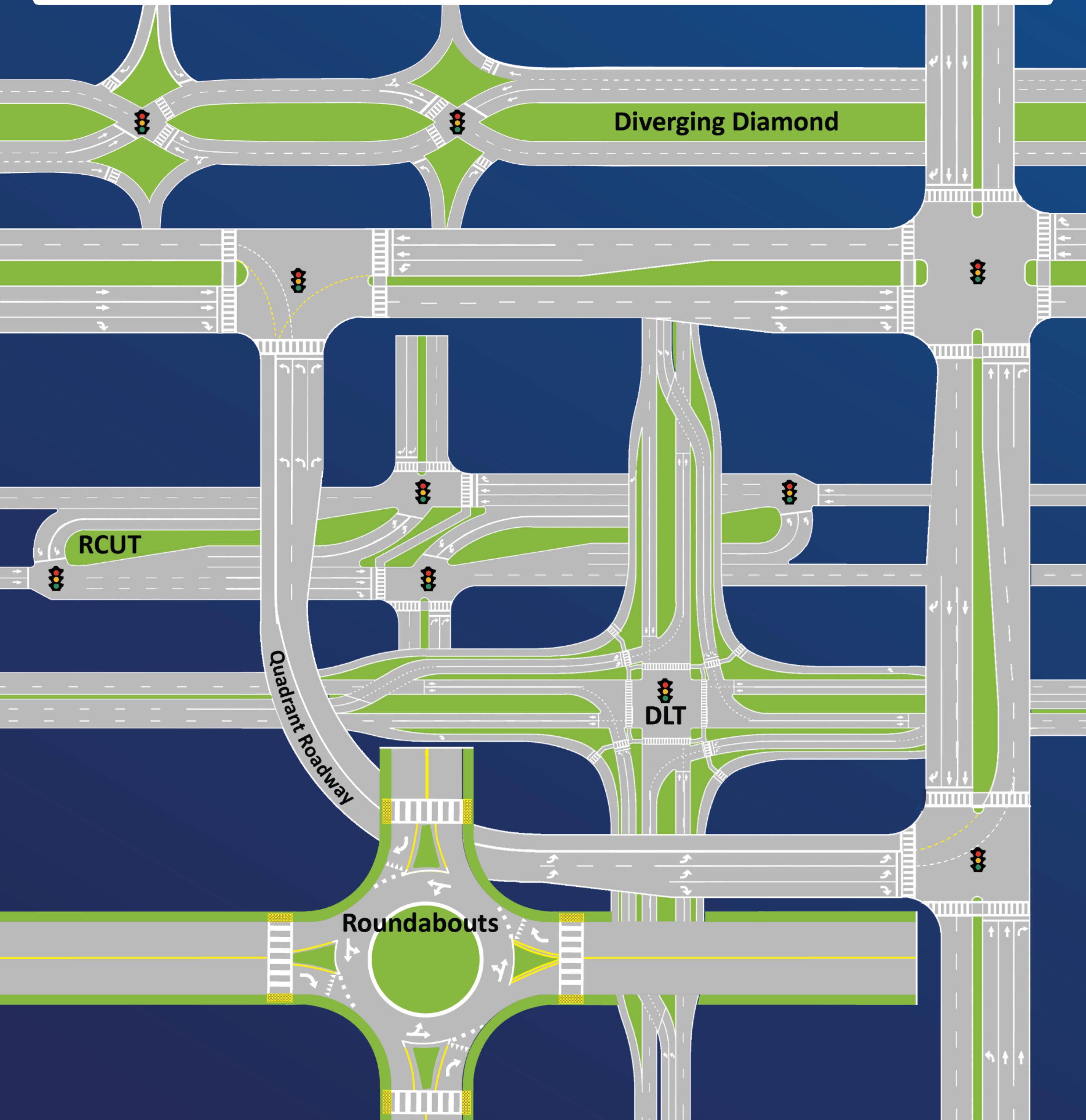
Manual on Intersection Control Evaluation

