure foundations) a minimum of 3 ft from the back of the wall facing units. Greater offset distances may be required depending on the size and nature of the interfering design element. If possible, locate these elements to miss reinforcement layers or other portions of the wall system. Conceptual details for accommodating concrete traffic barriers and beam guardrails are provided in Figure 1130-3.

Where impact to the wall elements is unavoidable, the wall system must be designed to accommodate these impacts. For example, it may be necessary to place drainage structures or guardrail posts in the reinforced backfill zone of MSE walls. This may require that holes be cut in the upper soil reinforcement layers, or that discrete reinforcement strips be splayed around the obstruction. This causes additional load to be carried in the adjacent reinforcement layers due to the missing soil reinforcement or the distortion in the reinforcement layers.

The need for these other design elements and their impact on the proposed wall systems must be clearly indicated in the wall site data that is submitted so that the walls can be properly designed. Contact the Bridge and Structures Office (or the Geotechnical Services Branch, for geosynthetic walls/slopes and soil nail walls) for assistance regarding this issue.
1130.05 Guidelines for Wall/Slope Selection

Wall/slope selection is dependent on the following considerations:

- Whether the wall/slope will be located primarily in a cut or fill (how much excavation/shoring will be required to construct the wall or slope?)
- If located in a cut, the type of soil/rock present
- The need for space between the right of way line and the wall/slope or easement
- The amount of settlement expected
- The potential for deep failure surfaces to be present
- The structural capacity of the wall/slope in terms of maximum allowable height
- The nature of the wall/slope application
- Whether or not structures or utilities will be located on or above the wall
- Architectural requirements
- Overall economy

(1) Cut and Fill Considerations

Due to the construction technique and base width required, some wall types are best suited for cut situations whereas others are best suited for fill situations. For example, anchored walls and soil nail walls have soil reinforcements drilled into the in-situ soil/rock and, therefore, are generally used in cut situations. Nongravity cantilevered walls are drilled or cut into the in-situ soil/rock, have narrow base widths, and are also well suited to cut situations. Both types of walls are constructed from the top down. Such walls are also used as temporary shoring to allow other types of walls or other structures to be constructed where considerable excavation would otherwise be required.

MSE walls and reinforced slopes, however, are constructed by placing soil reinforcement between layers of fill from the bottom up and are therefore best suited to fill situations. Furthermore, the base width of MSE walls is typically on the order of 70 percent of the wall height, which would require considerable excavation in a cut situation. Therefore, in a cut situation, base width requirements usually make MSE structures uneconomical and possibly unconstructible.

Semigravity (cantilever) walls, rigid gravity walls, and prefabricated modular gravity walls are free-standing structural systems built from the bottom up but they do not rely on soil reinforcement techniques (placement of fill layers with soil reinforcement) to provide stability. These types of walls generally have a narrower base width than MSE structures, (on the order of 50 percent of the wall height). Both of these factors make these types of walls feasible in fill situations as well as many cut situations.

Reinforced slopes generally require more room overall to construct than a wall because of the sloping face, but are typically a feasible alternative to a combination wall and fill slope to add a new lane. Reinforced slopes can also be adapted to the existing ground contours to minimize excavation requirements where fill is placed on an existing slope. Reinforced slopes may also be feasible to repair slopes damaged by landslide activity or deep erosion.

Rockeries are best suited to cut situations, as they require only a narrow base width, on the order of 30 percent of the rockery height. Rockeries can be used in fill situations, but the fill heights that they support must be kept relatively low as it is difficult to get the cohesive strength needed in granular fill soils to provide minimal stability of the soil behind the rockery at the steep slope typically used for rockeries in a cut (such as 1H:6V or 1H:4V).

The key considerations in deciding which walls or slopes are feasible are the amount of excavation or shoring required and the overall height. The site geometric constraints must be well defined to determine these elements. Another consideration is whether or not an easement will be required. For example, a temporary easement may be required for a wall-in-a-fill situation to allow the contractor to work in front of the wall. For walls in cut situations, especially anchored walls and soil nail walls, a permanent easement may be required for the anchors or nails.
(2) Settlement and Deep Foundation Support Considerations

Settlement issues, especially differential settlement, are of primary concern for selection of walls. Some wall types are inherently flexible and can tolerate a great deal of settlement without suffering structurally. Other wall types are inherently rigid and cannot tolerate much settlement. In general, MSE walls have the greatest flexibility and tolerance to settlement, followed by prefabricated modular gravity walls. Reinforced slopes are also inherently very flexible. For MSE walls, the facing type used can affect the ability of the wall to tolerate settlement. Welded wire and geosynthetic wall facings are the most flexible and the most tolerant to settlement, whereas concrete facings are less tolerant to settlement. In some cases, concrete facing can be placed, after the wall settlement is complete, such that the concrete facing does not limit the wall's tolerance to settlement. Facing may also be added for aesthetic reasons.

Semigravity (cantilever) walls and rigid gravity walls have the least tolerance to settlement. In general, total settlement for these types of walls must be limited to approximately 1 in or less. Rockeries also cannot tolerate much settlement, as rocks could shift and fall out. Therefore, semigravity cantilever walls, rigid gravity walls, and rockeries are not used in settlement prone areas.

If very weak soils are present that will not support the wall and that are too deep to be overexcavated, or if a deep failure surface is present that results in inadequate slope stability, the wall type selected must be capable of using deep foundation support and/or anchors. In general, MSE walls, prefabricated modular gravity walls, and some rigid gravity walls are not appropriate for these situations. Walls that can be pile supported such as concrete semigravity cantilever walls, nongravity cantilever walls, and anchored walls are more appropriate for these situations.

(3) Feasible Wall and Slope Heights and Applications

Feasible wall heights are affected by issues such as the capacity of the wall structural elements, past experience with a particular wall, current practice, seismic risk, long-term durability, and aesthetics.

See Table 1 for height limitations.

(4) Supporting Structures or Utilities

Not all walls are acceptable to support other structures or utilities. Issues that must be considered include the potential for the wall to deform due to the structure foundation load, interference between the structure foundation and the wall components, and the potential long-term durability of the wall system. Using retaining walls to support other structures is considered to be a critical application, requiring a special design. In general, soil nail walls, semigravity cantilever walls, nongravity cantilever walls, and anchored walls are appropriate for use in supporting bridge and building structure foundations. In addition to these walls, MSE and prefabricated modular gravity walls may be used to support other retaining walls, noise walls, and minor structure foundations such as those for sign bridges and signals. On a project specific basis, MSE walls can be used to support bridge and building foundations, as approved by the Bridge and Structures Office.

Also consider the location of any utilities behind the wall or reinforced slope when making wall/slope selections. This is mainly an issue for walls that use some type of soil reinforcement and for reinforced slopes. It is best not to place utilities within a reinforced soil backfill zone because it would be impossible to access the utility from the ground surface without cutting through the soil reinforcement layers, thereby compromising the integrity of the wall.

Sometimes utilities, culverts, pipe arches, etc., must penetrate the face of a wall. Not all walls and facings are compatible with such penetrations. Consider how the facing can be formed
around the penetration so that backfill soil cannot pipe or erode through the face. Contact the Bridge and Structures Office for assistance regarding this issue.

(5) Facing Options
Facing selection depends on the aesthetic and the structural needs of the wall system. Wall settlement may also affect the feasibility of the facing options. More than one wall facing may be available for a given system. The facing options available must be considered when selecting a particular wall.

For MSE walls, facing options typically include the following:
• Precast modular panels
• In some cases, full height precast concrete panels. (Full height panels are generally limited to walls with a maximum height of 20 ft placed in areas where minimal settlement is expected.)
• Welded wire facing
• Timber facing
• Shotcrete facing with various treatment options that vary from a simple broom finish to a textured and colored finish
• Segmental masonry concrete blocks
• Cast-in-place concrete facing with various texturing options.

Plantings on welded wire facings can be attempted in certain cases. The difficulty is in providing a soil at the wall face that is suitable for growing plants and meets engineering requirements in terms of soil compressibility, strength, and drainage. If plantings in the wall face are attempted, use only small plants, vines, and grasses. Small bushes could be considered for plantings between wall steps. Larger bushes or trees are not considered in these cases due to the loads on the wall face that they can create.

Geosynthetic facings are not acceptable for permanent facings due to potential facing degradation when exposed to sunlight. For permanent applications, geosynthetic walls must have some type of timber, welded wire, or concrete face. (Shotcrete, masonry concrete blocks, cast-in-place concrete, welded wire, or timber are typically used for geosynthetic wall facings.)

Soil nail walls can use either architecturally treated shotcrete or a cast-in-place facia wall textured as needed to produce the desired appearance.

For prefabricated modular gravity walls, the facing generally consists of the structural bin or crib elements used to construct the walls. For some walls, the elements can be rearranged to form areas for plantings. In some cases, textured structural elements may also be feasible. This is also true of rigid gravity walls, though planting areas on the face of rigid gravity walls are generally not feasible. The concrete facing for semigravity cantilever walls can be textured as needed to produce the desired appearance.

For nongravity cantilevered walls and anchored walls, a textured cast-in-place or precast facia wall is usually installed to produce the desired appearance.

(6) Cost Considerations
Usually, more than one wall type is feasible for a given situation. Consider cost throughout the selection process. Decisions in the selection process that may affect the overall cost might include the problem of whether to shut down a lane of traffic to install a low cost gravity wall system that requires more excavation room or to use a more expensive anchored wall system that would minimize excavation requirements and impacts to traffic. In this case, determine if the cost of traffic impacts and more excavation justifies the cost of the more expensive anchored wall system.

Decisions regarding aesthetics can also affect the overall cost of the wall system. In general, the least expensive aesthetic options use the structural members of the wall as facing (welded wire, concrete or steel cribbing or bins, for example), whereas the most expensive aesthetic options use textured cast-in-place concrete facias. In general, concrete facings increase in cost in the following order: shotcrete, segmental masonry concrete
blocks, precast concrete facing panels, full height precast concrete facing panels, and cast-in-place concrete facing panels. Special architectural treatment usually increases the cost of any of these facing systems. Special wall terracing to provide locations for plants will also tend to increase costs. Therefore, the value of the desired aesthetics must be weighed against costs.

Other factors that affect costs of wall/slope systems include wall/slope size and length, access at the site and distance to the material supplier location, overall size of the project, and competition between wall suppliers. In general, costs tend to be higher for walls or slopes that are high, but short in length, due to lack of room for equipment to work. Sites that are remote or have difficult local access increase wall/slope costs. Small wall/slope quantities result in high unit costs. Lack of competition between materials or wall system suppliers can result in higher costs as well.

Some of the factors that increase costs are required parts of a project and are, therefore, unavoidable. Always consider such factors when estimating costs because a requirement may not affect all wall types in the same way. Current cost information can be obtained by consulting the Bridge Design Manual or by contacting the Bridge and Structures Office.

(7) Summary
For wall/slope selection, consider factors such as the intended application, the soil/rock conditions in terms of settlement, need for deep foundations, constructibility, impact to traffic, the overall geometry in terms of wall/slope height and length, location of adjacent structures and utilities, aesthetics, and cost. Table 1 provides a summary of many of the various wall/slope options available, including their advantages, disadvantages, and limitations. Note that specific wall types in the table may represent multiple wall systems, some or all of which may be proprietary.

1130.06 Design Responsibility and Process
(1) General
The retaining walls available for a given project include standard walls, nonstandard walls, and reinforced slopes.

Standard walls are those walls for which standard designs are provided in the WSDOT Standard Plans. Standard plans are provided for reinforced concrete cantilever walls up to 35 ft in height. The internal stability design, and the external stability design for overturning and sliding stability, have already been completed for these standard walls. However, overall slope stability and allowable soil bearing capacity (including settlement considerations) must be determined for each standard-design wall location.

Nonstandard walls may be either proprietary (patented or trademarked) or nonproprietary. Proprietary walls are designed by a wall manufacturer for internal and external stability, except bearing capacity, settlement, and overall slope stability which are determined by WSDOT. Nonstandard nonproprietary walls are fully designed by WSDOT.

The geosynthetic soil reinforcement used in nonstandard nonproprietary geosynthetic walls is considered to be proprietary. It is likely that more than one manufacturer can supply proprietary materials for a nonstandard nonproprietary geosynthetic wall.

Reinforced slopes are similar to nonstandard nonproprietary walls in terms of their design process.

Some proprietary wall systems are preapproved. Preapproved proprietary wall systems have been extensively reviewed by the Bridge and Structures Office and the Geotechnical Services Branch. Design procedures and wall details for preapproved walls have already been agreed upon between WSDOT and the proprietary wall manufacturers, allowing the manufacturers to competitively bid a particular project without having a detailed wall design provided in the contract plans.
Note that proprietary wall manufacturers may produce several retaining wall options, and not all options from a given manufacturer have necessarily been preapproved. For example, proprietary wall manufacturers often offer more than one facing alternative. It is possible that some facing alternatives are preapproved, whereas other facing alternatives are not preapproved. WSDOT does not preapprove the manufacturer, but specific wall systems by a given manufacturer can be preapproved.

It is imperative with preapproved systems that the design requirements for all preapproved wall alternatives for a given project be clearly stated so that the wall proprietor can adapt the preapproved system to specific project conditions. For a given project, coordination of the design of all wall alternatives with all project elements that impact the wall (such as drainage features, utilities, luminaires and sign structures, noise walls, traffic barriers, guardrails, or other walls or bridges) is critical to avoid costly change orders or delays during construction.

In general, standard walls are the easiest walls to incorporate into project plans, specifications, & estimate (PS&E), but they may not be the most cost effective option. Preapproved proprietary walls provide more options in terms of cost effectiveness and aesthetics and are also relatively easy to incorporate into a PS&E. Nonstandard state-designed walls and nonpreapproved proprietary walls generally take more time and effort to incorporate into a PS&E because a complete wall design must be developed. Some nonstandard walls (state-designed geosynthetic walls, for example) can be designed relatively quickly, require minimal plan preparation effort, and only involve the region and the Geotechnical Services Branch. Other nonstandard walls such as soil nail and anchored wall systems require complex designs, involve both the Bridge and Structures Office and the Geotechnical Services Branch, and require a significant number of plan sheets and considerable design effort.

The Bridge and Structures Office maintains a list of the proprietary retaining walls that are preapproved. The region should consult the Bridge and Structures Office for the latest list. The region should consult the Geotechnical Services Branch for the latest geosynthetic reinforcement list to determine which geosynthetic products are acceptable if a critical geosynthetic wall or reinforced slope application is anticipated.

Some proprietary retaining wall systems are classified as experimental by the FHWA. The Bridge and Structures Office maintains a list of walls that are classified as experimental. If the wall intended for use is classified as experimental, a work plan must be prepared by WSDOT and approved by the FHWA.

Gabion walls are nonstandard walls that must be designed for overturning, sliding, overall slope stability, settlement, and bearing capacity. A full design for gabion walls is not provided in the Standard Plans. Gabion baskets are typically 3 ft high by 3 ft wide, and it is typically safe to build gabions two baskets high (6 ft) but only one basket deep, resulting in a wall base width of 50 percent of the wall height, provided soil conditions are reasonably good (medium dense to dense granular soils are present below and behind the wall).

(2) Responsibility and Process for Design

A flow chart illustrating the process and responsibility for retaining wall/reinforced slope design is provided in Figure 1130-4. As shown in the figure, the region initiates the process, except for walls developed as part of a preliminary bridge plan. These are initiated by the Bridge and Structures Office. In general, it is the responsibility of the design office initiating the design process to coordinate with other groups in the department to identify all wall/slope systems that are appropriate for the project in question. Coordination between the region, Bridge and Structures Office, Geotechnical Services Branch, and the Principle Architect should occur as early in the process as possible.

OSC or region consultants, if used, are considered an extension of the OSC staff and must follow the process summarized in Figure 1130-4.
All consultant designs, from development of the scope of work to the final product, must be reviewed and approved by the appropriate OSC offices.

(a) Standard Walls. The regions are responsible for detailing retaining walls for which standard designs are available.

For standard walls greater than 10 ft in height, and for all standard walls where soft or unstable soil is present beneath or behind the wall, a geotechnical investigation must be conducted, or reviewed and approved, by the Geotechnical Services Branch. Through this investigation, provide the foundation design including bearing capacity requirements and settlement determination, overall stability, and the selection of the wall types most feasible for the site.

For standard walls 10 ft in height or less where soft or unstable soils are not present, it is the responsibility of the region materials laboratory to perform the geotechnical investigation. If it has been verified that soil conditions are adequate for the proposed standard wall that is less than or equal to 10 ft in height, the region establishes the wall footing location based on the embedment criteria in the Bridge Design Manual, or places the bottom of the wall footing below any surficial loose soils. During this process, the region also evaluates other wall types that may be feasible for the site in question.

Figure 1130-5 provides design charts for standard reinforced concrete cantilever walls. These design charts, in combination with the Standard Plans, are used to size the walls and determine the applied bearing stresses to compare with the allowable soil bearing capacity determined from the geotechnical investigation. The charts provide two sets of bearing pressures: one for static loads, and one for earthquake loads. Allowable soil bearing capacity for both the static load case and the earthquake load case can be obtained from the Geotechnical Services Branch for standard walls over 10 ft in height and from the region materials laboratories for standard walls less than or equal to 10 ft in height. If the allowable soil bearing capacity exceeds the values provided in Figure 1130-5, the Standard Plans can be used for the wall design. If one or both of the allowable soil bearing capacities does not exceed the values provided in Figure 1130-5, the Standard Plans cannot be used for wall design and the Bridge and Structures Office must be contacted for a nonstandard wall design.

If the standard wall must support surcharge loads from bridge or building foundations, other retaining walls, noise walls, or other types of surcharge loads, a special wall design is required. The wall is considered to be supporting the surcharge load and is treated as a nonstandard wall if the surcharge load is located within a 1H:1V slope projected up from the bottom of the back of the wall. Contact the Bridge and Structures Office for assistance.

The Standard Plans provide six types of reinforced concrete cantilever walls (which represent six loading cases). Reinforced concrete retaining wall Types 5 and 6 are not designed to withstand earthquake forces and are not used in Western Washington (west of the Cascade crest).

Once the geotechnical and architectural assessment have been completed, the region completes the PS&E for the standard wall option(s) selected including a generalized wall profile and plan, a typical cross-section as appropriate, details for desired wall appurtenances, drainage details, and other details as needed.

Metal bin walls, Types 1 and 2, have been deleted from the Standard Plans and are therefore no longer standard walls. Metal bin walls are seldom used due to cost and undesirable aesthetics. If this type of wall is proposed, contact the Bridge and Structures Office for plan details and toe bearing pressures. The applied toe bearing pressure would then have to be evaluated by the Geotechnical Services Branch to determine if the site soil conditions are appropriate for the applied load and anticipated settlement.

(b) Preapproved Proprietary Walls. Final design approval of preapproved proprietary walls, with the exception of geosynthetic walls, is the responsibility of the Bridge and Structures Office. Final approval of the design of preapproved...
proprietary geosynthetic walls is the responsibility of the Geotechnical Services Branch. It is the region’s responsibility to coordinate the design effort for all preapproved wall systems.

