Chapter 1300 Intersection Control Type

1300.01 General
1300.02 Intersection Control Objectives
1300.03 Common Types of Intersection Control
1300.04 Modal Considerations
1300.05 Procedures
1300.06 Documentation
1300.07 References

1300.01 General

It is WSDOT practice to analyze potential intersection solutions at all intersection improvement locations in accordance with E 1082 – *Business Practices for Moving Washington* and E 1090 – *Moving Washington Forward: Practical Solutions*. The objective is to provide the optimum solution within available limited resources. The analysis may be done for individual intersections, or on a corridor basis. This chapter provides guidance on preliminary intersection analysis and selection of control type. Intersection design is completed using Chapter 1310 for the geometrics of intersections, Chapter 1320 for roundabouts, and Chapter 1330 for traffic signals. Use the aforementioned chapters in conjunction with chapters 1106, 1230, 1430, 1510, and 1520 to assist with dimensioning design elements.

Motorized traffic and driver characteristics, bicycle and pedestrian needs, physical features, and economics are considered in selecting traffic control that facilitates efficient multimodal traffic flow through intersections. Signs, signals, channelization, and physical geometric layout are the major tools used to establish intersection control.

Typically, potential project locations with safety performance needs will have been identified through the safety priority programming process described in Chapter 321. Other performance category programs may identify intersection needs through the priority array programming process, but the influence of the intersection control with respect to specific performance category needs may not be fully understood until contributing factors analysis is completed (see Chapter 1101).

An Intersection Control Analysis (ICA) should be completed as early in the project development process as feasible. ***The level of effort of the ICA should be scalable to the project***; for example, evaluation of adding a turn lane to an existing intersection control may take less effort than evaluating new intersection control. This may occur during planning or corridor studies, but should not be initiated later than the scoping stage of a project. Data-based knowledge and scientific evaluation provides the basis for performance based improvements.

When analysis determines that an at-grade intersection cannot provide adequate performance, consider a grade separation or an interchange. The ramp terminal intersections are subject to the analysis requirements of this chapter. See Chapters 1360 and 550 for additional guidance.

For additional information, see the following chapters:

Chapter	Subject
320	Traffic analysis
321	Sustainable Safety
530	Limited access control
540	Managed access control
550	Interchange Justification Report
1100	Practical Design
1101	Need Identification
1103	Design Controls
1106	Design Element Dimensioning
1230	Geometric Cross Section
1310	Intersections
1320	Roundabouts
1330	Traffic signals
1340	Road Approaches
1360	Interchanges
1510	Pedestrian facilities
1515	Shared-use paths
1520	Bicycle facilities

1300.02 Intersection Control Objectives

Intersections are an important part of highway design. They comprise only a small percentage of the overall highway system miles, yet they account for a high percentage of reported crashes and the majority of potential transportation conflict areas. Intersection control choice requires consideration of all potential users of the facility, including drivers of motorcycles, passenger cars, heavy vehicles of different classifications, public transit, and bicyclists and pedestrians.

Design users have varying skills and abilities. Young and elderly drivers in particular are subject to a variety of human factors that can influences elements of their driving ability. See NCHRP *Report 600 – Human Factors Guidelines for Road Systems: Second Edition* for additional information (http://www.trb.org/Main/Blurbs/167909.aspx). Bicyclists also have a variety of skill sets that can influence the effectiveness of bike facilities and intersection operational design (see Chapter 1520 for additional information). Meeting the needs of one user group can result in compromising service to others. The selection process evaluates these competing needs, resulting in optimal balance of performance categories for all design users.

The intent of intersection control type analysis is not to design an intersection, but to evaluate the compatibility of different intersection control types with respect to context, modal priority, intersection design vehicle and the identified balance of performance needs. Four basic areas of intersection design shown in Exhibit 1300-1 are to be considered in sustainable transportation practice, and can effects the consideration of intersection control types depending on the situation.

The objectives of the intersection control type analysis are to:

- Evaluate the operational performance of all design users for different intersection control types under consideration.
- Evaluate the multimodal performance trade-offs between different intersection control types with respect to the identified modal priority and intersection design vehicle (see Chapter 1103).
- Evaluate intersection control type with respect to potential operational effects with existing adjacent intersections.
- Understand the potential multimodal treatments that may need to augment typical control types, and their operational effect on other design users.
- Evaluate the intersection control types for potential sustainability, cost-effectiveness, and typical maintenance life cycle needs.
- Decide on the most compatible intersection controls types for that location and balance of performance needs that can be used in alternative formulation procedures (see Chapter 1104).