January 2024



MANUAL ON
INTERSECTION CONTROL EVALUATION

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LIST OF ACRONYMS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
CAP-X	Capacity Analysis for Planning of Junctions
CF	Calibration Factor
CMF	Crash Modification Factor
DDE	District Design Engineer
DDI	Diverging Diamond Interchange
DLT	Displaced Left Turn
DTOE	District Traffic Operations Engineer
FDM	FDOT Design Manual
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FI	Fatal and Injury
HCM	Highway Capacity Manual
HSM	Highway Safety Manual
ICE	Intersection Control Evaluation
LOS	Level of Service
LTS	Level of Traffic Stress
MUT	Median U-Turn
MUTCD	Manual on Uniform Traffic Control Devices
NASEM	National Academies of Sciences, Engineering, and Medicine
NCHRP	National Cooperative Highway Research Program
PD&E	Project Development and Environment
PE	Professional Engineer
PER	Preliminary Engineering Report
PTAR	Project Traffic Analysis Report
QR	Quadrant Roadway
RCUT	Restricted Crossing U-Turn
RRR	Resurfacing, Restoration, and Rehabilitation
SHS	State Highway System
SPICE	Safety Performance for Intersection Control Evaluations
SSI	Safe System for Intersections
TRB	Transportation Research Board

CHAPTER 1
ADOPTION PROCEDURE

1.1 Purpose

The Manual on Intersection Control Evaluation (ICE) sets forth procedures, standards, and guidelines for evaluating intersection control strategies on the State Highway System (SHS).

1.2 Authority

Sections 20.23(3)(a), 334.048(3), Florida Statutes.

1.3 References

Chapter 316, F.S.; Rule 14-15.010 of the Florida Administrative Code; Manual on Uniform Traffic Control Devices (MUTCD).

1.4 Scope

The ICE Manual affects the following Florida Department of Transportation (FDOT) Offices and consultants at the state and district level: Traffic Engineering and Operations, Safety, Roadway Design, Environmental Management, Access Management, Program Management, and Permitting.

1.5 Distribution

This document is available electronically on the State Traffic Engineering and Operations website: *www.fdot.gov/traffic/TrafficServices/intersection-operations.shtm*

1.6 Registration

Practitioners interested in receiving automatic notifications of ICE Manual revisions by e-mail can subscribe to the FDOT Contact Management Database at: *https://fdotewp1.dot.state.fl.us/ContactManagement*.

As required by Section 283.55, Florida Statutes, by March 1st of each odd-numbered year, we will survey e-mail addresses from our current registration list and purge any outdated registrations.

1.7 Revisions

The State Traffic Operations Engineer/Director of the State Traffic Engineering and Operations Office, the District Traffic Operations Engineers (DTOEs), and the State Roadway Design Engineer/Director of the Roadway Design Office constitute the Manual Review Committee.

Items warranting immediate change can be made with the approval of the Director of the State Traffic Engineering and Operations Office after a majority vote of the Manual Review Committee and consultation with any other affected parties. In all other cases, any additions or changes either necessary or recommended need to be discussed in statewide meetings of DTOEs held every six months.

Substantive revisions or policy-related issues, as determined by the Manual Review Committee, will be reviewed for approval by the Chief Engineer.

The approved revisions are posted on the State Traffic Engineering and Operations Office website: *www.fdot.gov/traffic/TrafficServices/intersection-operations.shtm*. An e-mail notification is sent to all registered users about the revisions.

1.8 Training

Training has been previously provided by the FDOT Traffic Engineering and Operations – Central Office. New Computer-Based Training (CBT) is under development and will be available in 2024.

1.9 Forms Access

The FDOT ICE Form (Form No. 750-010-30) is available in the FDOT Procedural Document Library (*https://pdl.fdot.gov*) and the State Traffic Engineering and Operations Office website (*www.fdot.gov/traffic/trafficservices/intersection-operations.shtm*).

CHAPTER 2
INTERSECTION CONTROL EVALUATION

2.1 Background and Purpose

Intersections play an essential role in the roadway network as they offer connections to different routes and facilities while providing necessary access to adjacent residential, commercial, and industrial developments. Intersections comprise a small portion of total road system mileage, but they account for a high percentage of fatal and serious injury crashes. Nationally, Florida ranks as the #1 state in the country with the most intersection and intersection-related traffic fatalities. In 2021, approximately 35% of all traffic fatalities in Florida occurred from intersection-related crashes (National Highway Traffic Safety Administration, 2023). Intersection safety is one of the 12 emphasis areas identified in the FDOT's 2021 Strategic Highway Safety Plan.