The region materials laboratory performs the geotechnical investigation for preapproved proprietary walls 10 ft in height or less that are not bearing on soft or unstable soils. In all other cases, it is the responsibility of the Geotechnical Services Branch to conduct, or review and approve, the geotechnical investigation for the wall. The region also coordinates with the Principal Architect to ensure that the wall options selected meet the aesthetic requirements for the site.

Once the geotechnical and architectural assessments have been completed and the desired wall alternatives selected, it is the responsibility of the region to contact the suppliers of the selected preapproved systems to confirm in writing the adequacy and availability of the systems for the proposed use.

A minimum of three different wall systems must be included in the PS&E for any project with federal participation that includes a proprietary wall system unless specific justification is provided. Standard walls can be alternatives.

Once confirmation of adequacy and availability has been received, the region contacts the Bridge and Structures Office for special provisions for the selected wall systems and proceeds to finalize the contract PS&E in accordance with the Plans Preparation Manual. Provide the allowable bearing capacity and foundation embedment criteria for the wall, as well as backfill and foundation soil properties, in the special provisions. In general, assume that Gravel Borrow or better quality backfill material will be used for the walls when assessing soil parameters.

Complete wall plans and designs for the proprietary wall options will not be developed until after the contract is awarded, but will be developed by the proprietary wall supplier as shop drawings after the contract is awarded. Therefore, include a general wall plan, a profile showing neat line top and bottom of the wall, a final ground line in front of and in back of the wall, a typical cross-section, and the generic details for the desired appurtenances and drainage requirements in the contract PS&E for the proprietary walls. Estimate the ground line in back of the wall based on a nominal 1.5 ft facing thickness (and state this on the wall plan sheets). Include load or other design acceptance requirements for these appurtenances in the PS&E. Contact the Bridge and Structures Office for assistance regarding this.

It is best to locate catch basins, grate inlets, signal foundations, and the like outside the reinforced backfill zone of MSE walls to avoid interference with the soil reinforcement. In those cases where conflict with these reinforcement obstructions cannot be avoided, the location(s) and dimensions of the reinforcement obstruction(s) relative to the wall must be clearly indicated on the plans. Contact the Bridge and Structures Office for preapproved wall details and designs for size and location of obstructions, and to obtain the generic details that must be provided in the plans. If the obstruction is too large or too close to the wall face, a special design may be required to accommodate the obstruction, and the wall is treated as a nonpreapproved proprietary wall.

A special design is required if the wall must support structure foundations, other retaining walls, noise walls, signs or sign bridges, luminaires, or other types of surcharge loads. The wall is considered to be supporting the surcharge load if the surcharge is located within a 1H:1V slope projected from the bottom of the back of the wall. For MSE walls, the back of the wall is considered to be the back of the soil reinforcement layers. If this situation occurs, the wall is treated as a nonpreapproved proprietary wall.

For those alternative wall systems that have the same face embedment criteria, the wall face quantities depicted in the plans for each alternative must be identical. To provide an equal basis for competition, the region determines wall face quantities based on neat lines.
Once the detailed wall plans and designs are available as shop drawings after contract award, the Bridge and Structures Office will review and approve the wall shop drawings and calculations, with the exception of geosynthetic walls which are reviewed and approved by the Geotechnical Services Branch.

(c) Nonpreapproved Proprietary Walls. Final design approval authority for nonpreapproved proprietary walls is the same as for preapproved proprietary walls. The region initiates the design effort for all nonpreapproved wall systems by submitting wall plan, profile, cross-section, and other information for the proposed wall to the Bridge and Structures Office, with copies to the Geotechnical Services Branch and the Principal Architect. The Bridge and Structures Office coordinates the wall design effort.

Once the geotechnical and architectural assessments have been completed and the desired wall types selected, the Bridge and Structures Office contacts suppliers of the nonpreapproved wall systems selected to obtain and review detailed wall designs and plans to be included in the contract PS&E.

To ensure fair competition between all wall alternatives included in the PS&E, the wall face quantities for those wall systems subject to the same face embedment requirements should be identical.

The Bridge and Structures Office develops the special provisions and cost estimates for the nonpreapproved proprietary walls and sends the wall PS&E to the region for inclusion in the final PS&E in accordance with the Plans Preparation Manual.

(d) Nonstandard Nonproprietary Walls. With the exception of rockeries over 5 ft high, nonproprietary geosynthetic walls and reinforced slopes, and soil nail walls, the Bridge and Structures Office coordinates with the Geotechnical Services Branch and the Principal Architect to carry out the design of all nonstandard, nonproprietary walls. In this case, the Bridge and Structures Office develops the wall preliminary plan from site data provided by the region, completes the wall design, and develops the nonstandard nonproprietary wall PS&E package for inclusion in the contract.

For rockeries over 5 ft high, nonproprietary geosynthetic walls and reinforced slopes, and soil nail walls, the region develops wall/slope profiles, plans, and cross-sections and submits them to the Geotechnical Services Branch to complete a detailed wall/slope design.

For geosynthetic walls and slopes, and for rockeries, the region provides overall coordination of the wall/slope design effort, including coordination with the Principal Architect regarding aesthetics and finishes, and the Region or OSC Landscape Architect if the wall uses vegetation on the face. The Geotechnical Services Branch has overall design approval authority. Once the wall design has been completed, the Geotechnical Services Branch, and in some cases the Bridge and Structures Office, provides geotechnical and structural plan details to be included in the region plan sheets and special provisions for the PS&E. The region then completes the PS&E package.

For soil nail walls, once the Geotechnical Services Branch has performed the geotechnical design, the Bridge and Structures Office, in cooperation with the Geotechnical Services Branch, coordinates the design effort and completes the PS&E package.

(3) Guidelines for Wall/Slope Data Submission for Design

(a) Standard Walls, Proprietary Walls, Geosynthetic Walls/Slopes, and Soil Nail Walls. Where OSC involvement in retaining wall/slope design is required (as for standard walls and preapproved proprietary walls over 10 ft in height, gabions over 6 ft in height, rockeries over 5 ft in height, all nonpreapproved proprietary walls, geosynthetic walls/slopes, and all soil nail walls), the region submits the following information to the Geotechnical Services Branch or Bridge and Structures Office as appropriate:

- Wall/slope plans.
- Profiles showing the existing and final grades in front of and behind the wall.
• Wall/slope cross-sections (typically every 50 ft) or CAiCE files that define the existing and new ground-line above and below the wall/slope and show stations and offsets.

• Location of right of way lines as well as other constraints to wall/slope construction.

• Location of adjacent existing and/or proposed structures, utilities, and obstructions.

• Desired aesthetics.

• Date design must be completed.

• Key region contacts for the project.

Note that it is best to base existing ground measurements, for the purpose of defining the final wall geometry, on physical survey data rather than solely on photogrammetry. In addition, the region must complete a Retaining Wall/Reinforced Slope Site Data Check List, DOT Form 351-009 EF, for each wall or group of walls submitted.

(b) Nonstandard Walls, Except Geosynthetic Walls/Slopes and Soil Nail Walls. In this case, the region must submit site data in accordance with Chapter 1110. Additionally, a Retaining Wall Site Data Check List, DOT361-009EF, for each wall or group of walls must be completed by the region.

1130.07 Documentation

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

☐ Wall Site Data Check List, DOT361-009EF, and attachments

☐ Final selection approval
<table>
<thead>
<tr>
<th>Specific Wall Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel soil reinforcement with full height precast concrete panels</td>
<td>Relatively low cost</td>
<td>Can tolerate little settlement; generally requires high quality backfill; wide base width required (70% of wall height)</td>
<td>Applicable primarily to fill situations; maximum feasible height is approximately 20 ft</td>
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<tr>
<td>Steel soil reinforcement with modular precast concrete panels</td>
<td>Relatively low cost; flexible enough to handle significant settlement</td>
<td>Generally requires high quality backfill; wide base width required (70% of wall height)</td>
<td>Applicable primarily to fill situations; maximum height of 33 ft; heights over 33 ft require a special design</td>
</tr>
<tr>
<td>Steel soil reinforcement with welded wire and cast in place concrete face</td>
<td>Can tolerate large short-term settlements</td>
<td>Relatively high cost; cannot tolerate long-term settlement; generally requires high quality wall backfill soil; wide base width required (70% of wall height); typically requires a settlement delay period during construction</td>
<td>Applicable primarily to fill situations; maximum height of 33 ft for routine designs; heights over 33 ft require a special design</td>
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<tr>
<td>Steel soil reinforcement with welded wire face only</td>
<td>Can tolerate large long-term settlements; low cost</td>
<td>Aesthetics, unless face plantings can be established; generally requires high quality backfill; wide base width required (70% of wall ht.)</td>
<td>Applicable primarily to fill situations; maximum height of 33 ft for routine designs; heights over 33 ft require a special design</td>
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Table 1(a).
Summary of mechanically stabilized earth (MSE) gravity wall/slope options available.
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<th>Specific Wall Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
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<tbody>
<tr>
<td>Segmental masonry concrete block faced walls, generally with geosynthetic soil</td>
<td>Low cost; flexible enough to handle significant settlements</td>
<td>Internal wall deformations may be greater than for steel reinforced systems but are still acceptable for most applications; generally requires high quality backfill; wide base width required (70% of wall height)</td>
<td>Applicable primarily to fill situations; in general, limited to wall height of 20 ft or less; greater wall heights may be feasible by special design in areas of low seismic activity and when geosynthetic products are used in which long-term product durability is well defined (see Qualified Products List).</td>
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<tr>
<td>Geosynthetic walls with a shotcrete or cast in place concrete face</td>
<td>Very low cost, esp. with shotcrete face; can tolerate large short-term settlements</td>
<td>Internal wall deformations may be greater than for steel reinforced systems but are still acceptable for most applications; generally requires high quality backfill; wide base width required (70% of wall height)</td>
<td>Applicable primarily to fill situations; in general, limited to wall height of 20 ft or less unless using geosynthetic products in which long-term product durability is well defined (see Qualified Products List). For qualified products, heights of 33 ft or more are possible.</td>
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<tr>
<td>Geosynthetic walls with a welded wire face</td>
<td>Very low cost; can tolerate large long-term settlements</td>
<td>Internal wall deformations may be greater than for steel reinforced systems but are still acceptable for most applications; generally requires high quality wall backfill soil; wide base width required (70% of wall height)</td>
<td>Applicable primarily to fill situations; in general, limited to wall height of 20 ft or less unless using geosynthetic products in which long-term product durability is well defined (see Qualified Products List). For qualified products, heights of 33 ft or more are possible.</td>
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Table 1(a), continued.
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<th>Specific Wall Type</th>
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<th>Limitations</th>
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<tr>
<td>Geosynthetic walls with a geosynthetic face</td>
<td>Lowest cost of all wall options; can tolerate large long-term settlements</td>
<td>Internal wall deformations may be greater than for steel reinforced systems but are still acceptable for most applications; generally requires high quality backfill; wide base width required (70% of wall height); durability of wall facing</td>
<td>Applicable primarily to fill situations; use only for temporary applications due to durability of facing; can be designed for wall heights of 40 ft or more</td>
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<tr>
<td>Soil nail walls</td>
<td>Relatively low cost; can be used in areas of restricted overhead or lateral clearance</td>
<td>Soil/rock must have adequate standup time to stand in a vertical cut approximately 6 ft high for at least 1 to 2 days; not feasible for bouldery soils; may require an easement for the nails</td>
<td>Applicable to cut situations only; not recommended in clean or water bearing sands and gravels, in bouldery soils which could interfere with nail installation, or in landslide deposits, esp. where deep potential failure surfaces are present; maximum wall heights of 35 ft are feasible, though greater wall heights are possible in excellent soil/rock conditions. A special design is always required.</td>
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Table 1(a), continued.
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<th>Limitations</th>
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<tr>
<td>Concrete crib walls</td>
<td>Relatively low cost; quantity of high quality backfill required relatively small; relatively narrow base width, on the order of 50% to 60% of the wall height; can tolerate moderate settlements</td>
<td>Aesthetics</td>
<td>Applicable to cut and fill situations; reinforced concrete can typically be designed for heights of up to 33 ft and unreinforced concrete up to 16 ft; not used to support bridge or building foundations</td>
</tr>
<tr>
<td>Metal crib walls</td>
<td>Quantity of high quality backfill required relatively small; relatively narrow base width, on the order of 50% to 60% of the wall height; can tolerate moderate settlements</td>
<td>Relatively high cost; aesthetics</td>
<td>Applicable to cut and fill situations; can be designed routinely for heights up to 35 ft; not used to support bridge or building foundations</td>
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<td>Timber crib walls</td>
<td>Low cost; minimal high quality backfill required; relatively narrow base width, on the order of 50% to 60% of the wall height; can tolerate moderate settlements</td>
<td>Design life relatively short, aesthetics</td>
<td>Applicable to cut and fill situations; can be designed for heights up to 16 ft; not used to support structure foundations</td>
</tr>
<tr>
<td>Concrete bin walls</td>
<td>Relatively low cost; narrow base width, on the order of 50 to 60% of the wall height; can tolerate moderate settlements</td>
<td>Aesthetics</td>
<td>Applicable to cut and fill situations; can be designed routinely for heights up to 25 ft; not used to support bridge or building foundations</td>
</tr>
<tr>
<td>Gabion walls</td>
<td>Relatively narrow base width, on the order of 50 to 60% of the wall height; can tolerate moderate settlements</td>
<td>Relatively high cost, depending on proximity to source of high quality angular rock to fill baskets</td>
<td>Applicable to cut and fill situations; can be designed routinely for heights up to 15 ft, and by special design up to 21 ft; not used to support structure foundations</td>
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</table>

Table 1(b). Summary of prefabricated modular gravity wall options available.
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<th>Specific Wall Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortar rubble masonry walls</td>
<td>Quantity of high quality backfill required is relatively small</td>
<td>High cost; relatively wide base width, on the order of 60% to 70% of the wall height; cannot tolerate settlement</td>
<td>Applicable mainly to fill situations where foundation conditions consist of very dense soil or rock; due to expense, only used in areas where other mortar rubble masonry walls are present and it is desired to match aesthetics; typically, can be designed for maximum heights of 25 ft</td>
</tr>
<tr>
<td>Unreinforced concrete gravity walls</td>
<td>Quantity of high quality backfill required is relatively small</td>
<td>High cost; relatively wide base width, on the order of 60% to 70% of the wall height; cannot tolerate settlement</td>
<td>Applicable mainly to fill situations where foundation conditions consist of very dense soil or rock; due to expense, only used in areas where other concrete gravity walls are present and it is desired to match aesthetics; typically, can be designed for maximum heights of 25 ft</td>
</tr>
<tr>
<td>Reinforced concrete cantilever walls</td>
<td>Relatively narrow base width on the order of 50% to 60% of the wall height; can be used to support structure foundations by special design</td>
<td>High cost; cannot tolerate much settlement; relatively deep embedment could be required on sloping ground due to toe in front of wall face</td>
<td>Applicable to cut and fill situations; can be routinely designed for heights up to 35 ft</td>
</tr>
<tr>
<td>Reinforced concrete counterfort walls</td>
<td>Relatively narrow base width on the order of 50% to 60% of the wall height; can be used to support structure foundations by special design</td>
<td>High cost; cannot tolerate much settlement; relatively deep embedment could be required on sloping ground due to toe in front of wall face</td>
<td>Applicable to cut and fill situations; can be routinely designed for heights up to 50 ft; proprietary versions typically 33 ft max</td>
</tr>
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</table>

Table 1(c). Summary of rigid gravity and semigravity wall options available.
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<th>Specific Wall Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soldier pile wall</td>
<td>Very narrow base width; deep embedment to get below potential failure surfaces relatively easy to obtain</td>
<td>Relatively high cost</td>
<td>Applicable mainly to cut situations; maximum feasible exposed height is on the order of 10 ft; difficult to install in bouldery soil or soil with water bearing sands</td>
</tr>
<tr>
<td>Sheet pile wall</td>
<td>Low to moderate cost; very narrow base width</td>
<td>Difficult to get embedment in dense or bouldery soils; difficult to protect against corrosion</td>
<td>Applicable mainly to cut situations in soil; maximum feasible exposed height is on the order of 10 ft</td>
</tr>
<tr>
<td>Cylinder pile wall</td>
<td>Relatively narrow base width; can produce stable wall even if deep potential failure surfaces present</td>
<td>Very high cost</td>
<td>Applicable mainly to cut situations; max. feasible exposed height is on the order of 20 to 25 ft, depending on passive resistance available; can be installed in bouldery conditions, though cost will increase</td>
</tr>
<tr>
<td>Slurry wall</td>
<td>Relatively narrow base width; can produce stable wall even if deep potential failure surfaces present</td>
<td>Very high cost; difficult construction</td>
<td>Applicable mainly to cut situations; maximum feasible exposed ht. is on the order of 20 to 25 ft, depending on passive resistance available</td>
</tr>
</tbody>
</table>

Table 1(d). Summary of nongravity wall options available.
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<tr>
<th>Specific Wall Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>All nongravity cantilever walls with tiebacks</td>
<td>Relatively narrow base width; can produce stable wall even if deep potential failure surfaces present</td>
<td>Very high cost; difficult to install in areas where vertical or lateral clearance is limited; easements may be necessary; installation activities may impact adjacent traffic</td>
<td>Applicable only to cut situations; can be designed for heights of 50 ft or more depending on the specifics of the structure of the wall</td>
</tr>
<tr>
<td>All nongravity cantilever walls with deadman anchors</td>
<td>Relatively narrow base width; can produce stable wall even if deep potential failure surfaces present</td>
<td>Moderate to high cost; must have access behind wall to dig trench for deadman anchor; may impact traffic during deadman installation; easements may be necessary</td>
<td>Applicable to partial cut/fill situations; can be designed for wall heights of approximately 16 ft</td>
</tr>
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</table>

Table 1(e). Summary of anchored wall options available.
<table>
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<tr>
<th>Wall/Slope Classification</th>
<th>Specific Wall Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rockeries</td>
<td>Only variations are in rock sizes used and overall wall dimensions</td>
<td>Low cost; narrow base width on the order of 30% of the wall ht. required</td>
<td>Slope must be at least marginally stable without rockery present; cannot tolerate much settlement</td>
<td>Applicable to both cut and fill situations; max. feasible ht. in a cut even for excellent soil conditions is approx. 16 ft and 8 ft in fill situations</td>
</tr>
<tr>
<td>Reinforced slopes</td>
<td>Only variations are in geosynthetic products used and in erosion control techniques used on slope face</td>
<td>Low cost; can tolerate large settlements; can adapt well to sloping ground conditions to minimize excavation required; high quality fill is not a requirement</td>
<td>Must have enough room between the right of way line and the edge of the shoulder to install a 1H:1V slope</td>
<td>Best suited to sloping fill situations; max. height limited to 30 ft unless geosynthetic products are used in which long-term product durability is well defined. Certain products can be used in critical applications and for greater slope heights on the order of 60 ft or more but consider need, landscaping maintenance, and the reach of available maintenance equipment.</td>
</tr>
</tbody>
</table>

Table 1(f). Other wall/slope options available.
Typical Mechanically Stabilized Earth Gravity Walls

*Figure 1130-1a*
Typical Prefabricated Modular Gravity Walls

Figure 1130-1b

Metal Bin Wall
Precast Concrete Crib Wall
Precast Concrete Bin Wall
Gabion Wall
Typical Rigid Gravity, Semigravity Cantilever, Nongravity Cantilever, and Anchored Walls

Figure 1130-1c
Typical Rockery and Reinforced Slope

Figure 1130-1d
MSE Wall Drainage Detail

Figure 1130-2

- Gravel backfill for drains
- Geotextile for underground drainage, low survivability Class?
  overlap on top
- 6 inch diameter daylight to face of wall or tie-in to drainage system every 300 ft.
Retaining Walls with Traffic Barriers

**Concrete Traffic Barrier with Concrete Roadway**

**Beam Guardrail on Top of MSE Retaining Wall**

**Concrete Traffic Barrier with Concrete Roadway**

**Beam Guardrail on Top of Gabion Wall**

*Figure 1130-3*
Retaining Wall Design Process

Figure 1130-4a

Design Process — Initiated by region, except by Bridge Office for walls included in bridge preliminary plan.