Exhibit 1300-1: Intersection Design Areas

Human Factors	
➢ Driving habits	➢ Conformance to natural paths of movement
➢ Driver workload	➢ Pedestrian use and habits
➢ Driver expectancy	➢ Bicycle traffic use and habits
➢ Driver error	➢ Visual recognition of roadway cues
➢ Perception-reaction time	➢ Demand for alternative mode choices
Traffic Considerations	
➢ Design users, modal priority, and intersection design vehicle	➢ Vehicle speeds
➢ Design and actual capacities	➢ Transit involvement
➢ Design-hour turning movements	➢ Crash experience
➢ Size and operating characteristics of vehicle	➢ Bicycle movements
➢ Variety of movements (diverging/merging/weaving/crossing)	➢ Pedestrian movements
Physical Elements	
➢ Character and use of abutting property	➢ Traffic control devices
➢ Vertical alignments at the intersection	➢ Illumination
➢ Sight distance	➢ Roadside design features
➢ Angle of the intersection	➢ Environmental factors
➢ Conflict area	➢ Crosswalks
➢ Speed-change lanes	➢ Driveways
➢ Accessible facilities	➢ Streetside design features
➢ Parking zone	➢ Pavement markings
➢ Geometric design features	➢ Access management treatments
Economic Factors	
➢ Cost of improvements, annual maintenance, and life cycle costs, and salvage value.	
➢ Effects of controlling right of way on abutting properties where channelization restricts or prohibits vehicular movements	
➢ Energy consumption	
➢ Compatibility with context characteristics	

1300.03 Common Types of Intersection Control

1300.03(1) Uncontrolled Intersections

- Uncontrolled intersections do not have signing, and the normal right of way rule (RCW 46.61.180) applies.
- Most uncontrolled intersections are found on local roads and streets where the volumes of the intersecting roadways are low and roughly equal, speeds are low, and there is little to no crash history.
- Uncontrolled intersections are generally not appropriate for intersections with state routes.

1300.03(2) Yield Control

- Intersections with yield control assign right of way without requiring a stop.
- It is mainly used at roundabouts, ramps, and wye (Y) intersections.

Refer to the MUTCD for information on the locations where yield control traffic control devices may be appropriate.

1300.03(3) Two-Way Stop Control

- Intersections with two-way stop control are a common, low-cost control, which require the traffic on the minor roadway to stop before entering the major roadway. It is used where application of the normal right of way rule (RCW 46.61.180) is not appropriate for certain approaches at the intersection.
- Where U-turn opportunities exist within a corridor, or are employed by an alternative, consider limiting access at two-way stops to “right-in, right-out only.”

1300.03(4) Multi-Way Stop Control

Intersections with multi-way stop control:

- Normally require all traffic to stop before entering the intersection.
- Increase traffic delays, fuel consumption, and air pollution.
- Are most effectively used on low-speed facilities with approximately equal volumes on all legs and total entering volumes not exceeding 1,400 vehicles during the peak hour.
- Are often used as an interim measure when a traffic signal is warranted and has been determined to be the best solution, but has yet to be installed.

Guidance for consideration of the application of multi-way stop control is provided in the MUTCD.

Multilane facilities present more operational issues than on two-lane two-way facilities and multi-way stop control is not recommended on multilane state routes. Multi-way stop control is less desirable at intersections with very unbalanced directional traffic due to the delay introduced on the major-volume leg.

1300.03(5) Roundabouts

Roundabouts are traditionally near circular at-grade intersections, but can be a variety of shapes and sizes. Properly designed, located, and maintained roundabouts are an effective intersection type that normally offer the following:

- Fewer conflict points.
- Lower speeds.
- An alternative for areas where wrong-way driving is a concern.
- Reduced fatal- and severe-injury crashes.
- Reduced traffic delays.
- Traffic-calming.
- More capacity than a two-way or multi-way stop.
- More consistent delay relative to other intersection treatments.