Common solutions to intersection challenges typically involve stop-control, conventional signal control, or diamond interchanges. Many of the performance metrics used to select between these common solutions focus on the vehicular movement through the intersection. In recent years, a number of new or innovative intersection designs—including roundabouts, crossover-based designs, and U-turn-based designs—have been introduced across the United States to enhance intersection safety and mobility for all road users. The ICE procedure promotes thoughtful consideration of the innovative intersections to the conventional intersection.

FDOT has developed the ICE procedure for a range of activities to support objective evaluations of intersection control types or control strategies. The flexible and adaptable procedure guides practitioners to conduct an ICE using quantitative analysis. The goal of ICE is to better inform the FDOT's decision-making to identify and select an intersection control strategy meeting the project's purpose and need, fitting the intersection location's context classification, providing efficient and safe travel facilities for all road users, and reflecting the overall best value. FDOT's ICE procedure is a key component of its complete streets program.

2.2 Applicability

An ICE is required for intersections on the SHS when any of the following applies:

(a) New intersection signalization is proposed (i.e., any existing or new intersection is projected to meet signal warrants).
(b) Major reconstruction of an existing signalized intersection is proposed (e.g., adding a left-turn lane to an approach, adding an intersection leg, and converting to a roundabout).
(c) A change from a directional or bi-directional median opening to a full median opening is proposed.
(d) The District Design Engineer (DDE) and the District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project.
(e) A single connection to the SHS generates or is expected to generate more than 4,001 average daily traffic or more under E, F, and G standard connection categories (defined by average vehicle trips per day thresholds in Rule 14-96.004, F.A.C.) or a connection permit is proposed with the removal, installation, or modification of traffic signal or any of the above in (b) through (d).

An ICE is not required for the following applications:

(a) Signalization of a midblock pedestrian crosswalk.
(b) Work involved does not include any substantive proposed changes to an intersection (e.g., a project limited to only “mill and resurface” pavement with no change to intersection geometry or control; converting a two-way stop-controlled intersection to a four-way stop-controlled intersection; changing a full median opening to a directional median opening).
(c) Minor intersection operational improvements (e.g., adding right-turn lanes or changing signal phasing/timing) or signal replacement projects where the primary purpose is to upgrade deficient equipment and installations.

For service interchanges, an ICE is recommended for ramp terminal intersections. For example, if a diamond configuration is selected, an ICE can be used to consider and recommend a control strategy at the ramp terminal intersections, with options including stop control, signalized, or yield control (e.g., roundabouts). ICE can also be used to comparatively evaluate the ramp terminal intersection of different diamond interchange types such as signalized standard diamond, diverging diamond, and single point diamond. It should be noted that ICE does not replace FDOT’s Interchange Access Request process and procedure, which is required for all modifications at interchanges with limited access facilities. Please refer to the FDOT Interchange Access Request User’s Guide on this process.

FDOT encourages local agencies and counties to perform an ICE for projects they lead on locally maintained roadways, but ultimately it is the choice of the local jurisdiction.

2.3 Intersection Control Strategies

An ICE comparatively evaluates the safety and operational benefits of various intersection control strategies for both at-grade intersections and ramp terminal intersections. The at-grade intersection control strategies covered in the FDOT ICE procedure are listed below:

- Minor Road Stop Control
- All-Way Stop Control
- Signalized Control
- One-Lane Roundabout
- Two-Lane Roundabout
- Full Median U-Turn (MUT)
- Partial MUT
- Signalized Restricted Crossing U-turn (RCUT)
- Unsignalized RCUT
- Jughandle (Forward Ramps)
- Jughandle (Reverse Ramps)
- Full Displaced Left-Turn (DLT)
- Partial DLT
- Continuous Green T (CGT)
- Quadrant Roadway (QR)
- Signalized Thru-Cut
- Unsignalized Thru-Cut
- Bowtie

The second group of intersection control strategies are called ramp terminal intersections. These are the locations on the roadway where a freeway ramp connects to an arterial crossroad. The ICE procedure is only to comparatively evaluate various ramp terminal intersection forms for diamond and partial cloverleaf interchanges. It does not include safety or operations analysis of the ramps. The ramp terminal intersection control strategies covered in the FDOT ICE procedure are listed below:

- Diamond Signalized
- Diamond Signalized (Alt.)
- Diverging Diamond

- Single-Point Diamond
- Diamond Stop Control
- Signalized Tight Diamond
- One-Lane Roundabout
- Two-Lane Roundabout
- Half-Diamond Signalized
- Half-Diamond Stop Control
- Two-Quadrant Partial Cloverleaf A Signalized
- Two-Quadrant Partial Cloverleaf A Stop Control
- Four-Quadrant Partial Cloverleaf A Signalized
- Four-Quadrant Partial Cloverleaf A Stop Control
- Two-Quadrant Partial Cloverleaf B Signalized
- Two-Quadrant Partial Cloverleaf B Stop Control
- Four-Quadrant Partial Cloverleaf B Signalized
- Four-Quadrant Partial Cloverleaf B Stop Control

A short description of each intersection control strategy can be found in ***Appendix A***.

2.4 Conducting an ICE

Conducting an ICE requires three important elements to be initially addressed. These are: (1) project purpose and need, (2) design year, and (3) study area. Each element is addressed below.

- **Project Purpose and Need.** Projects may be initiated for a variety of reasons. Traffic operations, safety, multimodal access, land access, and placemaking are examples of potential project needs. The project's purpose and need and the project location's context classification guide the selection of a control strategy.
- **Design Year.** An ICE is to be completed for the existing year (year of data collection), the opening year, and the design year. The design year is 10 years for operation improvement projects such as signalization; resurfacing, restoration, and rehabilitation (RRR); and safety or operational improvements. The design year is 20 years for projects that add capacity with new construction or reconstruction. Further information is provided in Section 201.3 of the 2024 FDOT Design Manual (FDM). For interchange access requests, additional analysis years may be requested. The DTOE or the DDE may require the analysis to be done for an additional design year further into the future. The development of design year traffic volumes should follow the *2019 FDOT Project Traffic Forecasting Handbook* and the

guidance given in Section 2.7 – Project Traffic Demand Forecasting of the *2021 FDOT Traffic Analysis Handbook*.

- **Study Area.** ICE is focused on an isolated intersection. An ICE can be conducted for a group of intersections in a corridor given the intersections are independent of and uncoordinated with each other. However, evaluations may need to be expanded beyond the study intersections using some other tools for any of the following situations:
    - Queue spillback is anticipated to impact the operations of adjacent intersections or freeway mainline (for ramp terminal intersections).
    - Modifications are to be made to an intersection within a coordinated signal system.
    - Modifications are to be made to intersections that do not operate independently of each other.

Following the determination of project purpose and need, the ICE procedure entails activities in three stages. These are:

(1) Stage 1: Screening/Preliminary Analysis
(2) Stage 2: Detailed Analysis
(3) Stage 3: Supplemental Analysis

However, determining the most viable intersection control strategy may not require all three stages. Stage 2 analysis is required only if a single control strategy cannot be determined in Stage 1. Following Stage 2, Stage 3 analysis is required only if a single control strategy cannot be determined in Stage 2. The ICE Stages are discussed in detail in the next section.

An ICE shall be conducted under the supervision of a licensed Professional Engineer (PE) in the State of Florida. At the completion of analysis in each stage, the appropriate FDOT ICE Form (Form 750-010-30, with Stage 1 ICE Form for Stage 1 analysis, Stage 2 ICE Form for Stage 2 analysis, and Stage 3 ICE Form for Stage 3 analysis) with supporting documentation is required to be submitted to the DTOE and the DDE for all projects as outlined in Section 2.2. Supporting documentation shall be signed and sealed by the PE overseeing the evaluation. The breadth of supporting documentation appended to the form should be proportionate to the level of analysis required to identify the selected control strategy. Details of the FDOT ICE Forms can be found in ***Appendix B***.

The party responsible for completing and submitting the ICE Forms and supporting analysis depends on project type, as follows:

- For FDOT projects, it is on the FDOT staff or their consultants to complete the ICE Form(s).
- For driveway connection permits on the SHS, the applicant or the engineer appointed by the party shall complete the ICE Form(s).

The ICE Form(s) for each stage shall be approved by the DTOE and the DDE. FDOT retains final approval authority for the ICE on the SHS.