Coordination with Principal Architect. Bridge Office and Geotech. Branch to identify wall concepts and constraints. (0.5 to 1 month)

Region Develops and submits wall profile, plan, and cross sections (site data) with design request to RME.

Proprietary

Wall type: All other nonstandard, nonproprietary walls (1)

Submit wall site data to Bridge Office

Geotech. Branch performs geotech design and recommends wall alternatives as appropriate (1.5 to 4.5 months)

Bridge Office coordinates with Geotech. Branch, Principal Architect and region for final wall selection (0.5 to 1.5 months)

Bridge Office develops wall preliminary plan (1 to 2 months)

Bridge Office prepares PS&E (3 to 6 months)

Standard wall (Std. Plan walls, gabions up to 6 ft and rockeries up to 5 ft)

Wall Ht

> 10 ft

Submit wall site data with design request to Geotech Branch

Geotech Branch performs geotech design and recommends wall alternatives as appropriate (1.5 to 4.5 months)

Soil nail nongravity cantilever, anchored, or other structural walls

Geosynthetic walls and slopes, rockeries

Region evaluates potential alternative wall systems and coordinates with the Principal Architect for final wall selection

Geotech. Branch and/or Bridge Office provides plan details and specials and region prepares PS&E (05. to 1 month)

Yes

No

Geotech by region Materials Lab (1.5 to 3 months)

> 10 ft

< 10 ft

Gabions ≤ 6 ft, Rockeries ≤ 5 ft

Submit wall site data with design request to Geotech Branch

Geotech Branch performs geotech design and recommends wall alternatives as appropriate (1.5 to 3 months)

Region evaluates potential for alternative wall systems to be used and coordinates with the Principal Architect for final wall selection

Region prepares wall PS&E

Standard wall selected

Yes

No

Region Develops and submits wall profile, plan, and cross sections (site data) with design request to RME.

(1) Geosynthetic walls, concrete block walls, soil nail walls, rockeries > 5 ft height, reinforced slopes, and other nonstandard nonpreapproved walls if the desired wall type is uncertain.

(2) All other nonstandard, nonproprietary walls

(3) See notes and legend on Figure 1130-3b
Retaining Wall Design Process - Proprietary

Figure 1130-4b

Notes:
The "Bridge Office" refers to the WSDOT Bridge and Structures Office in the Olympia Service Center.
The "Geotech Branch" refers to the WSDOT Geotechnical Services Branch in the Olympia Service Center.
The "Principal Architect" refers to the WSDOT Architecture Section of the Bridge and Structures Office in the Olympia Service Center.
Regarding time estimates:
Assumes no major changes in the wall scope during design.
Actual times may vary depending on complexity of project.
Contact appropriate design offices for more accurate estimates of time.

Legend:
▲ Region provides courtesy copy of region geotech report to geotech services.
* Assumes soft or unstable soil not present and wall does not support other structures.
** The preapproved maximum wall height is generally 33 ft. Some proprietary walls may be less. (Check with the Bridge and Structures Office.)
*** If the final wall selected is a different type than assumed, go back through the design process to ensure all steps have been taken.
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**Notes**

¹ 2 ft surcharge or traffic barrier with vertical front face.

² 2 ft surcharge or traffic barrier with sloping front face.

³ 2H:V1 backslope with vertical front face.

⁴ 2H:1V backslope with sloping front face.

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**Retaining Wall Bearing Pressure**

*Figure 1130-5*
1140.01 General
The function of a noise barrier is to reduce traffic noise levels at adjoining areas. The noise abatement decisions are made during the environmental stage of the project development process. This is a highly interactive process. Before a noise barrier is designed, the department must be confident that there is significant need, a cost effective and environmentally acceptable noise barrier, a source of funds, and acceptance by adjacent property owners, local governmental agencies, and the general public.

The designer will find the following preliminary design information in the noise report:

- Sources of noise
- Noise receiver locations
- Predicted level of noise reduction
- Locations of existing and future noise impacts along the project corridor
- Barrier location and height recommendations based on what is feasible and reasonable

Design of a noise barrier project is the result of a team effort coordinated by the project engineer.

This chapter addresses the factors that are considered when designing a noise barrier and the associated procedures and documentation requirements.

1140.02 References
Environmental Procedures Manual, M 31-11, WSDOT
Guide Specifications for Structural Design of Sound Barriers, AASHTO
Roadside Manual, M 25-30, WSDOT

1140.03 Design
The two basic types of noise barriers are the earth berm and the noise wall. An earth berm can be constructed to the full height required for noise abatement or to partial height in conjunction with a noise wall to reach the required height. A noise wall can be made of concrete, masonry, metal, wood, or other approved innovative products, and can be supported by spread, pile, shaft, or trench footings.

Consideration of the noise report and the visual characteristics of adjacent land forms, vegetation, and structural elements (such as buildings, bridges, and retaining walls) will determine whether a proposed noise barrier might be berm, wall, or both.

An earth berm should be the primary alternative if the visual and environmental quality of the corridor would be preserved or enhanced and materials and right of way widths are available. See the Roadside Manual for criteria for determining if a vegetated earth berm is appropriate.

The region uses the noise report and other environmental documents (see the Environmental Procedures Manual) to help determine the location, exposure conditions, length, and heights of the proposed noise barrier.

To design and locate a noise barrier of any kind, consider the following:

- Desired noise abatement
- Future right of way needs
- Cost and constructibility
- Visual character and quality of the corridor
- Future maintenance of the noise barrier and the whole right of way
- Wind
• Supporting soil
• Earthquakes
• Ground water
• Existing drainage systems and water courses
• Exposure to vehicular impacts
• Potential vandalism
• Existing vegetation and roadside restoration required
• Access for maintenance equipment and enforcement, traffic service, and emergency vehicles
• Pedestrian and bicycle access
• Available and attainable width of right of way for berms
• Aesthetic and structural characteristics of available wall designs
• Visual compatibility of each wall design with other transportation structures within the corridor
• Construction limits for footings
• Access to, and maintenance of, right of way behind a wall, including drainage structures
• Use of right of way and wall by adjacent property owners
• Drainage and highway runoff
• Drainage from adjacent land
• Existing utilities and objects to relocate or remove
• Water and electricity; needs, sources, and access points

A noise barrier must not have anything (such as bridge columns, light fixtures, or sign supports) protruding in such a way as to present a potential for snagging vehicles.

(1) Earth Berm

(a) Berm slopes are a function of the material used, the attainable right of way width, and the desired visual quality. Slopes steeper than 2H:1V (3H:1V for mowing) are not recommended.

Design the end of the berm with a lead-in slope of 10H:1V and curve it toward the right of way line.

(b) See Chapter 710 and the Standard Plans for guidance on redirectional land forms if the berm is to function as a traffic barrier.

(2) Noise Wall

(a) When feasible, to encourage competitive bidding, include several alternate noise wall designs in the contract and permit the contractor to submit alternate designs under the value engineering specification.

(b) There are standard noise wall designs in the Standard Plans manual. Additional designs are in various stages of development to become standard plans. The draft-standard design sheets and other preapproved plans are available from the Bridge and Structures Office. The Bridge Office also works with the regions to facilitate the use of other designs as bidding options.

(c) When a noise wall has ground elevations that are independent of the roadway elevations, a survey of ground breaks (or cross sections at 25-ft intervals) along the entire length of the wall is needed for evaluation of constructibility and to assure accurate determination of panel heights.

(d) Size of openings (whether lapped, door, or gated) depends on the intended users. Agencies such as the local fire department can provide the necessary requirements. Unless an appropriate standard plan is available, such openings must be designed and detailed for the project.

(e) When a noise wall is inside the Design Clear Zone, design its horizontal and vertical (ground elevation) alignment as if it were a rigid concrete traffic barrier. See Chapter 710 for maximum flare rates.

(f) Provide a concrete traffic barrier shape at the base of a new noise wall constructed 12 ft or less from the edge of the nearest traffic lane. The traffic barrier shape is optional at the base of the new portion when an existing vertical-faced wall is being extended (or the existing wall may be retrofitted for continuity). Standard Concrete Barrier Type 4 is recommended for both new and
existing walls except when the barrier face can be cast as an integral part of a new wall. Deviations may be considered but require approval as prescribed in Chapter 330. For deviations from the above, deviation approval is not required where sidewalk exists in front of the wall or in other situations where the wall face is otherwise inaccessible to traffic.


(g) To designate a standard noise wall, select the appropriate general special provisions and state the standard plan number, type, and foundation type. For example: Noise Barrier Standard Plan D-2a, Type 1A, Foundation D1. Wall type is a function of exposure and wind speed. See Figure 1140-1.

A geotechnical/soils report identifying the angle of internal friction $f$ and the allowable bearing pressure is needed for selection of a standard foundation. The standard spread footing designs require an allowable bearing pressure of 1 Tsf. The standard trench and shaft footing designs require a $f$ of at least $32^\circ$ for D1 and $38^\circ$ for D2.

A special design of the substructure is required for noise walls on substandard soil, where winds exceed 90 mph, and for exposures other than B1 and B2 as defined in Figure 1140-1.

**1140.04 Procedures**

The noise unit notifies the Project Engineer’s Office when a noise barrier is recommended in the noise report.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>B1</th>
<th>B2</th>
<th>C</th>
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<tr>
<td>Wind Speed</td>
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<td>90 mph</td>
<td>80 mph</td>
</tr>
<tr>
<td>Wall Type</td>
<td>A</td>
<td>B</td>
<td>C</td>
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</table>

Wind speed is according to Figure 1-2.1.2.A of the (AASHTO) *Guide Specifications for Structural Design of Sound Barriers*. Assume the wind to be perpendicular to the wall on both sides and design for the most exposed side.

Exposure is determined by the nature of the immediately adjacent ground surface and the extension of a plane at the adjacent ground surface elevation for 1,500 ft to either side of the noise wall:

- **Exposure B1** = Urban and suburban areas with numerous closely spaced obstructions having the size of single-family dwellings or larger that prevail in the upwind direction from the noise barrier for a distance of at least 1,500 ft.
- **Exposure B2** = Urban and suburban areas with more open terrain not meeting the requirements of Exposure B1.
- **Exposure C** = Open terrain with scattered obstructions that include flat, open country, grasslands, and elevated terrain.

*For a noise wall with Exposure C, on a bridge or overpass, or at the top of a slope, consult the Bridge and Structures Office, as a special design will probably be necessary.

**Standard Noise Wall Types**

*Figure 1140-1*
The Project Engineer’s Office is responsible for interdisciplinary teams, consultation, and coordination with the public, noise specialists, maintenance, construction, region’s Landscape Architecture Office (or the Roadside and Site Development Services Unit), right of way personnel, Materials Laboratory, Principal Architect (in the Bridge and Structures Office), Bridge and Structures Office, CAE Support Team, Access and Hearings Engineer, consultants, and many others.

The region evaluates the soils (see Chapters 510 and 1110) and, if a noise wall is contemplated, obtains a list of acceptable wall design options by sending information pertaining to soils and drainage conditions, the alignment, and heights of the proposed wall to the Principal Architect.

If a vegetated earth berm is considered, see the Roadside Manual for procedures.

The Principal Architect coordinates with the Bridge and Structures Office, Hydraulics Design Branch, Geotechnical Branch, and the region to provide a list of acceptable standard, draft-standard, and preapproved-proprietary noise wall designs, materials, and finishes that are compatible with existing visual elements of the corridor. Only wall designs from this list may be considered as alternatives. Design visualizations of the highway side of proposed walls (available from the CAE Support Team in Olympia) must be limited to options from this list. The visual elements of the private-property side of a wall are the responsibility of the region unless addressed in the environmental documents.

After the noise report, any changes to the dimensions or location of a noise barrier must be reviewed by the appropriate noise unit to determine the impacts of the changes on noise abatement.

On limited access highways, any opening in a wall or fence (for pedestrians or vehicles) must be coordinated with the Access and Hearings Engineer and approved by the State Design Engineer.

On nonlimited access highways, an access connection permit is required for any opening (approach) in a wall or fence.

The Bridge and Structures Office provides special substructure designs to the regions upon request; reviews contract design data related to standard, draft-standard, and preapproved designs; and reviews plans and calculations that have been prepared by others. (See Chapter 1110.) Approval of the Bridge and Structures Office and the Architecture Office is required for any attachment or modification to a noise wall and for the design, appearance, and finish of door and gate type openings.

Approval of the Principal Architect is required for the final selection of noise wall appearance and finish.

1140.05 Documentation

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

- Noise report
- Geotechnical/soils report
- List of design options considered and summary of evaluations
- Report on impacts due to changes
- Openings approvals
- Wall attachments approval
- Final selection approval
1210 Hydraulic Design

1210.01 General
Hydraulic design factors can significantly influence the corridor, horizontal alignment, grade, location of interchanges, and the necessary appurtenances required to convey water across, along, away from, or to a highway or highway facility. An effective hydraulic design conveys water in the most economical, efficient, and practical manner to ensure the public safety without incurring excessive maintenance costs or appreciably damaging the highway or highway facility, adjacent property, or the total environment.

This chapter is intended to serve as a guide to highway designers so they can identify and consider hydraulic related factors that impact the design. Detailed criteria and methods that govern highway hydraulic design are in WSDOT’s Hydraulics Manual and Highway Runoff Manual.

Some drainage, flood, and water quality problems can be easily recognized and resolved; others might require extensive investigation before a solution can be developed. Specialists experienced in hydrology and hydraulics can contribute substantially to the planning and project definition phases of a highway project by recognizing potentially troublesome locations, making investigations and recommending practical solutions. Regions may request that the Olympia Service Center (OSC) Hydraulics Branch provide assistance regarding hydraulic problems.

Since hydraulic factors can affect the design of a proposed highway or highway facility from its inception, consider these factors at the earliest possible time during the planning phase.

1210.02 References
(1) Existing Criteria and References
Existing criteria and additional information for hydraulic design requirements, analyses, and procedures are contained in the following references:

Hydraulics Manual, M 23-03, WSDOT
Highway Runoff Manual, M 31-16, WSDOT
Standard Plans for Road, Bridge and Municipal Construction, M 21-01, WSDOT
Standard Specifications for Road, Bridge and Municipal Construction, M 41-10, Amendments, and General Special Provisions, WSDOT
Utilities Manual, M 22-87, Section 1-19, “Storm Drainage,” WSDOT

(2) Special Criteria
Special criteria for unique projects are available on request from the OSC Hydraulics Branch.

1210.03 Hydraulic Considerations
(1) The Flood Plain
Encroachment of a highway or highway facility into a flood plain might present significant problems. A thorough investigation considers the following:

(a) The effect of the design flood on the highway or highway facility and the required protective measures.

(b) The effect of the highway or highway facility on the upstream and downstream reaches of the stream and the adjacent property.

(c) Compliance with hydraulic related environmental concerns and hydraulic aspects of permits from other governmental agencies per Chapters 220 and 240.
Studies and reports published by the Federal Emergency Management Agency (FEMA) and the Corps of Engineers are very useful for flood plain analysis. The OSC Hydraulics Branch has access to all available reports and can provide any necessary information to the region.

(2) **Stream Crossings**

When rivers, streams, or surface waters (wetland) are crossed with bridges or culverts (including open bottom archs), consider the following:

- **Locating the crossing** where the stream is most stable.
- Effectively conveying the design flow(s) at the crossing.
- Providing for passage of material transported by the stream.
- The effects of backwater on adjacent property.
- Avoiding large skews at the crossing.
- The effects on the channel and embankment stability upstream and downstream from the crossing.
- Location of confluences with other streams or rivers.
- Fish and wildlife migration.
- Minimizing disturbance to the original streambed.
- Minimizing wetland impact.

(3) **Channel Changes**

It is generally desirable to minimize the use of channel changes because ongoing liability and negative environmental impacts might result. Channel changes are permissible when the designer determines that a reasonable, practical alternative does not exist. When used, consider:

(a) Restoration of the original stream characteristics as nearly as practical. This includes:
- Meandering the channel change to retain its sinuosity.
- Maintaining existing stream slope and geometry (including meanders) so stream velocity and aesthetics do not change in undisturbed areas.
- Excavation, selection, and placement of bed material to promote formation of a natural pattern and prevent bed erosion.
- Retention of stream bank slopes.
- Retention or replacement of streamside vegetation.

(b) The ability to pass the design flood.
(c) The effects on adjacent property.
(d) The effects on the channel and embankment upstream and downstream from the channel change.
(e) Erosion protection for the channel change.
(f) Environmental requirements such as wetlands, fish migration, and vegetation re-establishment.

Do not redirect flow from one drainage basin to another. (Follow the historical drainage pattern.) Consult the OSC Hydraulic section for the best guidance when channel changes are considered.

(4) **Roadway Drainage**

Effective collection and conveyance of storm water is critical. Incorporate the most efficient collection and conveyance system considering initial highway costs, maintenance costs, and legal and environmental considerations. Of particular concern are:

(a) Combinations of vertical grade and transverse roadway slopes that might inhibit drainage.
(b) Plugging of drains on bridges as the result of construction projects. This creates maintenance problems and might cause ponding on the structure. The use of drains on structures can be minimized by placing sag vertical curves and crossovers in superelevation outside the limits of the structure.
(c) See Chapter 630 for discussion of the relationship of roadway profiles to drainage profiles.

(5) **Subsurface Drainage**

Subsurface drainage installations control ground water encountered at highway locations. Ground water, as distinguished from capillary water, is free water occurring in a zone of saturation below the ground surface. The subsurface discharge depends on the effective hydraulic head and on the permeability, depth, slope, thickness, and extent of the aquifer.

The solution of subsurface drainage problems often calls for specialized knowledge of geology and the application of soil mechanics. The region Materials Engineer evaluates the subsurface conditions and includes findings and recommendations for design in the Soils Report.