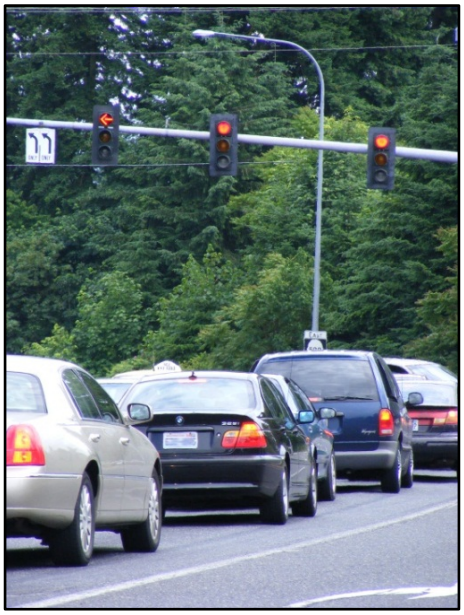
- The ability to serve high turning volumes.
- Improved operations where space for queuing is limited.
- At ramp terminals where left-turn volumes are high, improved capacity without widening the structure.
- Facilitation of U-turn movements.

Roundabouts are site-specific solutions. There are no warranting conditions; each is justified on its own merits as the most appropriate choice. See Chapter 1320 for more information on roundabout types and design. However, there is modeling software for roundabouts, making the comparison of intersection control types and justification possible from an operations perspective.

1300.03(6) Traffic Control Signals

Properly designed, located, operated, and maintained traffic control signals may offer the following:

- Allow for the orderly movement of traffic.
- Increase the traffic-handling capacity of the intersection.
- Reduce the frequency of severe crashes, especially right-angle crashes.
- Can be coordinated to provide for continuous or nearly continuous movement of traffic at a definite speed along a given corridor under favorable conditions.
- Can be used to interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.
- Can be preempted to allow emergency vehicle passage.



Traffic control signals are not the solution for all intersection traffic concerns. Indiscriminate installation of signals can adversely affect the safety and efficiency of vehicle, bicycle, and pedestrian traffic.

As a result, installation of a traffic control signal is to meet specific “warrants,” which are found in the MUTCD. A signal warrant is a minimum condition in which a signal may be installed. Satisfying a signal warrant does not mandate the installation of a traffic signal; it only indicates that an engineering study, as described in this chapter, is needed to determine whether the signal is an appropriate traffic control solution.

Some crashes are usually not correctable with the installation of a traffic signal; in fact, the installation of a signal often increases rear-end crashes. These types of crashes are only used to satisfy the crash warrant in special circumstances. If they are used, include an explanation of the conditions that support using them to satisfy the crash experience warrant.

State statutes (RCW 46.61.085) require WSDOT approval for the design and location of all conventional traffic signals and for some types of beacons located on city streets forming parts of state highways. The Traffic Signal Permit (DOT Form 242-014 EF) is the formal record of the department's approval of the installation and type of signal. For traffic signal permit guidance, see Chapter 1330.

1300.03(7) Alternative Intersections

A number of alternative intersections have been developed to reduce the delay to through traffic, the number of conflict points, and the number of signal phases for signalized intersections.

Alternative intersections work mainly by rerouting U and left turns, and/or separating movements. Alternative intersections include:

- Median U-turn
- Jug handle
- Bowtie
- Restricted crossing U-turn
- Continuous flow intersection
- Continuous green tee (T)
- Split intersection
- Quadrant roadway intersection
- Single quadrant interchange
- Echelon
- Center turn overpass

Like any intersection control solution, alternative intersection designs are site specific in how well they operate. Performance is to be addressed during the intersection control selection process prior to proceeding with the actual design. Trade-offs in selecting alternative intersections may include higher construction costs, driver education, longer left-turn travel distance, circuitous access to adjacent properties, and less direct pedestrian crossing.

Two types of alternative intersections are reviewed in the subsections below: Median U-Turn and Restricted Crossing U-Turn (Superstreets). For more information about these and other intersection design solutions, see the Federal Highway Administration (FHWA) *Alternative Intersections/Interchanges: Informational Report (AIIR)*:
http://www.fhwa.dot.gov/publications/research/safety/09060/index.cfm.