Typical subdrain installations control seepage in cuts or hillsides, control base and shallow subgrade drainage, or lower the ground water table (in swampy areas, for example).

Design a system that will keep the stormwater out of the subsurface system when stormwater and subsurface drainage systems are combined.

(6) **Subsurface Discharge of Highway Drainage**

Consider subsurface discharge of highway drainage when it is a requirement of the local government or when existing ground conditions are favorable for this type of discharge system. Criteria for the design of drywells or subsurface drainage pipe for this type of application are described in Chapter 6 of the *Hydraulics Manual*. The criteria for the design of infiltration ponds are described in the *Highway Runoff Manual*.

(7) **Treatment of Runoff**

On certain projects, effective quantity control of runoff rates and removal of pollutants from pavement are intended to address flooding and water quality impacts downstream. See the *Highway Runoff Manual* for specific criteria on quantity and quality control of runoff.
1300 Roadside Development

1300.01 General
The roadside is the area outside the traveled way. This applies to all lands managed by WSDOT and may extend to elements outside the right of way boundaries.1 This includes unpaved median strips and auxiliary facilities such as rest areas, roadside parks, viewpoints, heritage markers, pedestrian and bicycle facilities, wetlands and their associated buffer areas, stormwater treatment facilities, park and ride lots, and quarries and pit sites.

The roadside is managed to fulfill operational, environmental, visual and auxiliary functions. In reality, these functions are interrelated and inseparable. However, the four categories help communicate the range of roadside management issues.

- **Operational functions** are functions that provide safe, multiuse roadsides. Operational functions include access control, and providing recovery areas and sight distances with accommodations for signs and utilities.

- **Environmental functions** are those roadside functions that protect and enhance our natural and built surroundings. Environmental functions include water quality preservation and improvement, stormwater detention and retention, wetland and sensitive area protection, noxious weed control, noise control, habitat preservation, air quality improvement, and erosion control.

- **Visual functions** are those roadside functions that are designed and experienced primarily from a visual perspective. Visual functions promote a positive quality of life and are integral to operational, environmental, and auxiliary functions. They include positive guidance and navigation, distraction screening, corridor continuity, roadway and adjacent property buffering, and scenic view preservation.

- **Auxiliary functions** are those roadside functions that provide additional operational, environmental, and visual functions for a complete transportation system. Examples of auxiliary functions include community enhancement areas, safety rest areas, roadside parks, viewpoints, agricultural uses, historic markers, bicycle and pedestrian facilities, park and ride lots, and maintenance facilities.

One element can provide multiple functions simultaneously. Roadside functions are described in greater detail in the Roadside Manual, (M 25-30).

The design level planning effort of a roadside project incorporates site conditions, commitments, the extent of need, and available funding. Roadside development concepts covered elsewhere in the Design Manual are:

- Signs (Chapter 820)
- Safety rest areas, roadside parks, viewpoints, and historical markers (Chapter 1030)
- Retaining walls (Chapter 1130)
- Noise barriers (Chapter 1140)
- Roadside safety (Chapter 700)
- Traffic barriers (Chapter 710)
- Contour grading (Chapter 1310)
- Vegetation (Chapter 1320)

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1 WSDOT owns and manages the land within the right of way boundaries. WSDOT also owns, or has partial investment in, properties outside of the right of way boundaries; for example, wetland mitigation sites. In addition, WSDOT has an interest in elements outside the right of way boundaries which may affect roadway safety.
• Irrigation (Chapter 1330)
• Fencing (Chapter 1460)
• Utilities (Utilities Manual and Utilities Accommodation Policy)

It is WSDOT policy to employ roadside treatments for the protection and restoration of roadside character as designated in the Roadside Classification Plan.

1300.02 References
Roadside Classification Plan, M 25-31, WSDOT
Roadside Manual, M 25-30, WSDOT
Utilities Accommodation Policy, M 22-86, WSDOT
Utilities Manual, M 22-87, WSDOT
Roadside Design Guide, AASHTO

1300.03 Roadside Classification Plan
The Roadside Classification Plan coordinates and guides the management of Washington State highway roadsides within a framework of roadside character classifications. It provides guidelines for roadside restoration and advocates the use of native plants, integrated vegetation management (IVM), and a long-term management approach to achieve sustainable roadsides.

1300.04 Roadside Manual
The Roadside Manual provides a link and coordination between all WSDOT partners responsible for roadside activities, and establishes a common basis for consistent roadside management decisions statewide.

It also establishes a convenient and accessible reference for new and previously unpublished material related to roadside management including planning, design, construction, and maintenance. In addition, the manual supplements statewide roadside guidelines established in the Roadside Classification Plan.

The Roadside Manual includes information on, or references to:
• Federal, state, and departmental roadside law and policy.
• Considerations such as the Americans with Disabilities Act.
• Heritage Corridors Program and Scenic Byways.
• Roadside treatments such as erosion control, contour grading, rock cuts, soil bioengineering, wetland mitigation, and revegetation.
• Right of way issues such as commercial impacts, view exposure, agricultural uses, acquisitions, and scenic easements.
• Partnerships such as Adopt a Highway.

See the Roadside Manual table of contents for more information on the contents of the manual.

1300.05 Design Requirements
For all projects outside the roadway edge, consult the region’s Landscape Architect, or the OSC Region Liaison Landscape Architect in regions without a Landscape Architect. The Landscape Architects can help coordinate all the various aspects of roadside projects including siting and design for maintenance facilities, safety rest areas, noise berms, noise walls, and revegetation, restoration, and wetland mitigation projects.

For any work in, or near wetlands, Section 404 of the Clean Water Act may apply.

The act requires a permit to discharge dredge or fill into most waters of the United States, including wetlands. The Section 404 permitting process requires advanced planning and coordination with the permitting agency: the U.S. Army Corps of Engineers.

1300.06 Documentation
Document all roadside projects with a project file (see Chapter 330 for information on design documentation and design approval levels). A roadside project file may include the following documents:
• Site analysis
  • Soils
  • Soil boring logs
  • Climate
  • Slopes
• Aspect (north facing slope, for example)
• Vegetation present (species, percentage of each species, location, health)
• Adjacent land uses
• Location of any surface water bodies
• Movement of water
• Views into and out of site
• General impressions
• Conceptual diagrams
• Preliminary plans
• Final PS&E
• Decision documentation; for example:
  • Jurisdictional requirements
  • Commitments
  • Soil analysis
  • Slope stability analysis
  • Hydrologic analysis
  • Horticultural reports
  • Plant availability
  • Proprietary product information

Participants in reviews for roadside projects may include:
  • OSC Region Liaison Landscape Architect
  • Maintenance Office
  • Construction Office
  • OSC Horticulturist
  • Region’s Traffic Office
  • Region’s Project Development Office
  • Environmental Office
  • Affected Community Groups

The OSC Region Liaison Landscape Architect is also available for roadside design in regions without a regional Landscape Architect.

1300.07 Design Recommendations

The region’s Landscape Architect designs and approves revegetation plans. They are available for assistance on any roadside projects. A review of preliminary plans to provide additional perspective on the design is recommended at the following roadside project benchmarks:

• Shortly after field data has been collected - consists of site analysis and conceptual diagrams
• Preliminary plans
• Final PS&E plans

These reviews help to ease the final PS&E process.
1310.01 General
Contour grading is an important element in achieving operational, environmental and visual functions.

Contour grading plans are required when profiles and cross sections do not provide a complete picture. Examples include stream channel changes, interchanges, redirectional berms, noise abatement berms, wetland mitigation sites, and detention/retention ponds. Contour grading plans show the subtle changes in grading that occur between cross sections and can allow for finer grading so that the constructed earthform blends smoothly into the surrounding landscape. While engineered slopes define grades to meet engineering requirements, contours can be used to define a finished grade that will blend the facility into the surrounding landscape and meet the requirements of the Roadside Classification Plan.

A detention/retention pond can be designed and constructed to appear as if it were naturally formed. Contour grading plans facilitate this kind of earth sculpting. In addition, contour grading plans can be critical to wetland mitigation sites where inaccurate grading can leave a proposed mitigation site without access to a water source.

See the Roadside Manual for more detailed information on grading for roadsides.

1310.02 References
Roadside Manual, M 25-30, WSDOT
Roadside Classification Plan, M 25-31, WSDOT
Standard Plans for Road, Bridge and Municipal Construction, M 21-01, WSDOT

1310.03 Procedures
See Chapter 330 for design approval levels.

When contour grading plans are needed, consult the region’s or Olympia Service Center (OSC) Design Landscape Architect.

Submit plans for contour grading on structures (such as lids) to the OSC Bridge and Structures Office for approval.

1310.04 Recommendations
Consider the following factors when developing a contour grading plan:

- Balancing of cut and fill within project limits.
- Preservation of existing desirable vegetation.
- Preservation of existing topsoil.
- Vehicle recovery areas.
- Sight distance.
- Pedestrian safety and security.
- Impacts to groundwater and surface water both on and off the right of way, including wetlands.
- Slope angle and potential soil erosion.
- Slope rounding.
- Drainage (including detention/retention functions).
- Surrounding landscape.
- Visual factors (a form that blends with the adjacent landforms).
- Grading construction cost
- Slopes steeper than 2 horizontal:1 vertical may be difficult to stabilize and establish vegetation on.
- Soil properties and angle of repose.
• Maintenance access to drainage and traffic operational features.
• Maintenance requirements for slopes (slopes steeper than 3 horizontal:1 vertical cannot be mowed).
• Access along fence line or noise walls, if necessary.
• Maximum allowable cut/fill next to a structure (minimum cover over a footing, maximum fill behind a wall or next to a pier).

Use a known stationing point or baseline as a starting point in drawing contours.

Recommended contour interval:
• 3 to 5 ft for highway plan drawings.
• 2 ft contour intervals for redirectional berms, and pedestrian related facilities.
• 0.5 to 1.5 ft contour intervals for wetland mitigation sites, stream mitigation sites, and wetland bank sites. Include two or more cross-sections done at a vertical exaggeration sufficient to communicate the design intent.
1320 **General**

Roadside vegetation provides operational, environmental and visual benefits to WSDOT roadway users. Vegetation preservation and restoration is an integral part of roadside planning and design. When a project disturbs a roadside segment, that project is responsible for meeting the requirements of the roadside classification for that road segment. This may include working outside the actual disturbed area for buffering and blending into the surrounding landscape.

Consult early in the project process with the region’s Landscape Architect, or the OSC Region Liaison Landscape Architect for regions without a Landscape Architect, for all projects involving revegetation.

1320 **References**

*Roadside Classification Plan, M 25-31, WSDOT*

*Roadside Manual, M 25-30, WSDOT*

*Integrated Vegetation Management for Roadsides, WSDOT*

*Standard Specifications for Road, Bridge and Municipal Construction, APWA and WSDOT*

1320 **Discussion**

**Operational, Environmental and Visual Functions of Roadside Vegetation**

Roadside vegetation servers various functions. Functions include, but are not limited to, the following:

- Prevent soil erosion.
- Enhance water quality.
- Provide for water storage and slow runoff.
- Aid in de-watering soils.
- Slope stabilization.
- Protect or restore wetlands and sensitive areas.
- Preserve and provide habitat.
- Prevent noxious weed infestation.
- Provide positive driver cues for guidance and navigation.
- Provide for corridor continuity.
- Screen glare and distractions, and buffer view of neighboring properties from the roadway.
- Buffer view of roadway by neighboring property owners.
- Preserve scenic views.
- Reduce driver monotony.
- Provide for a pleasing roadside experience.

For more detail see the *Roadside Manual*.

1320 **Recommendations**

(1) **Reviews**

Refer to Chapter 1300, Design Recommendations, for review recommendations.

(2) **Preliminary Plans**

The region’s Landscape Architect designs and approves revegetation plans. A review of preliminary plans to provide addition perspective on the design is recommended at least six weeks before submittal of the Plans, Specification and Estimate package (PS&E). Participants in design reviews for revegetation projects include:

- OSC Region Liaison Landscape Architect
- Maintenance Office
- Construction Office
- OSC Horticulturist
- Region’s Traffic Office
• Region’s Project Development Office
• Affected Community Groups

Preliminary plans may consist of print or pencil drawings of plans (excluding standardized details) being developed for the PS&E. The preliminary plans provide for an informal review which allows adaptation of the plan and can ease the formal PS&E review.

The Olympia Service Center (OSC) Region Liaison Landscape Architect is also available to prepare plans for regions without a Landscape Architect.

1320.05 Design Guidelines

(1) General

The type and extent of vegetation will vary depending on the roadside character classification of the road segment, the approved treatment level of the project, the affected roadside management zone, and the planting environment. Select and maintain vegetation so that it does not present a hazard or restrict sight distances to other vehicles and to signs.

• Apply the following guidelines when designing roadside projects:
• Apply the requirements of the Roadside Classification Plan.
• Design revegetation plans, including wetland mitigation sites and detention/retention ponds to be as maintenance-free as possible.
• Select and maintain plants to achieve required clear zone, sight distance, clear sight to signing, and headlight screening.
• Preserve existing desirable vegetation and topsoil to the maximum extent reasonable.
• Select native plants as the first choice.
• Select plants adaptable to the site conditions. (See the Roadside Manual for more information.)
• Consider stripping, stockpiling and reapplying topsoil if construction will disturb topsoil.

• Consider design speeds in the selection and location of plants. For example, as traffic speed increases, include larger groupings of fewer species in the landscape since the motorist’s perception of detail along the roadside diminishes.
• When selecting vegetation, consider screening undesirable views, or consider allowing openings to reveal or maintain desirable views.
• Accommodate existing and proposed utilities.
• Consider maintenance requirements and design for sustainable roadsides.

Roadway geometrics will also affect the type and extent of vegetation in specific locations. The maximum allowable diameter of trees within the Design Clear Zone is 4 in measured at 6 in above the ground when the tree has matured. Consider limiting vegetation diameters on the outside of curves beyond the Design Clear Zone to improve safety. See the Roadside Manual for more information.

(2) Existing Vegetation.

Avoid destruction of desirable existing vegetation, reduce impacts on desirable existing vegetation, and restore desirable damaged vegetation.

• Protect desirable existing vegetation wherever possible.
• Delineate trees that are to remain within the construction zone and provide adequate protection of the root zone (extending from the tree trunk to a minimum of 3 ft beyond the drip line).
• Encourage desirable vegetation by using revegetation techniques to prevent or preclude the establishment of undesirable vegetation. See Integrated Vegetation Management for Roadsides.
• Limit clearing and grubbing (especially grubbing) to the least extent possible.
Selectively remove vegetation to:

- Remove dead and diseased trees when they are a hazard (including those outside the clear zone).
- Maintain clear zone and sight distance.
- Increase solar exposure and reduce accident rates, if analysis shows that removing vegetation will improve safety.
- Open up desirable views.
- Encourage understory development.
- Encourage individual tree growth.
- Prevent plant encroachment on adjacent properties.
- Ensure long-term plant viability.

Refer to Division 8 of the *Roadside Manual* for more information.

(3) **Plant Material Selection.**

Select noninvasive vegetation (not having the potential to spread onto roadways, ditches and adjacent lands).

Base plant material selection on:

- Site analysis and conditions expected after the facility is constructed.
- Horticultural requirements.
- Plant availability.
- Plant cost.
- Plant success rates in the field.
- Traffic speed.

The *Roadside Manual* provides more detailed guidelines on plant selection, sizing, and location.

(4) **Establishment of Vegetation**

Most WSDOT projects have 1 to 3 year plant establishment periods. Wetland mitigation projects often include additional years of monitoring to ensure that mitigation standards of success are met. The goal of plant establishment is to promote a healthy, stable plant community.

Soil treatments, such as the use of slow release fertilizer; incorporation of soil amendments such as compost into the soil layer; and surface mulching, may improve the success rate of introduced vegetation. Consult the WSDOT Horticulturist for recommendations. (Check with the local maintenance office or the local jurisdiction’s comprehensive plan for any restrictions such as those in well-head protection areas.)

- Use soil amendments based on the soil analysis done for the project. Soil testing is coordinated through the OSC Horticulturist or the Landscape Architect. Soil amendments will enhance the soil’s moisture holding capacity.
- Use surface mulches to conserve soil moisture and moderate soil temperatures. Mulches also help keep weeds from competing with desirable plants for water and nutrients, and provide organic matter and nutrients to the soil.
- Use irrigation only when necessary. If irrigation is required, see Chapter 1330 for design guidelines and the *Roadside Manual* for more detail.

1320.06 **Documentation**

Refer to Chapter 320 for guidance on reviews and approvals, and Chapter 330 for design approval levels. Include the following as a part of the project file for a revegetation project:

(a) **Roadside Classification** of the road segment. Park-and-ride lots and other off-road facilities may not have a roadside classification. However, if there are local requirements driving the design for these facilities, then those need to be documented.

(b) **Scope and Conceptual Approach** of the planting design

Include commitments to adjacent property owners.

(c) **Treatment Level** (Described in the *Roadside Classification Plan.*)

- Treatment Level 1 is for maintenance activities.
• Treatment Level 2 is used in most cases.
• Treatment Level 3 requires OSC approval.

(d) Horticultural Requirements of the vegetation:
• Collect and analyze soil sample data.
• Develop a proposed plant list.
• Document the need for irrigation (if proposed).

Consult the WSDOT Horticulturist for assistance.

(e) Wildflower Requirements.

The Surface Transportation and Uniform Relocation Assistance Act of 1987, Section 130 requires at least 0.25% of funds expended for landscape projects be used to plant native wildflowers.

Wildflowers are defined by the Federal Highway Administration (FHWA) as any native flowering plant growing in fields, woods, etc., without cultivation. Native flowering shrubs and trees also qualify as wildflowers and are generally more sustainable than herbaceous wildflowers.

For federal-aid landscape projects, include the amount of wildflower plantings, expressed as a percentage of all landscaping costs (excluding erosion control costs), in the project summary. If the project contains wildflower plantings amounting to less than 0.25% of all landscaping costs (excluding erosion control costs), a deviation must be requested from FHWA.

The wildflower requirement may be waived by FHWA if any of the following conditions exist:
• Wildflowers cannot be grown satisfactorily within the project limits.
• The available right of way is to be used for agricultural purposes.
• There are no suitable planting areas available within the project limits.

• Wildflower planting would pose a threat to endangered or rare species.

(f) Construction. The project file will include the following roadside construction considerations and requirements.
• Commitments to adjacent property owners.
• Instructions for special testing procedures (examples are compost maturity test, clay liner requirements, permeability test, etc.).

Communication with the assigned construction office is recommended throughout the design process to improve constructibility of the project.

(g) Maintenance. The project file will include the following roadside maintenance considerations and requirements:
• Maintenance requirements and estimated costs necessary to achieve the design intent.

Coordinate with the regional maintenance or operations engineer (as appropriate for your region) to allow for funding.
• Guidelines, schedules, and prioritized list of activities required to meet the design intent.

The project file will state whether the project is within the scope of the existing maintenance program.