1300.03(7)(a) Median U-Turn

The Median U-Turn (MUT) intersection treatment is an approach to simplifying operations at an intersection by removing left-turning movements from the major and/or minor approaches. Left-turning drivers proceed straight through the at-grade intersection, and then execute a U-turn at some distance downstream from the intersection location in place of the traditional left-turning movement. The MUT intersection design is best applied in situations where:

- The intersection is failing due to congestion.
- There is an existing median (on at least one of the roadways) and/or sufficient or low-cost right of way needs can be accommodated.
- Minimal bicycle accommodations are needed.
- There is a need to improve pedestrian mobility.
- There is a need to reduce vehicle and pedestrian/vehicular conflict points.
- There is a need to shorten cycle lengths of signal timing or improve progression.

Refer to FHWA's *Alternative Intersection/Interchanges: Informational Report (AIIR)* for geometric design considerations and recommendations. (See 1310.05 for geometrics when designing the U-turn movement for the MUT intersection.)

1300.03(7)(b) Restricted Crossing U-Turn Intersection

Restricted crossing U-turn (RCUT) intersections, also known as superstreets, work by moving the minor road through and left-turning movements up- and downstream from the intersection location itself. (Exhibit 1300-2 shows an example of an RCUT intersection.)

RCUT intersections:

- Operate by forcing drivers entering from the minor road to turn right onto the major road, and then make a U-turn maneuver at a one-way median opening downstream.
- Provide potential increased traffic safety advantages, due to the reduction of conflict points as compared to a more traditional intersection approach.
- May or may not warrant signalization due to traffic volumes, and those with signalization may require fewer phases and shorter cycles than a similar four-way intersection.

RCUT intersections are best applied in situations where:

- There is a rural expressway or urban arterial.
- There is partial control or managed access facilities.
- Major and minor traffic flows intersect.
- There is a high ratio of through movements to left turns on the main line.
- There are low through traffic volumes on the minor road.
- The major roadway is multilane.
- The major roadway contains sufficient median width, or total right of way width, to support the U turn movements.

Exhibit 1300-2 RCUT Intersection US23, North Carolina

Photo Credit: NCDOT

The RCUT intersection may be a competitive alternative compared to a grade-separated interchange, at locations meeting grade-separated considerations identified in 530.04(3). Refer to *Alternative Intersection/Interchanges: Informational Report (AIIR)* for geometric design considerations and recommendations. (See 1310.05 for geometrics when designing the U-turn movement for the RCUT.)

1300.04 Modal Considerations

When designing a multimodal intersection, consideration needs to be given to all design users at the intersection, the intersection design vehicle and selected modal priority (see Chapter 1103). While specific intersection control types do not exist for each mode, treatments that augment different control types do exist for different users. Some of these treatments are specific to certain control types while others can be provided for several intersection control types.

It is not appropriate to design for specific modal treatments on the outset of evaluating intersection control types. However, modally oriented intersection treatments may be necessary to enhance specific modal baseline or contextual performance needs (see Chapter 1101), and may influence the control type selection. Include a discussion of the potential modally oriented treatments relevant to the control types being analyzed and modal performance needs. Evaluate the potential effect of modal specific treatments on all design users relevant for the control types evaluated in the ICA (see 1300.06).

1300.04(1) Pedestrian Considerations

Discuss the elements and/or treatments applicable for pedestrians (see chapters 1230 and 1510) to meet modal performance needs identified (see Chapter 1101). Additional information on emerging practices to address pedestrian performance needs for different intersection control types can be found at the Pedestrian and Bicycle Information Center (www.pedbikeinfo.org/)

1300.04(2) Bicycle Considerations

For consideration of bicycle needs at intersections and treatments that may have an operational effect on other design users, see chapters 1515 and 1520. Additional emerging practice information to address bicycle performance needs for different intersection control types can be found at the Pedestrian and Bicycle Information Center (www.pedbikeinfo.org/) and the *NACTO Urban Bikeway Design Guide* (http://nacto.org/cities-for-cycling/design-guide/).

1300.04(3) Transit Considerations

When transit vehicles are identified as a modal priority, consider treatments to meet the performance needs of the specific transit vehicle types and their effect on the performance of other design users (see Chapter 1103). Transit oriented treatments can vary significantly depending on the proximity of stop locations with respect to the intersection location and origin of the transit movement (see Chapter 1430 for bus stop placement guidelines), and the type of transit vehicle (such as a fixed guideway vehicle). Discuss treatment options and any operating restrictions the transit provider may have regarding different intersection control types.

1300.05 Procedures

For new intersections, determine and document traffic control according to the applicable procedures in this chapter.

For intersection improvement projects involving pavement construction and/or reconstruction, or signal replacement/rehabilitation, evaluate intersection control in accordance with this chapter unless there is documentation that this analysis has already been completed and is referenced in the Project Summary.

Control for existing intersections that are unaffected by the project (per the contributing factors analysis) or are receiving minor revisions such as signal phasing changes (as shown through the analysis) may remain in place without further evaluation. Document the impacts and recommended revisions to all intersections affected by the project.

1300.05(1) Intersection Control Analysis (ICA)

Use the following steps when screening intersection control alternatives for selection, or to support the need for modifications to existing intersection control:

- **Determine the right of way requirements and feasibility.** Discuss the right of way requirements and the feasibility of acquiring that right of way in the analysis. Include sketches or plan sheets with sufficient detail to identify topography (including utilities), environmental constraints, drainage, buildings, and other fixed objects. An economic evaluation will be useful if additional right of way is needed. Include the right of way costs in the benefit/cost analysis.

- **Check signal warrants.** Evaluate existing peak period counts to determine the need for additional count data. If these counts do not meet a warrant, obtaining 12- or 24-hour count information is likely unnecessary. In some cases, the project may alter traffic patterns at an existing signal enough that it may no longer meet a warrant. See the MUTCD for a list of the traffic signal warrants and information on how to apply them.

  For new intersections, project hourly volumes, and movements using established methodology; see Chapter 320.

  If signal warrants are met, evaluate multi-way stop, roundabout, and signal. If warrants are not met, evaluate yield, two-way stop, multi-way stop, and roundabout. Please note, the evaluation of a roundabout option is always required by resolution of the Multimodal Safety Executive Committee (MSEC). This evaluation requirement is based on the measured performance benefits of roundabouts.
  For more information about the benefits of roundabouts see:
  http://www.wsdot.wa.gov/Safety/roundabouts/benefits.htm.

  Alternative configurations are encouraged for consideration, especially if standard forms of control do not satisfy the performance needs identified.

- **Determine environmental impacts.** Evaluate the impacts and permit requirements of each intersection control option (see the *Environmental Manual*). Any environmental risks that may substantially increase the cost of the project should be identified early in the process. Risk impacts to each alternative should be quantified for comparison.

- **Identify modal treatments.** In some locations, given the modal priority and modal performance needs identified, it may be necessary to evaluate specific modal treatments applicable to the various intersection control types in the analysis. Understand common movements or travel patterns for the modes or future patterns assumed for the redesign. The objective is to provide visible, distinct, predictable and clear travel paths for the various modes, and understand the operational effect for all design users to meet these needs. See chapters 1430, 1510, 1515, and 1520 for additional information. The type and extent of multimodal treatments varies for each control type. Some control types require less additional multimodal treatments to meet multimodal performance needs depending on the configuration and use of the intersection. The extent to which treatments are applied to meet modal operational performance needs may have a significant influence on the control type selected at a location.

- **Analyze alternatives and document the selection.** In addition to documenting the screening process for selecting the alternatives to be analyzed, the Intersection Control Analysis should include the following information: existing conditions, delay analysis, operational considerations, including a crash risk analysis if appropriate (see Chapter 321), Benefit/Cost Analysis, Bicycle and Pedestrian Facilities, Context-Specific/Sustainable Design, and any Additional Information that is relevant. ***The***

single-lane roundabout is the preferred alternative. If selected, no comparison with other alternatives is required.

1300.05(1)(a) Existing Conditions

The description should include, physical characteristics of the site, posted speed, traffic counts (Tuesday through Thursday average and peak hour manual counts), available sight distance(s), channelization, mulitmodal facilities, and modal priority.

Analyze the crash history and use current diagnostic tools described in Chapter 321 to determine the expected and predicted crash rates are used to figure excess crashes for intersection performance in sustainable safety. Identify any conflict movements.