Communication with the area maintenance office is recommended throughout the design process.
1330

1330.01 General

Irrigation provides additional moisture to plants during their establishment (the first 3-5 years), or in special cases, on a continuing basis. Irrigation is a high maintenance and high cost item; use only when absolutely necessary. Irrigation is only used in semiurban and urban character classifications in Treatment Levels two and three. Refer to the Roadside Classification Plan for more information. Contact the region’s Landscape Architect or the OSC Irrigation Specialist for assistance with irrigation plans.

1330.02 References

Roadside Classification Plan, M 25-31, WSDOT
Roadside Manual, M 25-30, WSDOT

1330.03 Design Considerations

During the project planning phase:
(a) Determine whether irrigation is necessary
  • Analyze soils
  • Determine local climate conditions and microclimates
  • Consult with the OSC Horticulturist, regional Landscape Architect, or OSC Landscape Architect for regions without landscape architectural expertise for site, soil, and plant recommendations to reduce or eliminate need for irrigation
  • Describe where irrigation is needed based on a functional design concept, such as “irrigation is needed to provide green lawn at a safety rest area”

(b) Determine the source of water and its availability and connection fees

Sources of water for irrigation use include municipal water systems and water pumped from a well, pond, or stream. When selecting a source of water, consider what permits and agreements may be needed as well as the cost and feasibility of bringing water from the source to the site.

(c) Determine applicable laws and regulations regarding water, and backflow prevention

During the design and implementation phases:
(a) Coordinate with the local water purveyor.
(b) Select durable, readily available, easy to operate, and vandal resistant irrigation components.
(c) Justify any proprietary device selections.
(d) Determine power source and connection fees.
(e) Consider the need for winterization of the irrigation system to avoid freeze damage to system components.

Use this information to document design decisions for the project file.

Show the location and type of water source on their irrigation plan.

For more detailed information on irrigation systems and irrigation documentation, see the Roadside Manual.

P65:DP/DMM
1350 Soil Bioengineering

1350.01 General
Soil bioengineering is a land stabilization technology applied to disturbed sites and on slope and streambank projects. A multidisciplinary partnership is used to implement soil bioengineering techniques. Project managers initiate and design bioengineering features by employing the expertise of WSDOT hydraulic engineers, geotechnical engineers, engineering geologists, landscape architects, horticulturists, biologists, water quality specialists, environmental planners, and others. Soil bioengineering for slope stabilization provides additional environmental benefits such as habitat enhancement and water quality improvement.

All soil bioengineering proposals should include consideration of slope geometry, climate, water regime, soil properties, and surrounding vegetation. Applications of soil bioengineering are divided into three general categories: erosion control, streambank or shoreline stabilization, and upland slope stabilization. Refer to manuals according to the related discipline.

1350.0 References
For more detailed information, see:

Design Manual chapters, M 21-01, WSDOT:
- 1300 Roadside Development
- 510 Investigation of Soils and Surfacing Materials
- 640 Geometric Cross Section
- 1210 Hydraulics
- 1130 Retaining Walls

Geotechnical Guidance — see geotechnical report or soils report for slope/soil stability. If further assistance is needed, contact Regional Materials Engineer.

Hydraulics Manual, M 23-03, WSDOT — for hydrology criteria.


Roadside Classification Plan, M 25-31, WSDOT — policy and guidelines for roadside treatment. Contact the region’s Landscape Architect Office or the OSC Roadside and Site Development Services Unit at the Olympia Service Center.

Environmental Procedures Manual, M 31-11, WSDOT — permits.

Internet Bioengineering Drawings, WSDOT Homepage (http://www.wsdot.wa.gov)

1350.03 Uses
(1) General
Soil bioengineering combines the use of live plants or cuttings, dead plant material, and inert structural members to produce living, functioning land stabilization systems. This technique uses living plants to control and prevent soil erosion, sedimentation, and shallow slope instability. The bioengineered solution benefits from engineering techniques that use live plant material.

Soil bioengineering methods can be cost effective and a useful mitigation solution for site specific problems. Soil bioengineering is effective in erosion control, streambank stabilization, and some upland instabilities. Soil bioengineering, like other engineering techniques, is not applicable in all situations. Soil bioengineering
techniques may not effectively mitigate severe bridge scour, severe roadway erosion conditions, or deep seated slope instabilities. In such cases, soil bioengineering can be used in combination with other engineering techniques.

The use of native vegetation that is adapted to the conditions of the project site will increase the success of the application of soil bioengineering techniques. Over time, native vegetation will encourage the establishment of a diverse plant community and discourage undesirable and invasive plant species.

Other applications of soil bioengineering include:
- Wildlife and fisheries habitat enhancement
- Reinforcement and steepening of cut and fill slopes to limit impacts to adjacent properties and sensitive areas
- Vegetated buffer enhancement on steep slopes
- Enhancement of stormwater treatment areas and stabilization of drainage ways by providing siltation and pollution control
- Site specific mitigations using standard geotechnical solutions in combination with vegetative control

(2) Erosion Control
Soil Bioengineering techniques can address erosion control problems that occur in the top 8 in of soil. Erosion is the detachment and transport of surficial soil particles through the action of water, wind, and ice. Plant shoots and foliage diminish rainfall erosion and remove excess moisture through transpiration. Roots reinforce the soil mantle, allowing the system to grow more stable with age. Vegetative material slows down runoff and traps soil thereby reversing the effects of erosion. Refer to the Roadside Management Manual for more information.

(3) Streambank Stabilization
Soil bioengineering techniques can be used to stabilize streambanks, enhance wildlife habitat, improve water quality by controlling sediments, and protect structures. Bioengineering in the riparian zone (banks of streams, wetlands, lakes, or tidewater) requires an hydraulic study of stream characteristics and changes in stream alignment. Refer to the Hydraulics Manual for more information.

(4) Upland Slope Stabilization (generally less than one meter in depth)
Upland slope stabilization refers to the use of vegetation and plant materials to reduce or prevent soil erosion caused by wind or water on dry slopes.

There are three classifications of unstable slopes:
- **Surface movement** refers to surface erosion caused by wind or water on slopes
- **Shallow-seated instability** is defined as a failure surface less than one meter in depth
- **Deep-seated instability** is defined as a failure surface greater than one meter in depth

Soil Bioengineering is used for slopes that are at risk of shallow landslides, slumps, sloughing, and surface erosion. Soil bioengineering techniques are most applicable to shallow slope stabilization projects characterized by unstable slopes that have surface movement. Surface movement of soils can be induced by soil creep, repeated freeze-thaw cycles, and soil erosion. The processes that influence overall slope stability, such as heavy and prolonged erosion and continuous slow soil movement, can significantly alter slope geometry.

Soil bioengineering techniques can be used to stabilize the slopes of construction sites or to repair disturbed or damaged slopes. Soil bioengineering is applied to both cut and fill slopes.

(5) Strategies
When planning for site specific soil bioengineering design, consider the factors, parameters, and design considerations/ specifications in the following table.
<table>
<thead>
<tr>
<th>Factors</th>
<th>Parameters</th>
<th>Design Considerations/Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate/Microclimate</td>
<td>Growing season</td>
<td>Select suitable plants, methods and construction timing</td>
</tr>
<tr>
<td></td>
<td>Exposure/Aspect</td>
<td></td>
</tr>
<tr>
<td>Soil, Physical</td>
<td>Density and rootability, Permeability</td>
<td>Modify during construction, Select suitable plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, Water</td>
<td>Profile available water</td>
<td>Modify soil during construction, Install structures (drains, ditches etc.) to remove excess water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, Chemical</td>
<td>pH, Fertility, Cation Exchange</td>
<td>Select suitable plants, Add lime, fertilizers, Ameliorate soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion Risk</td>
<td>Soil erodibility, Rainfall erosivity, Channel discharge, Slope, Wind, Water, Ice</td>
<td>Temporary or Permanent covers, Select suitable plants, Management, Reinforcement with geotextile</td>
</tr>
<tr>
<td>Geotechnical</td>
<td>Shear strength, Slope, Factor of Safety</td>
<td>Select suitable soil materials, Structures, Soil density and moisture, Reinforcement with geosynthetics (Chapter 530)</td>
</tr>
</tbody>
</table>

**1350.04 Design Responsibilities and Considerations**

Consider the possible applications for soil bioengineering during the project definition process. Address soil bioengineering applications during the design process as part of the recommendations in the Hydraulic Report (for streambank/shoreline), Stormwater Site Plan (SSP), Soils Report and Geotechnical Report (for slope stabilization), and in the Environmental Documents. These reports provide design criteria and guidelines.

**1350.05 Documentation**

For all applications, include in the documentation a summary of site analysis, a list of design options considered along with a summary of evaluations, and management plans. The following is a list of soil bioengineering applications and the documents that support the designs.

**Erosion Control**

- Temporary Erosion and Sediment Control Plan (TESC), *Highway Runoff Manual*
- Stormwater Site Plan (SSP), *Highway Runoff Manual*
- Roadside Restoration Plan including the Horticultural Report, OSC Horticulturalist and the region’s Landscape Architect Office or the OSC Roadside and Site Development Services Unit
Streambank/Shoreline Stabilization

- Hydraulics Report, *Hydraulics Manual*
- Roadside Restoration Plan, region’s Landscape Architecture Office or the OSC Roadside and Site Development Services Unit

Upland Slope Stabilization

- Soils Report, *Design Manual*
- Geotechnical Report, Geotechnical Branch
- Roadside Restoration Plan, region’s Landscape Architecture Office or the OSC Roadside and Site Development Services Unit
Right of Way Considerations

1410

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 23CFR Chapter 1 part 712 subpart B and 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 is 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 Olympia Service Center 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

49 CFR Part 24 Uniform Relocation Assistance and Real Property Acquisition Act of 1970

RCW 8.26, Relocation Assistance - Real Property Acquisition Policy

WAC 468-100. Uniform Relocation Assistance and Real Property Acquisition

Agreements Manual, M 22-99, Washington State Department of Transportation (WSDOT)

Plans Preparation Manual, M 22-31, WSDOT
1410.03 Special Features

(1) Road Approaches
On access managed 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 Olympia Service Center (OSC) 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 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 and limited access plan (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 or disposition of rights. These requests are to be directed through the region’s Real Estate Services Manager.

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.** Used when an easement must be acquired to replace an existing easement for a facility that is to be relocated. The region’s Real Estate Services Office obtains or prepares instruments that contain all necessary rights and provide for maintenance by the party to whom the easement will ultimately be conveyed. Easements are conveyed when they remain within state rights of way and are replacing existing property rights. Easements are transferred only when the easement is outside the state right of way and not needed for highway purposes. The right of way/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). WSDOT cannot condemn for a transfer easement to a private party.

(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 may be paid.

Temporary easements are usually shown on the right of way plans in accordance with the *Plans Preparation Manual* when the encroachment is significant; more than about 5 ft. Consult the region’s Plans and Real Estate Services personnel for exceptions. If the easement is not mapped, mark and submit plans as described for construction permits.

(4) **Construction Permits**

Construction permits are used for temporary rights during construction and not used when WSDOT needs a perpetual right. 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.

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.

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.

Permits are allowed where minor right of way acquisitions are obtained for intersections.

Mapping requirements for a construction permit are as follows:

1. Construction permits are not shown on the right of way plan.

2. The region’s Project Coordinator’s Office is provided two sets of right of way plans with all required construction permits delineated in red. The region sends one copy of the marked plans and copies of the permits to the OSC 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 not required for construction permits.)
   - Parcel number assigned to each ownership.
   - Sufficient engineering detail to write legal descriptions.
• Statement of the intended use of each construction permit area.

1410.05 Programming for Funds
The phases in Figure 1410-1, in relation to plan development, 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 OSC Real Estate Services Office.

1410.06 Appraisal and Acquisition
(1) All Highways
The phases in Figure 1410-1, in relation to plan development, 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.

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 OSC 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 done by OSC 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.

(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 OSC 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 may 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 OSC 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 at once.

1410.08 Documentation

The following documents are to be preserved in the design file or other permanent files. See Chapter 330.

- Agreements
- Permits
- Cattle pass studies and approvals
- International Boundary Commission approval

Deeds and plans are preserved as directed in the Right of Way Manual by the OSC Real Estate Services Office.
Limited Access Highways

**PHASE 1**
Access Report Plan

State Design Engineer* approves Access Report Plan for prehearing discussion with county and/or city officials.

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 Program Development Office for all projects with either state or federal funds.

Program appraisals of total takes. (No acquisition.)

**PHASE 2**
Access Hearing Plan

State Design Engineer* approves Access Hearing Plan for use at a public access hearing. R/W information is complete.

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.

Program all appraisals and acquisitions.

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.

**PHASE 3**
Findings and Order Plan

No signature required.

Results of Findings and Order Access Hearing are marked in red and green on Access Hearing plan and sent to OSC R/W Plans Branch.

Program appraisals of partial takes where data is available to appraisers.

Acquisition of total takes.

**PHASE 4**
Final R/W and L/A Plan

State Design Engineer* Approves final R/W and LA plans or approves revisions to established R/W and L/A plans

Program all remaining appraisals and all remaining acquisitions.

Note: If appeal period is not complete, delay action in areas subject to controversy and possible appeal.

Access Managed Highways

**PHASE 5**
Final R/W Plan

R/W plan submitted to OSC R/W Plans Branch for approval.

Program appraisals

State Design Engineer* approves new R/W plans or approves revisions to established R/W plans.

Program all appraisals and acquisitions.

*Or a designee.

**Appraisal and Acquisition**

*Figure 1410-1*
1420
Access Control Design Policy

1420.01 General
1420.02 Full Access Control Criteria
1420.03 Partial Access Control Criteria
1420.04 Modified Access Control Criteria
1420.05 Access Approaches
1420.06 Approaches Between Limited Access Highways and Adjacent Railroads
1420.07 Frontage Roads
1420.08 Multiple Use of Right of Way for Nonhighway Purposes
1420.09 Modifications to Established Limited Access Plans

1420.01 GENERAL

Access control is established to preserve the safety and efficiency of specific highways and to preserve the public investment. Control is effected by acquiring rights of access from abutting property owners, and by selectively limiting approaches to the facility.

Facilities thus controlled are termed limited access or access controlled highways, and are further distinguished as having full, partial, or modified access control. The number of access points per mile, spacing of interchanges or intersections, and the location of frontage roads or local road connections are determined by the functional classification and importance of the highway, the character of the traffic, the present and future land use, the environment and aesthetics, the highway design and operation, and the economic considerations involved.

The establishment of full, partial, or modified control of access shall be considered whenever major improvements, reconstruction, relocation, or new facilities are required on all highways or whenever the route is shown on the Master Plan for limited access highways as "planned for access control." The reasonable cost of access control must be evaluated considering future accident costs, future development, improved level of service of controlled facilities, and cost to replace the facility in the future if access control is not implemented. Because specific warrants cannot be logically or economically applied in every circumstance, the Assistant Secretary for Highways may consider exceptions upon presentation of justification for reasonable deviation from the policy.

Expansion of an existing facility may be undertaken without control of access where there is no practical alternative within reasonable cost, subject to approval of a deviation by the State Project Development Engineer. The decision to defer implementation of access control shall be documented in the design report.

Nothing in this policy should be construed to prevent short sections of full, partial, or modified control of access where unusual topographic, land use, or traffic conditions exist. Special design problems should be dealt with on the basis of sound engineering-economic principles.

Preliminary approval of the degree of access control recommended by the district as presented in the final access plan is granted by headquarters. The final plan is approved by the Transportation Commission, after a public hearing (Chapter 1430), by the signing of a findings and order document.

On all applicable classes of highways, except Interstate, stage development may be used, with initial construction as partial or modified control and ultimate planning for full control.

Turnbacks should be located at points of logical termination such that the department retains an adequate amount of right of way for maintenance of the facility and for other operational functions.

1420.02 FULL ACCESS CONTROL CRITERIA

(1) Introduction

Fully controlled access highways provide almost complete freedom from disruption by permitting access connections only through interchanges at selected public roads, rest areas, viewpoints, or weighing stations, and by prohibiting all crossings and private connections at grade.

(2) Application

Termini of access control sections should be at apparent logical points of design change. The following guides shall be used for the application of full access control on state highways: (Refer to Figure 1420-1a.)

(a) Interstate. Interstate highways require full access control.

(b) Principal Arterial. Unless approved for partial or modified access control on existing highways by the Assistant Secretary for Highways, principal arterial highways requiring four or more through traffic lanes within a 20-year design period require full access control.

(c) Minor Arterial and Collector. Minor arterial and collector highways will not normally be considered for development to full access control standards.

(3) Crossroads at Interchange Ramps

The limit of access control is measured from the center line of ramps, crossroads, or parallel roads or from the terminus of transition tapers. (See Figures 1420-1b and 1c.)
(a) **Ramp Connections.** Connections from the highway to abutting property or local service or frontage roads are prohibited within the full length of any off or on interchange ramp. The ramp is considered to terminate at its intersection with the local road which undercrosses or overcrosses the highway or, in urban areas, with its connection to a local street.

(b) **Frontage Road Connections.** Direct connections from the highway to local service or frontage roads are permitted only via the interchange crossroad.

(c) **Interchange Crossroads.** In both urban and rural areas, access control must be established along the crossroad at an interchange for a minimum distance of 300 feet beyond the center line of the ramp or terminus of transition taper. If a frontage road or local road is located in a generally parallel position within 350 feet of a ramp, access control should be established along the crossroad and for an additional minimum distance of 130 feet in all directions from the center of the intersection of the parallel road and crossroad.

For interchanges incorporating partial cloverleaf and/or button-hook ramps, access control is required for all portions of the crossroad and frontage roads between the ramp terminals, and for a distance of 300 feet beyond the ramp terminals. If a grade intersection for a local road or street is to be served directly opposite the ramp terminals, access control should be extended additionally for a minimum of 130 feet, and preferably 300 feet, along that leg of the intersection.

(d) **Levels of Control, Location of Approaches.** Full access control should be provided for the first 130 feet from the center line of the ramp or terminus of a transition taper. If the economic considerations to implement full access control are excessive, partial or modified control may be provided for the remaining distance for a total minimum distance of 300 feet for the two types of control. Type A - residential, Type B - farm, and Type C - special use approaches may be permitted on that portion of the crossroad for which partial or modified control of access is established. Type D - commercial single and Type E - commercial double road approaches are permitted only within the limits of modified access control. Approaches should be sufficiently removed from a frontage road intersection to provide proper intersection operation. Access approach types are further defined in 1420.05.

(4) **Location of Utilities, Bus Stops, Mailboxes, and Pedestrian Crossings**

(a) **Utilities.** Utilities location and access shall be consistent with the Utilities Accommodation Policy (WAC 468-34).

(b) **Bus Stops.** No common carrier or school bus stops shall be permitted except at:
- Railroad crossings (Chapter 930);
- Locations provided by the state on the interchange;
- In exceptional cases, along the main roadway where pedestrian separation is available.

(c) **Mailboxes.** Mailboxes are permitted only on frontage roads. Mail delivery will be from frontage roads or other adjacent local roads.