1300.05(1)(b) Delay Analysis

Since two or more traffic streams cross, converge, or diverge at intersections, the capacity of an intersection is normally less than the roadway between intersections. (See Chapter 320 for additional details about traffic analysis.)

Provide a sketch of the intersection used for modeling. Include recommendations for channelization, turn lanes, multimodal treatments, as well as acceleration and deceleration lanes for the preferred option for each intersection. Turn prohibitions may be used to increase intersection capacity or enhance the performance of a specific mode (such as eliminating motorized vehicle turns to enhance safety performance for bicyclists). Analyze all relevant peak periods (with A.M. and P.M. as a minimum) for all intersection control alternatives. Holidays and special or seasonal events of short duration are generally not considered in the level of service (LOS) determination, although there are situations where a minor leg peak hour determines the hour used in analysis. Evaluating the 24-hour volumes may be necessary to maximize capacity and support the choice of intersection control that performs with the least overall delay.

Include the following in the delay analysis:

- Use the project's selected design year for analysis (see Chapter 1103). In some situations, it may also be appropriate to analyze the horizon year as well.
- Identify and justify any growth rate used for design year analyses.
- Provide turning-movement volumes for all scenarios.
- Discuss the steps taken to arrive at the peak hour volume determination and how it relates to design hourly volume (DHV).

There are several deterministic and microsimulation programs for analyzing delay and intersection performance. Traffic volumes and the proximity of the project to other access points will dictate the modeling effort required. Contact the region Traffic Office to determine the appropriate approved program. With each analysis iteration, account for agreement between the proposed intersection design and what is modeled. For example, in modeling signals, a free right turn affects timings and also removes those vehicles from consideration in warrant analysis.

1. Two-Way Stop Control

When the through roadway average daily traffic is 3,500 or less, delay analysis is not required except in cases where the higher-volume roadway is controlled or where channelization is proposed. This is because adequate LOS for channelization projects does not always correlate to operational safety.

2. Multi-Way Stop Control

Analyze according to the guidance provided in the MUTCD.

3. Roundabouts

Provide a capacity analysis to estimate the entry capacity of each roundabout entry leg. Innovative capacity analysis is occasionally needed on projects where metering a heavy leg for short periods of the day allows the most efficient operation 24 hours a day. Contact the region Traffic Office for the specific calibration information to use.

4. Signals

When modeling signals, consider the phasing design criteria contained in Chapter 1330. This may be guided by available opposing left-turn clearances at an intersection. Also, evaluate pedestrian movements and accommodate them in the proposed cycle lengths. Check the modeled signal phasing and timing for its ability to be programmed into the signal controller.

Progression of main line traffic is one reason given for using traffic signals; however, there are several reasons why progression may not realistically be obtained or sustained. Signal spacing, left-turn movements, speed, volume (particularly side street volume), and pedestrian movements can all affect the ability to achieve progression.

Consult the region Traffic Office for information on current signal operations practices. (See Chapter 1310 for additional guidance on turn lane considerations.)

5. Alternative Intersections

Operational considerations for modeling depend on the intersection design in question. They may include the LOS for turning movements, weaving requirements, the need for vehicle storage, acceleration lanes, and the LOS at the merge points. The analyst and reviewer should agree on what measures of effectiveness will be used in addition to the performance metrics chosen for the project (see Chapter 1101).

1300.05(1)(c) Operational Considerations

The transportation network has a mix of intersection controls. Traditional delay analysis focuses on determining the peak-hour letter-graded LOS of an individual intersection. Operational analysis is a more encompassing review of the ability of the intersection to provide sufficient multimodal capacity and safety performance in the network, and includes consideration of the environment that users will encounter at all hours of the day.

Intersection control has an influence on approaches, other intersections, and multimodal operations, even at acceptable LOS. Increased delay affects route choice. A driver's willingness to accept delay depends on the current circumstances and the driver's knowledge of the transportation network. The arrival of in-vehicle guidance systems will only increase the tendency of drivers to seek out routes with shorter travel times. Thus, it is important to consider the effects of intersection control on the surrounding network. Document the existing and proposed design. Points that may need to be addressed include the following:

- Use access management alternatives such as rerouting traffic to an existing intersection with available capacity. Check with the WSDOT region Planning Office for future land use plans or comprehensive plans to provide for future growth accommodation. Discuss options and strategies that have been developed through a collaborative planning process with the local agency or, where appropriate, the regional or metropolitan transportation planning organization.
- Consider the volume to capacity (V/C) ratio, the delay, and the queue length of the legs. Roundabout V/C ratios above 0.92 may require additional sensitivity analysis to determine the impacts of small changes in volume and propose solutions. Discuss the results of the capacity analysis and the lanes necessary for each leg of the intersection.
- Compare the geometry/number of lanes required by different alternatives to achieve similar results.
- Consider the effect on other travel modes: rail, bus, pedestrian, and bicycle.
- Examine the effects of existing conditions. Discuss progression through nearby intersections (corridor and network analysis) and known risky or illegal driving maneuvers. Work with the region Traffic Office to verify the network area of influence.
- Determine how the proposed control will meet the objectives for intersection control (see 1300.04) at all hours compared to other alternatives. This is particularly applicable when only the peak hour warrant is met for a signal, since it is used only in rare cases.
- Consider the possibility that traffic from other intersections with lower levels of service will divert to the new/revised intersection.
- Compare the predicted crash frequency of the alternatives using the tools described in Chapter 321. Discuss how each proposed solution might affect safety performance and crash types.
- Identify the intersection design vehicle (see Chapter 1103). Include truck types and sizes (including oversized vehicles) that travel through the area both currently and consider future users. Include verification of turning movements based on turn simulation software (such as AutoTURN®).
- Examine queue lengths in areas where there are intersections or approaches in close proximity. When other intersections are affected, if needed, use a calibrated simulation to fully evaluate the operational effects of the proposed traffic control on the system.
- Evaluate sight distances (stopping, intersection, decision) for the proposed designs prior to selection of an alternative.

1300.05(1)(d) Benefit/Cost Analysis

Benefit/cost analysis compares the value of benefits against costs. There is considerable debate on what can and should be included in this analysis, particularly in the area of environmental and societal benefits and costs. Generally, and in keeping with the objectives of intersection control, the only societal costs/benefits WSDOT evaluates are those due to crashes and delay. Include the following in the analysis:

- Project costs related to design, right of way, and construction.
- Annual maintenance cost differences between the options. For signals, this also includes the cost to review the signal timings in accordance with current signal operations guidelines. This value can be obtained from the region Traffic Office.
- 24-hour travel time savings. Workbook and annual information can be found at: www.wsdot.wa.gov/mapsdata/travel/mobility.htm
- A predictive method to compare societal benefits or costs calculated from the change in crash severity and/or frequency using the tools described in Chapter 321.
- Salvage value of right of way, grading and drainage, and structures.

While WSDOT benefit/cost analysis at intersections is restricted to only evaluate the mobility benefit for motorized vehicles in terms of delay, an intersection design that does not meet the identified performance trade-off balance (see Chapter 1104) on the project's Basis of Design (see Chapter 1100) will not be justified.

1300.05(1)(e) Context Sensitive/Sustainable Design

Context sensitive design is a model for transportation project development. A proposed transportation project is to be planned not only for its physical aspects as a facility serving specific transportation objectives, but also for its effects on the aesthetic, social, economic, and environmental values, needs, constraints, and opportunities in a larger community setting. Projects designed using this model:

- Optimize safety of the facility for both the user and the community.
- Promote multimodal solutions.
- Are in harmony with the community, and preserve the environmental, scenic, aesthetic, historic, and natural resource values of the area.
- Are designed and built with minimal disruption to the community.
- Involve efficient and effective use of the resources (time, budget, community) of all involved parties.

1300.05(1)(f) Additional Information

Discuss the following in the intersection analysis as needed to further support the selection (is it an item that will have a significant effect on the decision?):

- Information from the Route Development Plan or other approved corridor study.
- Review the corridor sketch plans and database with the regional planning office.
- Environmental permitting restrictions, such as the ones in place in scenic areas and other locations with similar restrictions.
- Current and future land use and whether or not the intersection control will reasonably accommodate future land use traffic changes.
- Current/proposed speed limits (changes in speed limits can affect signal warrants).
- Public meeting comments.
- Outside agency coordination and comments.
- Medians, lane widths, and parking.
- Effect on future local agency projects.
- Other elements considered in the selection of the intersection control.