(d) **Pedestrian Crossings.** Pedestrian crossings shall not be permitted at grade.

(5) **Nonmotorized Traffic**

All nonmotorized traffic is prohibited on highways established and operating as fully controlled limited access facilities. This prohibition does not apply to:
- Pedestrian separations or other facilities provided specifically for pedestrian use.
- Bicyclists utilizing facilities provided specifically for bicycle use (i.e., separated paths).
- Bicyclists utilizing the right-hand shoulders, except where such use has been specifically prohibited. Information pertaining to such prohibitions may be obtained from the Traffic Engineering Branch of the Operations and Maintenance Office.

1420.03 **PARTIAL ACCESS CONTROL CRITERIA**

(1) **Introduction**

Partial access control may be established when warranted on highways other than Interstate. Partial control provides a considerable degree of protection from traffic interference and protects the highway from future strip-type development.

Access control on partially controlled highways is exercised to the degree that, in addition to connections with selected public roads, some crossings and private driveway connections may be permitted at grade. Commercial approach types, D, or E are not allowed within the limits of partial access control.

(2) **Application**

Termini of access control sections should be at apparent logical points of design change. Refer to Figure 1420-2a.

(a) **Principal Arterial.** When the estimated traffic volumes exceed 3,000 average daily traffic within a 20-year design period, principal arterial highways requiring two through traffic lanes must have partial access control. Modified access control may be approved on existing principal arterial highways by the Assistant Secretary for Highways. For multilane principal arterial highways, see 1420.02(2)(b).
(Exception) Partial access control will not normally be used in urban areas, or inside corporate limits on existing principal arterial highways where traffic volumes are less than 700 DHV, if required levels of urban service, including operating speeds, can be maintained for traffic under existing and estimated future conditions, including traffic engineering operational improvements. If not, the route should be relocated or reconstructed in accordance with the modified or partial access control standards.

(b) Minor Arterial. Rural minor arterial highways on both new and existing location, and urban minor arterial highways on new location, requiring four or more through traffic lanes within a 20-year design period, or requiring only two through traffic lanes where the estimated traffic volumes exceed 3,000 average daily traffic within a 20-year design period, shall require partial access control; however, modified access control may be applied on existing highways when approved by the Assistant Secretary for Highways.

(Except) Partial access control normally will not be used in urban areas. Nor will it normally be used inside corporate limits on existing minor arterial highways where traffic volumes are less than 700 DHV, if required levels of service (including operating speeds) can be maintained for existing and estimated future conditions. If these conditions cannot be met, the route should be relocated or reconstructed in accordance with the modified or partial access control standards.

Other rural minor arterial highways with only two lanes may be considered for partial or modified control of access if any of the following conditions apply:

- The control can be acquired at a reasonable cost.
- The route connects two highways of a higher classification.
- The potential land development would result in numerous individual approaches, such as may be encountered in recreational or rapidly developing areas.
- The highway traverses publicly-owned lands where access control seems desirable.

(c) Collector (New Alignment). Collector highways on new location requiring four or more through traffic lanes in a 20-year design period shall require partial access control.

(d) Collector (Existing). Existing collector highways will normally be considered for access control only when all of the following conditions apply:

- The highway serves an area which is not directly served by a higher class of highway.
- Existing or planned development will result in traffic volumes significantly higher than what would be required for access control on minor arterials.
- Partial or modified access control may be established without a major impact on development of abutting properties within the constraints of zoning established at the time access control is proposed.

(3) Interchanges and Intersections

(a) Interchanges. See 1420.02(3). Full access control on crossroads at interchange ramps applies equally under conditions of partial control.

(b) Intersections. Access control limits on a partially controlled highway should be established along the crossroad at a grade intersection for a minimum distance of 300 feet from the center line of the nearest directional roadway. If a parallel road is located within 350 feet of the grade intersection, access control should be established along the crossroad for the required minimum 300 feet and for an additional minimum distance of 130 feet in all directions from the center of the intersection of the parallel road and crossroad. On multilane facilities, measurements should be made from the center line of the nearest directional roadway. (Figure 1420-2b.) Modified access control with Type D and E approaches may be permitted beyond 130 feet from the center line of the highway only when the approaches already exist and cannot reasonably be relocated. Approaches closer than 130 feet will be permitted only where application of the normal standards would have a severe adverse effect on existing development and where the location is such that retention of the approaches will not seriously affect traffic operations.

Grade intersections with public roads should be limited to the number permitted for the class of highway involved (Figure 1420-2a); however, shorter intervals may be used, with approval from headquarters, where topography or other conditions restrict the design. When intersecting roads are spaced farther apart than one per mile, median crossings may be considered for U-turns in accordance with Chapter 910. U-turns should be kept to a minimum, consistent with requirements for operation and maintenance of the highway.

(4) Access Approach Criteria

Access approaches on highways with partial control must be held to a minimum. Except for very large ownerships, or where terrain features will not allow the property to be served by a single approach, allow only one approach for each parcel. Where possible, locate a single approach to serve two or more parcels. Approaches should not be permitted for parcels which have reasonable access to other public roads unless the parcel has extensive highway frontage. Approaches in excess of the standards set
forth in Figure 1420-2a may be permitted as stage construction. The approved design should provide for future development of frontage roads which would eliminate the excessive number of approaches.

On routes with partial access control, only the following approach types may be permitted for direct access to the highways.

- Type A, residential use.
- Type B, farm use.
- Type C, special use (to accommodate utility access).

Commercial access is permitted only by way of public roads. Type D and Type E commercial approaches may be permitted within the access controlled area along intersecting roadways as outlined in 1420.03(3).

To discourage movement in the wrong direction on multiline highways, locate private access openings 300 feet or more from an at-grade intersection. At a tee intersection, a private access opening should be located directly opposite the intersection or a minimum of 300 feet away from the intersection. Extreme caution should be exercised to ensure that a private access opening directly opposite a tee intersection cannot be mistaken for a continuation or part of the public traveled way.

Access approach types are further defined in 1420.05.

(5) Location of Utilities, Bus Stops, Mailboxes, and Pedestrian Crossings

(a) Utilities. Utilities location and access shall be consistent with the Utilities Accommodation Policy (WAC 468-34). Connecting utility lines between intermittent frontage roads are permitted along the outer right of way line.

(b) Bus Stops. Bus stops for both common carriers and school buses shall not be permitted on either two or four-lane highways, except as follows:

- At railroad crossings (Chapter 930).
- At locations of intersections with necessary pullouts to be constructed by the state.
- Where shoulder widening has been provided for mail delivery service.
- For a designated school bus loading zone on the traveled lane or adjacent thereto which has been approved by the Department of Transportation.
- Buses are not permitted to stop on the traveled lanes at at-grade intersections or private approaches, to load or unload passengers.

School bus loading zones on partially controlled access highways shall be posted with school bus loading zone signs, in accordance with the latest edition of the Manual on Uniform Traffic Control Devices.

(c) Mailboxes. Mailboxes shall be located on frontage roads or at intersections with the following exceptions for properties which are served by Type A or B approaches:

- Mailboxes for Type A or B approaches on a four-lane highway shall be located only on the side of the highway on which the approach is provided.
- Mailboxes for Type A or B approaches on a two-lane highway shall be located on that side of the highway which is on the right in the direction of the mail delivery.

Whenever mailboxes are allowed, a mailbox turnout should be provided to allow mail delivery vehicles to stop clear of the through traffic lanes. See Chapter 730 for additional information concerning mailbox locations and turnouts.

(d) Pedestrian Crossings. Pedestrian grade crossings will be permitted only where an at-grade crossing is provided. Pedestrian crossings may be permitted:

- On two-lane highways at mailbox locations.
- On two-lane highways not less than 100 feet from a school bus loading zone adjacent to the traveled lane, if school district and Department of Transportation personnel determine that stopping in the traveled lane is hazardous.
- On two-lane highways when the school bus is stopped on the traveled lane to load or unload passengers and the proper sign and signal lights are displayed.

(6) Nonmotorized Traffic

Pedestrian and bicycle traffic will be permitted, consistent with Rules of the Road, on partially controlled highways, except when unusual safety conditions warrant prohibition. Information pertaining to such prohibitions may be obtained from the Traffic Engineering Office of the Program Development Division.

1420.04 MODIFIED ACCESS CONTROL CRITERIA

(1) Introduction

Modified access control is intended to prevent further deterioration in the safety and operational characteristics of existing highways due to traffic interference associated with strip development by limiting the number and location of access points to the highway.

(2) Application

In general, modified access control is applied where some degree of control is desired, but existing and potential commercial development preclude the implementation of partial or full control.
(a) **Existing Highways.** Modified access control may be established on existing highways other than Interstate. Priority should be given to route segments where one or both of the following conditions apply:
- Commercial development potential is high, but most of the adjoining property remains undeveloped.
- There is a reasonable expectation that the adjoining property will be redeveloped to a more intensive land use resulting in greater traffic congestion.

(b) **Design Analysis.** Selection of facilities on which modified access control may be applied is based on a design analysis including the following factors:
- Traffic volumes.
- Level of service.
- Safety.
- Level of Development Plan.
- Route continuity.
- Population density.
- Local land use planning.
- Present and potential land use.
- Predicted growth rate.
- Economic analysis.

(c) **Exceptions.** Where modified access control is to be established, developed commercial areas may be excepted from control when all or most of the abutting property has been developed to the extent that few, if any, additional commercial approaches would be required with full development of the area.

(3) **Interchanges and Intersections**

(a) **Interchanges.** Access control is applied in the same manner at interchanges as on full control, see 1420.02(3).

(b) **Intersections.** Access control limits at intersections on highways with modified control should be established along the crossroad for a minimum distance of 130 feet from the center line of a two-lane highway or for a minimum of 130 feet from the center line of the nearest directional roadway of a four-lane highway (Figure 1420-3). Approaches, especially Type D and Type E commercial approaches, should be permitted within this area only when there is no reasonable alternative.

(4) **Access Approach Criteria**

The number and location of approaches on a highway, with modified access control, must be carefully planned to provide a safe and efficient highway compatible with present and potential land use.

(a) **Approach Types.** On highways with modified access control, the following approach types may be permitted:
- Type A, residential.
- Type B, farm.
- Type C, approaches to serve more than one owner and/or utility
- Type D, commercial single (existing).
- Type E, commercial double (existing).

The type of access provided for each parcel shall take into consideration present and potential land use and should be based on an economic evaluation which considers the following:
- Local comprehensive plans, zoning, and land use ordinances.
- Property covenants and/or agreements.
- City or county ordinances.
- The highest and best use of the property.
- Highest and best use of adjoining lands.
- Change in use by merger of adjoining ownerships.
- All other factors bearing upon proper land use of the parcel.

Access approach types are further defined in 1420.05.

(b) **Design Considerations.** The following conditions are used to determine the number and location of access approaches:

1. Parcels which have access to another public road or street are not normally permitted direct access to the highway.

2. Approaches located in areas where sight limitations create undue hazard should be relocated or closed.

3. The number of access approaches should be held to a minimum. Access approaches are limited to one approach for each parcel of land, with the exception of extensive frontages where one approach is unreasonable or for Type E approaches which feature separate off and on approaches.

4. Joint use of access approaches shall be considered, where feasible.

5. Additional approaches may be permitted for future development consistent with local zoning.

6. Existing access approaches not meeting the above criteria should be closed.

(5) **Location of Utilities, Bus Stops, Pedestrian Crossings, and Mailboxes**

(a) **Utilities.** Utilities location and access shall be consistent with the Utilities Accommodation Policy (WAC 468-34). Connecting utility lines between
intermittent frontage roads are permitted along the outer right of way line.

(b) **Bus Stops and Pedestrian Crossings.** Bus stops and pedestrian crossings may be permitted as follows:

- In rural areas, bus stops and pedestrian crossings shall be subject to the same restrictions as in 1420.03(5)(b).
- In urban areas, bus stops for both commercial carriers and school buses may be permitted without restriction.

(c) **Mailboxes.** Mailboxes may be located adjacent to or opposite all authorized approaches as follows:

- Mailboxes on a four-lane highway shall be located only on the side of the highway on which the approach is provided.
- Mailboxes on a two-lane highway shall be located on that side of the highway which is on the right in the direction of the mail delivery.

Where mailboxes are allowed, a mailbox turnout should be provided to allow mail delivery vehicles to stop clear of the through traffic lanes. See Chapter 730 for additional information concerning mailbox locations and turnouts.

(6) **Nonmotorized Traffic**

Pedestrian and bicycle traffic is permitted, consistent with Rules of the Road, on highways with modified access control, except where unusual safety considerations warrant prohibition. Information pertaining to such prohibitions may be obtained from the Traffic Engineering Branch of the Operations and Maintenance Office.

1420.05 ACCESS APPROACHES

(1) **General**

Access approaches may be permitted on limited access highways consistent with the criteria outlined in 1420.02, 1420.03, 1420.04, and 1420.06.

For additional information pertaining to approaches, refer to Chapters 920 and 1410, and the Plans Preparation Manual, M 22-31.

(2) **Definitions**

The widths for the following approach types should be negotiated, and only the negotiated width shall be shown on the plan.

(a) **Type A Approach.** Type A Approach is an Off and On approach in legal manner, not to exceed 30 feet in width, for the sole purpose of serving a single family residence. It may be reserved by the abutting owner for specified use at a point satisfactory to the state at or between designated highway stations.

(b) **Type B Approach.** Type B Approach is an Off and On approach in legal manner, not to exceed 50 feet in width, for use necessary to the normal operation of a farm, but not for retail marketing. It may be reserved by the abutting owner for specified use at a point satisfactory to the state at or between designated highway stations.

(c) **Type C Approach.** Type C Approach is an Off and On approach in legal manner, for special purpose and width to be agreed upon. It may be specified at a point satisfactory to the state at or between designated highway stations.

(d) **Type D Approach.** Type D Approach is an Off and On approach in a legal manner not to exceed 50 feet in width for use necessary to the normal operation of a commercial establishment. It may be specified at a point satisfactory to the state at or between designated highway stations.

(e) **Type E Approach.** Type E Approach is a separated Off and On approach in a legal manner, with each opening not exceeding 30 feet in width, for use necessary to the normal operation of a commercial establishment. It may be specified at a point satisfactory to the state at or between designated highway stations.

1420.06 APPROACHES BETWEEN LIMITED ACCESS HIGHWAYS AND ADJACENT RAILROADS

(1) **General**

A highway and railroad are considered adjacent when they have a common right of way border with no other property separating them. This applies only to railroads on operating right of way and not to adjacent railroad property which is not directly used for railroad operation.

(2) **Warrants**

It is in the public interest to provide access to the railroad right of way from limited access highways for maintenance of the railroad and utilities located on the railroad right of way when other access is not feasible. This applies both to new highways and to existing highways where access control is obtained.

Direct access is permitted when local roads are infrequent or there are few highway-railroad crossings from which trail-type access for maintenance purposes is feasible, and when unique topography or other unusual conditions justify its use.

Direct access from the highway is considered unnecessary and is not permitted when:

- There are local roads adjacent to or crossing the railroad.
A trail-type road can be provided by the railroad between crossroads.

A roadway is paralleled by a frontage road adjacent to the railroad. Access between frontage roads is permitted as for any other nonlimited access road. Frontage roads may be connected to the freeway only by intersections and interchanges provided for the general public.

No highway previously existed adjacent to the railroad.

(3) Restrictions

When direct approaches to provide access to railroad right of way are warranted, the following conditions must be met:

- A maximum of one approach is permitted for every 2 miles of highway.
- The approach must not adversely affect the design, construction, stability, traffic safety, or operation of the highway.
- Except when the railroad is located in the median area, the approach is to be accomplished in legal manner by right turns only to and from the roadway nearest the railroad. Median crossing is not permitted.
- The approach is secured by a locked gate under arrangements satisfactory to the department. (See 1420.05(2)(c.)
- Parking of any vehicles or railroad equipment is prohibited within highway access control lines.
- A special emergency maintenance permit must be obtained for periods of intensive railroad maintenance.
- The approach must be closed if the railroad operation ceases.
- Approaches are limited to use by the railroad company unless specific provisions for other use are shown on the plan and included in the right of way negotiations.

1420.07 FRONTAGE ROADS

(1) General

Frontage roads are provided in conjunction with limited access highways to:

- Control access to through lanes.
- Provide access to abutting land ownership.
- Restore continuity of the local street or road system.
- Provide continuity when the construction causes unreasonable circuitry of travel. On partially controlled highways, when the number of property access openings exceed the requirements in Figure 1420-2a, a frontage road should be considered.

Refer to Chapter 620 for frontage road standards and general policy and to Chapter 330 for frontage road justification required in the design report.

Frontage roads that are not the responsibility of the state under the terms of this policy may be built by the state upon request of a local political subdivision, a private agency, or an individual, by agreement under which the state is reimbursed for all costs involved.

(2) County Road and City Street Connections

Short sections of county roads or city streets not adjacent to the highway may be constructed to connect roads or streets that have been closed off by the highway if the connection will serve the same purpose and be less costly than a frontage road.

(3) Cul-de-Sacs

Frontage roads or local streets bearing substantial traffic that are terminated or closed at one end should be provided with a cul-de-sac, or other facility consistent with the local policy or practice, sufficient to permit vehicles to turn around without encroachment on private property.

(4) Turnbacks

Local agency approval is required for any planned frontage roads, county road or city street connections, or cul-de-sacs. The local agency must also agree in writing to accept and maintain the connecting section as a county road or city street. See Utilities Manual, M 22-87, for turnback procedure.

1420.08 MULTIPLE USE OF RIGHT OF WAY FOR NONHIGHWAY PURPOSES

Use of right of way by either a private party or public agency is permitted by one of the following as applicable:

- Permit or Franchise (Highway, Nonhighway, or Utility Use). Refer to the Utilities Manual, M 22-87, Chapter 1.
- Utility Easement (Highway or Utility Use). Refer to the Utilities Manual, M 22-87, Chapter 2.
- Agreement (Highway or Utility Use). Refer to the Utilities Manual, M 22-87, Chapters 4 and 5, e.g., Private Party Agreement, Chapter 4. United States Bureau of Reclamation Blanket Crossing Agreement, Chapter 5.

Agreements for the nontransportation use of right of way must be coordinated with the appropriate district supervisor. Such use typically includes, but is not
limited to, landscaping, parking, storage, utilities, and construction of facilities, such as buildings. Unless specifically provided in the airspace agreement, permit, or franchise, direct access to the traveled way of any access controlled roadway is not permitted. Access may be permitted from outside the access controlled area for the specified use.

1420.09 MODIFICATIONS TO ESTABLISHED LIMITED ACCESS PLANS

(1) General

Revisions to established limited access facilities can only be made by application of current design criteria and with the approval of the Assistant Secretary for Highways. The following factors shall be considered when evaluating a request for modification of an established limited access facility:

- Existing level of access control on the highway,
- Functional classification and importance of the highway,
- Percentage of truck traffic,
- Highway operations,
- Present or future land use,
- Environment or aesthetics,
- Economic considerations,
- Safety considerations.

All revisions to established limited access highways should be evaluated to determine if a public hearing is required.

(2) Modifications for Private Access Approaches

(a) Requirements. Examples of access modification requested by individual owners include additional road approaches, changes in the permitted use, or number of users of existing road approaches.

Plan revisions which provide for additional access to individual ownerships after the department has purchased the access rights are normally not considered. However, these revisions may be considered if it can be established that:

- The efficiency and safety of the highway will not be significantly affected,
- There are no other reasonable alternatives,
- The existing situation causes extreme hardship on the owner(s), and
- The revision is consistent with the access control standards for the class of highway and level of existing or planned future access control.

(b) Procedures.

- District initiates an engineering review of the requested modification.
- District prepares and submits to headquarters Plans Branch a preliminary limited access plan revision together with a recommendation for preliminary approval by the Assistant Secretary for Highways. When federal aid funds were involved in any phase of the project, the proposed modification will be sent to FHWA for their review and approval.
- The recommendation should include an item by item analysis of the factors listed in 1420.09(1) and (2a) above.

(c) Valuation Determination. Upon the Assistant Secretary for Highways’ preliminary approval, district Land Management prepares an appraisal for the value of the access change.

- The appraisal follows the requirements set forth in the Right of Way Manual.
- The appraisal is reviewed by the headquarters Land Management Office. If the appraisal data does not support a value of $1,500 or more, a minimum value of $1,500 shall be used.
- For well documented special cases where it does not appear appropriate to base the charges on the reviewed appraisal, district Land Management documents the circumstances that support granting the requested change at less than the review appraisers determined value in an administrative settlement letter.
- The appraisal package is sent to the headquarters Land Management Office for review. If federal aid funds were involved in purchasing access, a copy of the administrative settlement letter will be sent to FHWA for their review and approval.
- The final value is submitted to the Assistant Secretary for Highways for his approval.

(d) Final Processing.

- District Land Management informs the requestor of the approved appraised value for the change.
- If requestor is still interested, district prepares a "Surplus Disposal Package" for headquarters Land Management Office review and Assistant Secretary for Highways approval.
- At the same time, the preliminary limited access plan revision previously transmitted is processed for Assistant Secretary for Highways approval.
- After the department collects the payment from the requestor, the district issues a permit for the construction, if required.
• Headquarters Land Management Office prepares and processes a deed granting the modified access rights.

(3) Modifications for public grade intersections

(a) Requirements.
• Public grade intersections on state highways with partial access control should serve local arterials that form part of the local transportation network.
• Requests for new intersections on established limited access highways must be made by or through the local governmental agency.
• New intersections require full application of current access control design and spacing criteria.

(b) Procedures.
• District evaluates request.
• District submits intersection plan for approval (Chapter 910) and right of way and limited access plan revision request (Plans Preparation Manual, M 22-31, ).

• State Project Development Engineer approves intersection plan.
• Assistant Secretary for Highways approves access revision.
• District submits construction agreement to State Project Development Engineer (Utilities Manual).
• Assistant Secretary for Highways approves construction agreement.

(c) Valuation Determination.
• When a requested public grade intersection will serve a local arterial that forms part of the local transportation network, compensation will not be required.
• When a requested public grade intersection will serve only a limited area or is primarily for the benefit of a limited number of developers, compensation for access change will be addressed in the plan revision request. In situations where compensation is appropriate, value will be determined as outlined in 1420.09(2)(c) above.
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**FULL ACCESS CONTROL CRITERIA**

Figure 1420-1a
ACCESS CONTROL FOR TYPICAL INTERCHANGE

Figure 1420-1b
(Metric)
ACCESS CONTROL AT RAMP TERMINATION

Figure 1420-1c
(Metric)

Access control extends 91.44 m MIN beyond end of farthest taper.
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<th>Item</th>
<th>Interstate</th>
<th>Principal Arterial</th>
<th>Minor Arterial</th>
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<td>Traffic Estimate</td>
<td></td>
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<td>20 Urban</td>
<td>20</td>
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<td>ADT</td>
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<td>Not Applicable</td>
<td>Over 3,000</td>
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<tr>
<td>Lanes Required</td>
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<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Minimum Route Length</td>
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<td>All Sections</td>
<td>Urban . . 3.2 km</td>
<td>Logical Points of Design Change</td>
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<td></td>
<td></td>
<td>Not requiring Full Control as Per Figure 1420-1a</td>
<td>Rural . . 8.0 km Combined . . 4.8 km</td>
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<td>New Locations Including Bypass</td>
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<td>Limit All Property Access - Allow Public Roads as Below</td>
<td>Limit All Property Access - Allow Public Roads as Below</td>
<td>Limit Property Public Roads as Below</td>
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<tr>
<td>All Other Locations Requiring or Permitting Partial Control</td>
<td>Public Road at All Crossroads</td>
<td>2 per Side per 1.6 km Plus Public Roads</td>
<td>4 per Side per 1.6 km Plus Public Roads</td>
<td>All 2-lane and 4-lane Where Crosroad . . 2,000 ADT Minimum 0.8 km Spacing Public Road or Property Access 6 per Side per 1.6 km</td>
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<td>Crossroad ADT Over 2,000 in 20 Years</td>
<td>Same as Principal Arterial</td>
<td>None Rural Only Crossroad ADT Over 4,000 in 20 Years</td>
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</table>

**PARTIAL ACCESS CONTROL CRITERIA**

Figure 1420-2a (Metric)

Design Manual
March 1994

1420-13
For Frontage road located 106.68 m or less from the center line of the nearest directional roadway, access control should be extended 39.62 m in all directions.

**ACCESS CONTROL FOR INTERSECTION AT GRADE**

Figure 1420-2b
(Metric)
ACCESS CONTROL LIMITS AT INTERSECTIONS

Figure 1420-3
(Metric)
ACCESS CONTROL FOR TYPICAL INTERCHANGE

Figure 1420-1b
Access control extends 300' MIN beyond end of farthest taper.

ACCESS CONTROL AT RAMP TERMINATION
Figure 1420-1c
### Partial Access Control Criteria

<table>
<thead>
<tr>
<th>Item</th>
<th>Interstate</th>
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<tr>
<td>Lanes Required</td>
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<td>4</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Minimum Route Length</td>
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<td>Comb..3 Miles</td>
<td>Logical Points of Design Change</td>
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<tr>
<td>All Other Locations Requiring or Permitting Partial Control</td>
<td>2 Per Side Per Mile Plus Public Roads</td>
<td>4 Per Side Per Mile Plus Public Roads</td>
<td>Public Road or Property Access 6 Per Side Per Mile</td>
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</tr>
<tr>
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<td>Crossroad ADT, Over 2,000 in 20 Years</td>
<td>Same as Principal Arterial</td>
<td>None</td>
<td>Rural Only Crossroad ADT Over 4,000 in 20 Years</td>
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</table>

**Partial Access Control Criteria**

Figure 1420-2a
For Frontage road located 350' or less from the centerline of the nearest directional roadway, access control should be extended 130' in all directions.

ACCESS CONTROL FOR INTERSECTION AT GRADE

Figure 1420-2b
1425

Access Point Decision Report

1425.01 General
For the Interstate System, any point that allows entrance to or exit from the traveled way of the freeway is by definition an access point. (This includes “locked gate” access.) For example, a new diamond interchange has four new access points.

Revised access is generally a change in the interchange configuration or the relocation of its access points even though the number of actual access points may not change. Replacing one of the direct ramps of a diamond interchange with a loop ramp, changing a cloverleaf interchange into a fully directional interchange, changing the number of lanes on a ramp, and revising either terminal of a ramp are examples of revised access.

Federal Highway Administration (FHWA) approval is required for added or revised access on the Interstate system, regardless of the source of funding for the construction project. Ramp terminal improvements which do not adversely affect Interstate traffic flow are exempt from FHWA approval.

The request for FHWA approval includes an Access Point Decision Report that addresses six specific policy topics. They are (1) need, (2) alternatives, (3) operational analyses, (4) design, (5) land use and transportation plans, and (6) coordination. The extent of this report varies considerably with the scope of the access change.

Approval of added or revised access is a two-step process.

The first step is acceptance of the proposed change in access by FHWA, which is a finding of engineering and operational acceptability. FHWA acceptance is based on the Access Point Decision Report which defines the access revision as well as needed modifications to the main line to protect Interstate operations.

The second step is final approval, a federal action which requires that National Environmental Policy Act (NEPA) procedures are followed. FHWA final approval of the added or revised access will be given concurrently with an environmental approval (as in the case of a Record of Decision) or after NEPA approval.

The Access Point Decision Report is developed early in the environmental process because it helps define the area of impact. Since the traffic data required for NEPA and the operational analysis of the report are similar, develop these documents together using the same data sources and procedures.

The following guidance on the preparation of the report applies to Interstate routes in both rural and urban areas.

1425.02 Access Point Decision Report and Supporting Analyses
The Interstate System provides the highest practical level of service (LOS) in terms of safety and mobility. Adequate control of access is critical to providing this service.

For any new or revised access to the existing Interstate System to be considered for acceptance, the following six topics must be addressed in the Access Point Decision Report. The guidance for each topic is written for the most extreme condition: a new interchange in an urbanized area. The scope of the analysis and documentation need not be as extensive for more modest access modifications. Factors that affect the scope include location (rural or urban), access points (new or relocated), ramps (new or widen existing), and ramp terminals (freeway or cross street).

(1) Need
Describe the proposal and document the need for new or revised access by demonstrating that:
• The design year traffic cannot be accommodated by the existing facilities, by improvements to the surface systems and the existing interchanges or ramps, or by Transportation System Management and Traffic Demand Management (TSM/TDM) measures.

• The traffic demanding the new or revised access is primarily regional traffic (longer trips) rather than local traffic circulation. Capacity required primarily for local traffic (shorter trips) is not an adequate need.

Use an accepted procedure (such as a “select link” analysis) to explain the origins and destinations of trips on the local systems, the existing interchanges, and the proposed access.

Conduct an analysis that includes the following steps:

(a) Define the study area and develop current and design year (20 years from start of construction) traffic estimates for the regional and local systems in the subarea of the proposal. Use regional transportation planning organization based forecasts refined, as necessary, by accepted travel demand estimating procedures. Forecasts for specific ramp traffic can require other methods of estimation, such as, a trend analysis.

(b) Assign that travel demand to aggressive and reasonable improvements that could be made to:
   • The surface systems; such as, widen, add new surface routes, coordinate the signal system, control access, improve local circulation, or improve parallel streets.
   • The existing interchanges; such as, lengthen or widen ramps, add park and ride lots, or add frontage roads.
   • The Interstate lanes; such as, add collector-distributor roads or auxiliary lanes.
   • TSM/TDM measures.

(c) Describe the level of service at all affected locations within the study area, systems, existing ramps, and Interstate lanes for current and design year. See 1425.02(3) below.

(d) Describe other potential traffic mitigation measures at locations where the level of service would be unacceptable.

(2) Alternatives
Assess all reasonable alternatives. Show that the proposal provides improvements that are currently justified and includes provisions to accommodate facilities that meet identified future (design year) needs.

Show that all reasonable alternatives have been considered and either incorporated, protected for the future, or dismissed. For example, if high occupancy vehicle (HOV) facilities are planned, show that all new infrastructure has been designed to accommodate the future need.

(3) Analyses
All analyses shall be of sufficient detail and include sufficient documentation to allow independent analysis. Include the following analyses in the report as appropriate:

• An operational analysis for both the opening and design years of existing Interstate and effected surface system.
• An operational analysis for both the opening and design years of proposed future Interstate and surface system.
• Accident analysis of Interstate and adjacent surface system.

As a minimum, use the Highway Capacity Manual, Special Report No 209 (HCM) operational analyses procedures. If other procedures are used, include performance measures data that are compatible with the HCM. Include data sufficient to allow verification of the results by using the HCM. Prepare a sketch or layout displaying adjacent facilities and the following data:

• Distances between ramps of the proposed interchange and that of adjacent interchanges
• Design speed
• Grades
• Truck volume percentages on the freeway, ramps, and adjacent roadways
• Adjustment factors for peak hour volumes
• Freeway, ramp, and surface street traffic volume forecasts for each option, including a “no-build” scenario, in the AM and PM peaks (also, noon peaks, if applicable) and average daily traffic (ADTs), for the opening and design year
• Current year (report year) traffic volumes based on traffic counts
• Main line, ramp, and surface street lane configurations

The required minimum limits of the analysis on the Interstate are through the adjacent interchanges on both sides of the new or revised access. If the interchanges are closely spaced, it may be necessary to go beyond adjacent interchanges. In urban areas, extend the analyses far enough to include the extent and scope of the traffic impacts.

The required limits of the capacity analysis on the surface system are the extent necessary to show that the system can safely and adequately collect and distribute any new traffic loads resulting from the new or revised access. Expand the limits of the study area, if necessary, to analyze the coordination required with an in-place or proposed traffic signal system. In the report, document the limits of the analysis as well as how the limits were established.

Analyze opening and design year traffic to demonstrate that the proposed access change will not have a significant adverse impact on the safety and operation of the Interstate facility. If entering traffic is to be metered, explain the effect on the connecting surface system.

Document the results of analyzing the proposed new or revised access 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 Interstate (main line and ramps) and on the surface system. In the report show the following:

• Any location for which there is a significant adverse impact on the operation or safety of the Interstate facility, such as, causing a LOS E merge condition at an existing ramp, introducing a weave, or reducing the level of service on the mainline due to additional traffic demand, as well as what will be done to mitigate this adverse impact.
• Any location that would be improved or the problem eliminated by the proposal, such as, proposed auxiliary lanes or collector-distributor roads for weave sections.
• Any surface street conditions that would affect traffic entering or exiting the Interstate.

For the accident analyses, identify accident histories, rates, and types for the freeway section and the adjacent surface system. Project the rates that will result from traffic flow and geometric conditions imposed by the proposed access. Document the basis for all assumptions.

(4) Design

The proposed interchange access must connect to the public crossroad, or in urban areas, it may connect to a local street, and shall provide for all directions of traffic movements. Less than full interchanges for special-purpose access for transit vehicles, for HOVs, or into park and ride lots will be considered on a case-by-case basis.

In the report, show that the proposed new or revised access can be designed to meet or exceed current standards for the Interstate System (Chapters 325, 440, and 940). Present the information in sufficient detail to show that the proposal can be designed to full Interstate standards, and for a minimum LOS C in rural areas and minimum LOS D in urban areas. See “Washington’s Transportation Plan, 1997-2016.” For example, include the number of lanes, horizontal and vertical curvature, lateral clearance, lane width, shoulder width, weave distance, ramp taper, and all traffic movements. Construction plans, specifications, and estimates of quantities are not necessary.

In the report, show that all new ramp terminals can be designed to meet or exceed current state and local full design standards.
(5) Land Use and Transportation Plans

Consider and be consistent with local regional land use and transportation plans. In the report, provide the following:

- Reference the existing and proposed land use and transportation plans and studies that apply to the area.
- Reference the regional and local transportation plans that include the proposal.
- Explain the consistency of the proposed new or revised access with those plans, and how land use may be affected by the new or revised access.
- Summarize any required plan refinement study or Interstate network study.

The proposed new or revised access will affect adjacent land use, and conversely, land use will affect travel demand generated. Therefore, the report on the proposed access must reference and be compatible with the land use plans, zoning controls, and transportation ordinances in the affected area.

If the proposed access is not specifically referenced in the transportation plans, define its consistency with the plans and indicate the process for the responsible planning agency to incorporate the project. In urban areas, the plan refinement must be adopted by the metropolitan planning organization (MPO) before the project is designed.

In larger urban areas, regional plans may be too generalized to specify individual interchanges. In order to plan the relative priority of new access points, a plan refinement study or traffic circulation study must be completed before requesting the new or revised access. The study must cover a major subarea of the urban region and must address all proposed, reasonable, and desired access points to the Interstate routes in that area. The study must demonstrate that the proposed new or revised access point is compatible with other feasible new access points.

(6) Coordination

When the request for new or revised access is generated by new or expanded private development, demonstrate appropriate coordination between the development and the changes to the transportation system. Show that the proposal includes a commitment to complete the non-interchange improvements that are necessary for the interchange to function as proposed. For example, the local circulation system must be in place before new ramps are opened to traffic and there must be commitment to the transportation system management concepts included in the proposal. All elements for interchange and noninterchange improvements shall include a fiscal commitment and definite time frame for completion.

1425.03 Report and Supporting Analyses

The region prepares the report and submits four copies to the Access and Hearings Engineer (in the Design Office, Olympia Service Center) for review and concurrence.

Following concurrence, the State Design Engineer submits the report to FHWA with a request for acceptance. Certain types of access modification can be reviewed by FHWA at the divisional level in Washington State and consequently require less time for a determination of acceptability. The following are examples:

- Realignment of existing ramps
- Minor relocation or modification of existing ramp termini at an interchange, including extension or addition of acceleration or deceleration lanes, or HOV by-pass lanes and terminals
- Addition of auxiliary lanes
- Addition of collector-distributor roads at an isolated interchange
- Addition of entrance or exit ramps that complete basic movements at an existing interchange
- Locked gate access points
• A new freeway-to-crossroad interchange not in a transportation management area
• Modification of an existing freeway-to-crossroad interchange
• Abandonment of existing ramps or interchanges

Any other additional or modified access points are reviewed by the Federal Highway Administrator in Washington, DC, and can require a more protracted review and acceptance process. The following are examples:

• A new freeway-to-freeway interchange
• Major modifications to an existing freeway-to-freeway interchange
• A new partial (less than full access) interchange
• A new freeway-to-crossroad interchange in a transportation management area

1425.04 Documentation

The request for acceptance and the associated report and records are to be preserved in the project file. The Access Point Decision Report shall include, if applicable, all of the following items:

☐ Need investigation
☐ Alternatives considered
☐ Operational traffic and accident analysis
☐ Proposed design standards and layout
☐ Compatibility with land use plans
☐ Developer and WSDOT commitments

P:DM14
1430
Development of Access Control

1430.01 General
1430.02 Access Report
1430.03 Access Hearing

1430.01 GENERAL

Requirements for the establishment of controlled access facilities are set forth in RCW 47.52. The degree of access control is determined during the early stages of design in conformance with Chapter 1420.

Access control is established in three stages of development: The access report plan, access hearing plan, and the findings and order plan. The findings and order plan becomes a permanent document and is approved by the Deputy Secretary of Transportation.

If all information required for the right of way plan is included, the findings and order plan may also become the right of way plan. If not, it is used as the basis for preparation of the right of way plan (Refer to the Plans Preparation Manual, M 22-31). Control section, project control, federal aid, state route, and sheet numbers, along with project name and county, will appear on each plan.

1430.02 ACCESS REPORT

(1) General

The access report is developed by the district to inform local governmental officials of the proposed route and principal access features involved, and to secure their approval. This report is not furnished to abutting owners. Three copies of the report are to be submitted to the headquarters Project Development Office for review and approval prior to submission to local authorities. The access report is to consist of:

(a) A description of the existing and proposed routes.