1300.05(2) Community Engagement

Community engagement is a necessary element of project development. Technical, public, and political aspects must be considered. There is often unwarranted concern from communities regarding certain control types that may be under consideration. Education and outreach efforts, if necessary, are collaborative and are most useful during the analysis and early design stages. It is critical that community engagement efforts occur with preparation and well organized content regarding the performance data associated with different control types to inform communities of the distinct advantages of different control types with respect to the context, modes, safety and operations desired. Use contextual performance needs (see Chapter 1101) identified by the community to help support the options being considered at a given location.

Follow the guidelines of WSDOT's *Community Engagement Plan* (www.wsdot.wa.gov/planning/), and document the effort as indicated in Chapter 1100.

1300.05(3) Approval

Refer to Chapter 300 for additional information on approval authorities. Approval of intersection control type (to be completed no later than the scoping phase) requires the following:

- Traffic Engineer's Stamp and Seal
- HQ Traffic Approval
- Region Approval

1300.05(4) Local Agency or Developer-Initiated Intersections

Chapter 320 provides guidance for preparation of a Traffic Impact Analysis (TIA). Early in the design process, local agencies and developers should coordinate with the region office to identify specific intersections for further analysis. The project initiator provides an Intersection Control Analysis (ICA) for approaches and intersections with state routes per 1300.05(1), or references this information in the TIA. The project initiator documents the design considerations and submits the ICA and all documentation to the region for approval (per 1300.05(1)). After the ICA is approved, finalize the intersection design and obtain approval per Chapters 300 (for documentation), 1310 (for intersections), 1320 (for roundabouts), and 1330 (for traffic signals).

State highway intersections in local agency projects are subject to the requirements of this chapter.

1300.06 Documentation

Refer to Chapter 300 for design documentation requirements.

1300.07 References

1300.07(1) Federal/State Laws, Codes, and Policies

Revised Code of Washington (RCW) 46.61, Rules of the road

Washington Administrative Code (WAC) 468-52, Highway access management – access control classification system and standards

Intersection Control/Modification Process, Highway Safety Executive Committee (HSEC) Policy Paper, April 2012, WSDOT

Secretary's Executive Order: E 1082, Business Practices for Moving Washington, August 2012, WSDOT

1300.07(2) Design Guidance

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

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

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

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)

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

1300.07(3) Supporting Information

Highway Safety Manual (HSM), AASHTO

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

Roundabouts: An Informational Guide, Second Edition, NCHRP Report 672, Transportation Research Board, 2010

A Review of the Signalized Intersections: Informational Guide. FHWA-HRT-04-092, USDOT, FHWA, APRIL 2004
www.fhwa.dot.gov/publications/research/safety/04092/

Choosing Intersection Control, IMSA Journal, Buckholz, Nov/Dec 2002.
www.imsasafety.org/journal/nd02/buckholz.pdf

Safety Effectiveness of Highway Design Features, Volume V: Intersections, Kuciemba, S. R., and J. A. Cirillo. Report No. FHWA-RD-91-048, Federal Highway Administration, November 1992.

A Comparison of a Roundabout to Two-way Stop Controlled Intersections with Low and High Traffic Volumes, Luttrell, Greg, Eugene R. Russell, and Margaret Rys, Kansas State University

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 5: A Guide for Addressing Unsignalized Intersection Collisions, NCHRP Report 500, Transportation Research Board, 2003
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v5.pdf

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan Volume 12: A Guide for Reducing Collisions at Signalized Intersections, NCHRP Report 500, Transportation Research Board, 2004
http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v12.pdf

Synthesis of the Median U-Turn Intersection Treatment, Safety, and Operational Benefits, FHWA-HRT-07-033, USDOT, FHWA

Alternative Intersections/Interchanges: Informational Report (AIIR), FHWA-HRT-09-060, Hughes et al., USDOT, FHWA, 2010

Field Evaluation of a Restricted Crossing U-Turn Intersection, FHWA-HRT-12-037, USDOT, FHWA

Roundabouts and Sustainable Design, Ariniello et al., Green Streets and Highways – ASCE, 2011

Pedestrian and Bicycle Information Center
www.pedbikeinfo.org/

Community Engagement Plan, WSDOT
www.wsdot.wa.gov/planning/