Data on the history of the existing route and development of the proposed routes should be included.

(b) Traffic analyses pertaining to the proposed facility, including available information concerning present and potential future traffic volumes of county roads and city streets crossing or severed by the proposed facility, and source of information (origin-destination surveys, etc.).

Traffic data developed for the design report, together with counts of existing traffic directly available from state or local records, is normally adequate. Special counts of existing traffic should be obtained only if circumstances indicate that the available data is inadequate or outdated.

(c) Factors affecting the design of the subject highway, including discussions of:

- Standards.
- Type of access control, with definition.
- Roadway section.
- Interchange, grade separation, and/or intersection spacing.
- Pedestrian and bicycle trails or paths.
- Operational controls with emphasis on proposed fencing for the protection of motorists and pedestrians, and definition of right of way limits; the general concept of illumination; and the need for use of signing and other traffic control devices.
- Locations of utilities and how affected.
- Proposed plan for landscaping and beautification, including an artist's graphic rendition.

(d) Governmental responsibility, comprehensive planning, land use, and community service relative to the new facility.

(e) The disposition of frontage roads, city street and county road connections, and excess right of way.

(f) An appendix containing the following:

- A glossary of engineering terms.
- A traffic volume diagram.
- Plates showing diagrammatically or graphically the roadway section or sections, operational controls, and rest areas (if rest areas are included in the project covered by the report).
- Vicinity map.
- Access report plan and profiles for the project.

(g) Access Report Plan. The access report plan shows the effects of the proposed highway on the street and road system by delineating the points of public access. Figure 1430-1 is a sample access report plan. The following items are minimum details to be shown on the plan:

- Highway facilities with standard access control delineated.
- Public road network.
- Proposed frontage roads and county road or city street connections. Individual private approaches need not be included but the report should describe general provisions for access to private properties.
- Location and identity of subdivisions.
- Corporate limits and boundaries.
- Rivers, streams, and major landmarks.
- Pedestrian and bicycle trails or paths.
- Beginning and end of plan.
• Legend and scale bar.
• Publicly owned utilities.
• Title block.
• Areas “for relinquishment to county, city or transfer to others” with “turnback lines” indicated, and “excess R/W” labeled as such.
• Structures labeled as “overcrossings” or “undercrossings.”
• Local names for interchanges on plan.
• Points of public access.
• Appropriate traffic movement notes on plan sheets.
• Project length on first page of vicinity map: Total length of project = miles.
• Directional arrows on all roadways and ramps.
• Number of lanes indicated on all roadways.

Matching of stationing and all details, especially in all plan sheets, will be carefully checked to assure relationship to adjacent plans.

To prevent confusion concerning the degree of access control intended for each area of a plan, the station where transition is made from one type of control to the other is clearly labeled. This applies to any such transition upon the highway proper or where such highway connects or intersects with another limited access facility, be it a state, county, or city roadway. This does not apply at intersections where the transition occurs between access controlled facilities and facilities with no access control. Modified access control adjacent to interchanges or intersections must be identified on the plan.

The title block on the plan sheet shall designate either full, partial, or modified access control. Whenever a transition occurs on a sheet, the title block shall indicate all degrees of access control appearing on the sheet.

(2) Conferences and Reviews

Upon receipt of Assistant Secretary for Highways’ approval of Phase 1 (Figure 1410-1), the district will publish the necessary copies, submit the access report to the county and/or city officials for review, and meet with all local governmental agencies involved to discuss the report. The district will review any request for modification and submit recommendations, with copies of any correspondence or minutes relating thereto, to the headquarters Project Development Office.

1430.03 ACCESS HEARING

(1) Access Hearing Plan

The district will prepare an access hearing plan to be used as an exhibit at the public hearing (Figure 1430-2) and forward it to the headquarters Project Development Office for review. The plan should contain the following data in addition to that required for the access report plan.

• Topographic features, buildings, fences, private driveways, etc.
• Ownership, including parcel numbers and names. See the Plans Preparation Manual, M 22-31 for details on assignment of property parcel identification numbers.
• Access approach schedule showing all private approaches within the limits of access control.
• Access notes in conformance with the Plans Preparation Manual M 22-31. Right of way dimensions need not be shown.

When the plan review is completed by headquarters, the access hearing plan will be placed on the Assistant Secretary for Highways’ calendar by the headquarters Project Development Office, for approval of Phase 2 or 2-A authority (Figure 1410-1).

(2) Preparation for Hearing

The district will assemble the prehearing documents for the access hearing, make arrangements for the hearing hall, and retain a court reporter.

The prehearing documents will consist of, but are not limited to, the proposed advertisement, a mailing list, legislator’s project description and list, sample “notice of appearance,” vicinity map, and all other material necessary to accomplish a proper hearing.

The district shall transmit the prehearing documents to the headquarters Project Development Office for concurrence. Subsequent to concurrence, the district shall notify the legislators in advance of publication, make the appropriate mailings, and advertise the hearing.

(3) Access Hearing

At the hearing, the Secretary of Transportation or his designee will preside as examiner. Hearing examiners are assigned by the headquarters Project Development Office. Any representative of the county, city, or town, or any other person, may appear and be heard as long as the material presented is pertinent to the issues at hand.

An Assistant Attorney General assists with the presentation of testimony and evidence for the department, and may question witnesses who present objections or counter proposals. Hearing testimony for the department will normally be provided by the district.

After the hearing, the court reporter will submit the original transcript to the examiner for certification, with copies to the district. Following the examiner’s certification, the original transcript is to be transmitted to the headquarters Project Development Office.

The district will review the transcript, prepare a findings and order analysis, draft a findings and order plan as it is modified from the access hearing plan, and transmit these documents to the headquarters Project Development Office.
Office. Care should be taken to ensure that no portion of the findings and order analysis or findings and order plan considers, or is based on, material not properly made part of the hearing record.

Along with the draft findings and order and hearing exhibits, the district shall submit to the headquarters Project Development Office one set of prints marked to show all plan revisions, in composite form, to be included in the findings and order. Any revisions which are not based on the hearing record cannot be included as part of the findings and order. They shall be held by the district until termination of the findings and order appeal period. Following the appeal period, additional plan revisions may be submitted in composite form and in accordance with the Plans Preparation Manual, M 22-31.

After the Secretary of Transportation or his designee adopts the findings and order document, the headquarters Project Development Office will make appropriate final revisions to the access hearing plan, in accordance with the adopted findings and order document. Prints of the findings and order plan (revised access hearing plan) will be reproduced in headquarters and reduced prints, together with a copy of the findings and order text, will be mailed by the district to all parties filing a notice of appearance, including local government officials. Subsequent to mailing, the district will prepare an “affidavit of service by mailing” and transmit it to headquarters in Olympia. On the mailing date of the findings and order documents, the district will notify the appropriate legislators of the Secretary’s action, with copies to the Public Affairs Office and the headquarters Project Development Office.

Right of way and limited access plans that follow are prepared in accordance with the provisions of the Plans Preparation Manual, M 22-31 and must conform to the findings and order document.

For further information refer to the latest issue of Directive D 22-52(HR) Public Hearings.
1440 Surveying and Mapping

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) Include any pertinent surveying information in the Project Summary.

(b) Research for recorded survey monuments existing within the project area.

(c) Determine and prioritize project survey needs and tasks to be completed.

- 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 Estimate**

(a) Hold a presurvey conference.

(b) Schedule tasks with surveyors.

(c) Perform field reconnaissance, mark existing recorded survey monuments, and determine location of possible new survey monuments. Also mark found unrecorded monuments for preservation if practical.

(d) Determine impact to geodetic monuments and notify OSC Geographic Services.

(e) See the *Highway Surveying Manual* to:

- Convert Washington state plane coordinates to project datum.
- Document the procedure and combined factor used for converting between datums.

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**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 either a licensed professional land surveyor or a licensed professional engineer.” See Figure 1440-1, Interagency Agreement.

**1440.02 References**

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”

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

*Construction Manual*, M 41-01, WSDOT

*Highway Surveying Manual*, M 22-97, WSDOT

*Plans Preparation Manual*, M 22-31, WSDOT

WSDOT Monument Database at http://www.wsdot.wa.gov/monument/
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.

Apply to the Department of Natural Resources (DNR) for permits for monuments that will be disturbed or removed (Chapter 1450).

Archive new primary and secondary survey control data in the WSDOT Monument Database and GIS, as appropriate, for future retrieval.

Ensure that all survey monuments within the right of way of the project are shown on the contract plans in order to avoid accidental damage.

Develop a Record of Survey (RCW 58.09) or a Record of Monuments and Accessories as required (Chapter 1450).

(3) After Construction is Completed


(b) Have DNR Completion Report signed and stamped by the appropriate professional in direct responsible 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 plane coordinates on a state system.

(1) Horizontal

WAC 332-130-060 states that “The datum for the horizontal control network in Washington shall be NAD83 (1991) 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 Federal Geodetic Control Subcommittee (FGCS) has affirmed the North American Vertical Datum of 1988 (NAVD88) as 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. This survey technology is used by WSDOT personnel. 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 application) for doing the survey. Often times a combination of GPS and traditional (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 Internet address http://www.wsdot.wa.gov/monument/ is used to access the WSDOT Monument Database.
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 Geographic Services Branch. 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

See Chapter 1450 for documentation related to monuments.

Primary and secondary survey control data are archived in the WSDOT Monument Database and GIS when available.

As a minimum, permanent hard copies of the following are to be preserved in a manner that can easily be retrieved in the future:

- Report of Survey Marks
- Project datum conversion documentation
- Legal research (descriptions, lists of references, etc.)
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.
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 Date
DEPUTY SECRETARY
Department of Transportation

This Agreement approved by motion of the Board dated January 19, 1990.

/s/ Wesley E. Taft
__________________________
Wesley E. Taft, PE Date
CHAIRMAN, Board of Registration
### 1450 Monumentation

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**1450.01 General**

Proper monumentation is important in referencing a highway’s alignment that is used to define its right of way and 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 and to a standard vertical datum. In addition, the department is required by law to perpetuate existing recorded monuments. (See RCW 58.09.) Consequently, the department shall provide monuments forealignments and new highway alignments and shall perpetuate existing monuments impacted by a project.

Both the Department of Natural Resources (DNR) and the Geographic Services Branch maintain records of surveys performed and survey monuments established. New monuments are to be reported to both operations.

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. WSDOT control and alignment monuments may be removed without replacement if approved by the Geographic Services Branch. (Notify DNR.)

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 obtaining all required permits before any existing monument is disturbed and for 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**

“Engineers and Land Surveyors,” RCW 18.43

“Surveys — Recording,” RCW 58.09

“State Agency for Surveys and Maps — Fees,” RCW 58.24

“Survey Monuments—Removal or Destruction,” WAC 332-120

“Minimum Standards for Land Boundary Surveys and Geodetic Control Surveys and Guidelines for the Preparation of Land Descriptions,” WAC 332-130


**1450.03 Definitions**

**monument**, as defined for this chapter, is any physical object or structure which marks or references a survey point. This includes 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 a state plane 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 two kilometers (1.24 miles) of the project and the required datum and accuracy were used. To omit monumentation when it is impractical, a variance must be sought from the State Survey Support Engineer.

When control monuments are required for a given project, either show the existing and proposed control monuments on the contract plans or include an approved variance in the design report.

For horizontal control:
- Use a minimum of second order, Class I procedures as defined in the *Highway Surveying Manual* (M 22-97).
- Provide two monuments near the beginning of the project.
- Provide two monuments near the end of the project.
- Provide a pair of monuments at about five kilometer (or 3-mile) intervals throughout the length of the project.

For vertical control:
- Use at least third order procedures within project limits as defined in the *Highway Surveying Manual*.
- Provide vertical control throughout the length of the project. Desirable spacing is at or near each milepost or every other kilometer. Maximum spacing is five kilometers (3.11 miles) apart.

All control monuments that are established, reestablished, or reset must be filed with the county engineer, Geographic Services, and DNR. Submit a Record of Monuments and Accessories that has been signed by the supervising, licensed, professional engineer, or land surveyor (or, if the monument is not used to reference right of way or land corners, submit a Record of Survey Mark).

### 1450.05 Alignment Monuments

Alignment monuments are permanent references required for the establishment or reestablishment of the highway and its right of way. Generally, highway and ramp center line P.C.s and P.T.s are monumented. 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 engineer and DNR. A Record of Monuments and Accessories is filed with the county engineer of the county in which the monument is located and copies are sent to the Geographic Services Branch and DNR for their records.
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 land surveyor. The licensed professional land surveyor must record the survey with the county auditor and send copies to the Geographic Services Branch and DNR.

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 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 Olympia Service Center Geographic Services Branch.

Resetting monuments must be done by or under the direct supervision of a licensed professional engineer or a licensed professional land surveyor. Submit a Record of Monuments and Accessories to the county engineer, Geographic Services Branch, and DNR.

1450.08 Documentation

The following documents are to be preserved for future reference in the project’s design documents file. See Chapter 330.

□ A general statement about the project’s impacts on existing monuments.

□ A general statement concerning new monuments.

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.

Monumentation work cannot be done until DNR has approved the permit. Verbal permission 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) Record of Monuments and Accessories

When a Record of Monuments and Accessories is required, a plan sheet similar to Figure 1450-3 is prepared. Generally, the plan sheet is based on a right of way plan obtained from the Olympia Service Center Plans Branch. A Record of Monuments and Accessories should contain 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.

The completed Record of Monuments and Accessories must be submitted to the county engineer of the county in which the monument is located and copies sent to the Geographic Services Branch and DNR.

(3) Land Corner Record

When a Land Corner Record is required, use the forms shown in Figure 1450-4. 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 and to the Geographic Services Branch and DNR.
**SET NEW**

**WSDOT Control Monument**
- **Before:** No permit required.
- **After:** File a Record of Monuments and Accessories with the county engineer, Geographic Services Branch, and DNR.

**Alignment Monument**
- **Before:** No permits required.
- **After:** Submit Record of Monuments and Accessories to the county engineer, Geographic Services Branch, and DNR.

**Property Corner Monument**
- **Before:** Engage a licensed professional land surveyor.
- **After:** Licensed professional land surveyor files Record of Survey with county auditor and DNR.

**DISTURB EXISTING**

**Control Monument**
- **Before:** Obtain DNR permit.
- **After:** File Record of Monuments and Accessories with the county engineer, Geographic Services Branch, and DNR.

**Alignment Monument**
- **Before:** Obtain DNR permit.
- **After:** File Record of Monuments and Accessories with the county engineer, Geographic Services Branch, and DNR.

**Section Corner, BLM, or GLO Monument**
- **Before:** Obtain DNR permit.
- **After:** File Land Corner Record with the county auditor and DNR.

**All Other Monuments**
- **Before:**
  - Obtain DNR permit.
  - Contact governmental agency.
- **After:** File Record of Monuments and Accessories with the county engineer, Geographic Services Branch, and DNR.

---

**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 (B.).)

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

Figure 1450-2b
Record of Monuments and Accessories

Figure 1450-3
LAND CORNER RECORD

(CORNER INDEXING INFORMATION:

TWP

RGE

CORNER CODE

(Willamette Meridian)

(See instructions on back of CR)

ADDITIONAL IDENTIFIER: (e.g., DNR designation for the corner, street
intersection, plat name, block, lot, etc.)

COUNTY:

AUDITOR'S USE

LAND SURVEYOR INFORMATION: (or Public Officer as per RCM 58.09.080)

This corner record correctly represents work performed by me or under my
direction in conformance with the Survey Recording Act.

COMPANY OR AGENCY:

ADDRESS:

WASHINGTON PLANE COORDINATES: N: E:

ORDER: ZONE: DATUM (Date of adjustment):

CORNER INFORMATION: Use the space below to provide the following information regarding the corner:

title and number the parts of your discussion accordingly. If additional space is needed use the blank. (For [3],
diagram the references. Also, provide the cross-reference to a map of record, if applicable, the surveyor's field
book no./page no., and the date of work.) (See the back of this form for the requirements of the Survey Recording
Act.)

DATE OF FORM: 2/92

Figure 1450-4a
ON THE CORNER LOCATION ON THE DIAGRAM BELOW AND FILL IN THE CORNER CODE BLANK ON THE OTHER SIDE.

1. For corners located at the intersection of two lines (Section corners, quarter corners and sixteenth corners):
   - The corner code is the alpha-numeric coordinate from the diagram below that corresponds to the appropriate intersection of lines.

2. For corners that are not located at the intersection of two lines (Meander corners, DLC's, HES's, reservation boundaries, mining claims, etc.):
   - For corners that are on one line only the corner code is the line designation and the related line segment; i.e., a corner on line S between "B" and "C" is designated BC-S.
   - 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 NW-4-5.

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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:

Figure 1450-4b
1460 Fencing

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.

The reason for discouraging encroachment onto the right of way is to limit the presence of people and animals that might disrupt the efficient flow of traffic on the facility. Fencing along the highway is not intended to be protection for people or animals approaching the highway or residing near it.

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 has a pleasing appearance and is most economical to construct and maintain. The recommended practice is to locate fencing to coincide with the final 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 that is acceptable to Maintenance.

Where 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 limited access control, fencing is mandatory unless it has been established that such fencing may be deferred. 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 in rural areas, fencing is not provided for the outside line of a frontage road 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 Olympia Service Center 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, 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 safe operation of the highway, it will be constructed and maintained by the state. Examples of this 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 is often needed at special sites such as pitsites, stockpiles, and borrow areas. 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 or livestock encroachment in limited access areas.

• See Chapter 640 for roadway sections in rock cuts.

The Standard Plans contains details for the four approved types of chain link fence. The recommended uses for each type of fence are as follows:

(a) **Type 1.** A high fence for areas of intensified use, such as industrial areas or school playgrounds. It is not to be used within the Design Clear Zone because the top rail of the fence is considered a hazard. (See Chapter 700.)

(b) **Type 3.** A high fence for use in suburban areas with limited existing development. It may be used within the Design Clear Zone.

(c) **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.

(d) **Type 6.** A lower fence used instead of Type 1 where it is deemed important not to obstruct the view toward or from areas adjacent to the highway. This fence is not to be used within the Design Clear Zone. (See Chapter 700.)

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 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: in 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 ft high) may be used in areas where there are exceptional hazards such as large concentrations of elk. See the region’s Environmental 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.

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 Chapter 1425, “Access Point Decision Report.”

Usually such gates are necessary only to allow highway maintenance personnel and operating equipment to reach the freeway border areas without using the through-traffic roadway. 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 are normally gated and locked, with a short section of fence on both sides of the gate.

1460.08 **Procedure**

Fencing is included in the access report, in accordance with Chapter 1430, and the PS&E, in accordance with the Plans Preparation Manual.

1460.09 **Documentation**

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

- Reasons for providing fencing and for the type and configuration selected.
- Justification for using a nonstandard fence design.
- Justification for deferring or not providing fencing on a highway with limited access control or as otherwise recommended in this chapter.
- Access Point Decision Report for gates on limited access highways.
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