2.5 ICE Stages

2.5.1 Stage 1: Screening/Preliminary Analysis

Stage 1 is conducted during a project's initial stage. The purpose of Stage 1 is to screen a number of potential control strategies and identify a single preferred control strategy or, if not possible, only a few viable control strategies narrowed down from the initial consideration based on preliminary analysis of traffic operations, safety, and other related factors. However, a single control strategy may not always be found at the end of Stage 1 analysis. In this case, it is expected to narrow down the control strategies to fewer viable alternatives from the initial consideration.

For Project Development and Environment (PD&E) studies, the Stage 1 ICE can serve as the initial screening of potential alternative intersection strategies as part of PD&E's Alternatives Analysis process and should be completed with the Project Traffic Analysis Report (PTAR). The ICE analysis required in a PD&E study will vary based on the level of engineering analysis needed for the PD&E phase and early coordination with the DTOE and the DDE. At a minimum, the Stage 1 ICE analysis shall be performed during a PD&E study; and based on the Stage 1 ICE results, alternatives will be developed, and analysis results will be documented.

For Driveway connection permit applications, the applicant-appointed engineers and FDOT staff should determine at the pre-application meeting or at a district's access management review committee meeting which viable control strategies the applicant should assess. The completed Stage 1 ICE Form is provided by the applicant's engineers at the pre-application meeting to facilitate this discussion.

2.5.1.1 Stage 1 Analysis Tools

The analysis in Stage 1 requires using two tools, including:

(1) Capacity Analysis for Planning of Junctions (CAP-X) Tool, and
(2) Safety Performance for Intersection Control Evaluation (SPICE) Tool

The tools are described below.

CAP-X Tool

CAP-X is a macro-based Microsoft Excel spreadsheet tool, originally developed by Federal Highway Administration (FHWA), to evaluate the anticipated operational performance of intersection control strategies. The CAP-X Tool uses a critical lane volume analysis to determine the volume to capacity ratio for a variety of intersection control strategies using the Highway Capacity Manual (HCM) methodologies (Transportation Research Board (TRB), 2016). FDOT has expanded this tool for use in Florida to include an enhanced evaluation for pedestrian and bicycle accommodations at intersections. Based on the input parameters, CAP-X generates a list of intersection strategies, ranked by volume to capacity ratio and given pedestrian and bicycle accommodation score. Analysts can choose to directly use turning volumes as input into the spreadsheet or grow the volumes based on a user specified volume growth percentage. Details can be found in the FHWA publication, *Capacity Analysis for Planning of Junctions (CAP-X) Tool User Manual* (Jenior et al., 2018a). ***Appendix C*** details the pedestrian and bicycle evaluations in CAP-X.

SPICE Tool

SPICE is another macro-based Microsoft Excel spreadsheet tool, originally developed by FHWA, for safety analysis based on crash predictions (Jenior et al., 2018b). The FDOT SPICE tool is an expanded version of the original tool, which includes two complimentary approaches to safety analysis:

(1) Crash prediction method
(2) Safe System for Intersections (SSI) method

Crash Prediction Method in the FDOT SPICE Tool

Crash predictions in the FDOT SPICE Tool are primarily based on the predictive method presented in the Highway Safety Manual (HSM) Part C that entails the use of Safety Performance Functions (SPFs), Crash Modifications Factors (CMFs), and Calibration Factors (CFs) (American Association of State Highway and Transportation Officials (AASHTO), 2010). FDOT has developed CFs to account for Florida conditions for several intersection control strategies, particularly those that are available in the HSM first edition published in 2010. However, CF is not available for all the intersection control strategies that are in the FDOT SPICE Tool. In these case, CF is assumed to be equal to 1.0 (i.e., uncalibrated). Below is a list of SPFs, CMFs, and CFs used in the FDOT SPICE Tool:

- HSM SPFs and CMFs for at-grade intersections, including three-leg and four-leg minor-road stop-control intersections on rural two-lane two-way roads, rural multilane highways, and urban and suburban arterials; four-leg signalized intersections on rural two-lane two-way roads, rural multilane highways, and urban and suburban arterials; and three-leg signalized intersections on urban and suburban arterials (AASHTO, 2010). All these SPFs and CMFs are calibrated to Florida conditions (see FDM Section 122.6.3), and those CFs are used in the FDOT SPICE Tool.
- HSM SPFs and CMFs for ramp terminal intersections, including three-leg and four-leg diamond (signalized and stop-control), Partial Cloverleaf A, and Partial Cloverleaf B (AASHTO, 2014). These SPFs are not calibrated to Florida conditions.
- SPFs and CMFs developed in the National Cooperative Highway Research Program (NCHRP) Project 17-70 for roundabouts (National Academies of Sciences, Engineering, and Medicine (NASEM), 2019). These SPFs are not calibrated to Florida Conditions.
- SPFs and CMFs for signalized and unsignalized RCUTs developed by FDOT (Ozguven et al., 2019). However, the SPFs are not calibrated to Florida conditions.
- SPFs and CMFs developed in the NCHRP Project 17-68 for at-grade and ramp terminal intersections not in the HSM 1st edition, including all-way stop-control intersections on rural roads and urban and suburban arterials; intersections (three-leg and four-leg minor road stop control and signalized) on high-speed urban and suburban arterials (i.e., major road approaches having speed limit ≥ 50 mph); three-leg signalized intersections on rural two-lane and rural multilane highways; urban four-leg signalized tight-diamond ramp terminal intersections; and urban single-point diamond ramp terminal intersections (NASEM, 2021a). None of the SPFs and CMFs are calibrated to Florida conditions.
- SPFs and CMFs developed in the National Cooperative Highway Research Program (NCHRP) Project 17-58 for intersections on urban and suburban six- and eight-lane roadways and one-way streets (NASEM, 2022). These SPFs are not calibrated to Florida conditions.

On the other hand, due to lack of available SPFs at this time, the crash prediction of some intersection control strategies in the FDOT SPICE Tool is based on the CMFs that indicate the safety performance of the conversion to the specific intersection control type from a base control type (see **Table 2-1**).

Stage 1 crash predictions in the FDOT SPICE Tool allows the user to compare the safety performance of multiple control strategies based on only a few primary variables, including Annual Average Daily Traffic (AADT), rural or urban facility type, posted speed limit, and the number of lanes. In Stage 1, the user may use preselected standard values for the CMFs since concepts have not been prepared.

SSI Method in the FDOT SPICE Tool

The SSI method provides a technical basis by which intersection planners and designers can apply Safe System-based principles, such as kinetic energy management and simplified decision-making for different road users, to common intersection projects. The SSI method incorporates concepts of conflict point identification and classification, exposure, kinetic energy transfer, conflict point severity, and intersection movement complexity. Application of the SSI method results in multiple measures of effectiveness (MOEs) and a set of SSI scores that characterize the extent to which an intersection alternative in a given context aligns with the principles of the Safe System-based approach.

Table 2-1. Alternative Intersection Crash Modification Factors

Intersection Control Strategy	Crash Modification Factors (CMFs)	Apply CMF to:	Data Source
Displaced Left Turn	Total: 0.88 FI: 0.88	Crash prediction for a conventional signalized intersection	Zlatkovic (2015)
Median U-Turn	Total: 0.63 FI: 0.77	Crash prediction for a conventional signalized intersection	Gluck et al. (1999)
Continuous Green T	Total: 0.96 FI: 0.85	Crash prediction for a conventional signalized intersection	Donnell et al. (2016)
Jughandle	Total: NA FI: 0.74	Crash prediction for a conventional signalized intersection	Jagannathan (2007)
Diverging Diamond Interchange Ramp Terminal	Based on posted speed limit, Total: 0.23 – 1.03 FI: 0.23 – 0.80	Crash prediction for a signalized ramp terminal intersection	NASEM, 2021b

Note: FI indicates Fatal and Injury crashes.

The SSI MOEs and SSI scores can also provide safety metrics for intersection forms where SPFs or CMFs are not available. The SSI method may also be valuable in cases where it is not possible to conduct crash prediction-based analyses on one or more alternatives, such as for atypical or emerging intersection concepts that are not addressed by crash prediction-based methods. In the FDOT SPICE Tool, the safety analysis for thru-cut (signalized and unsignalized) and bowtie intersections can only be done using the SSI method.

The calculations in the SSI method are based on several assumptions for each at-grade and ramp terminal intersection type. The assumptions are provided in ***Appendix D***. Details of the SSI method can be found in FHWA Report, *A Safe System-Based Framework and Analytical Methodology for Assessing Intersections* (Porter et al., 2021).

2.5.1.2 Stage 1 Steps

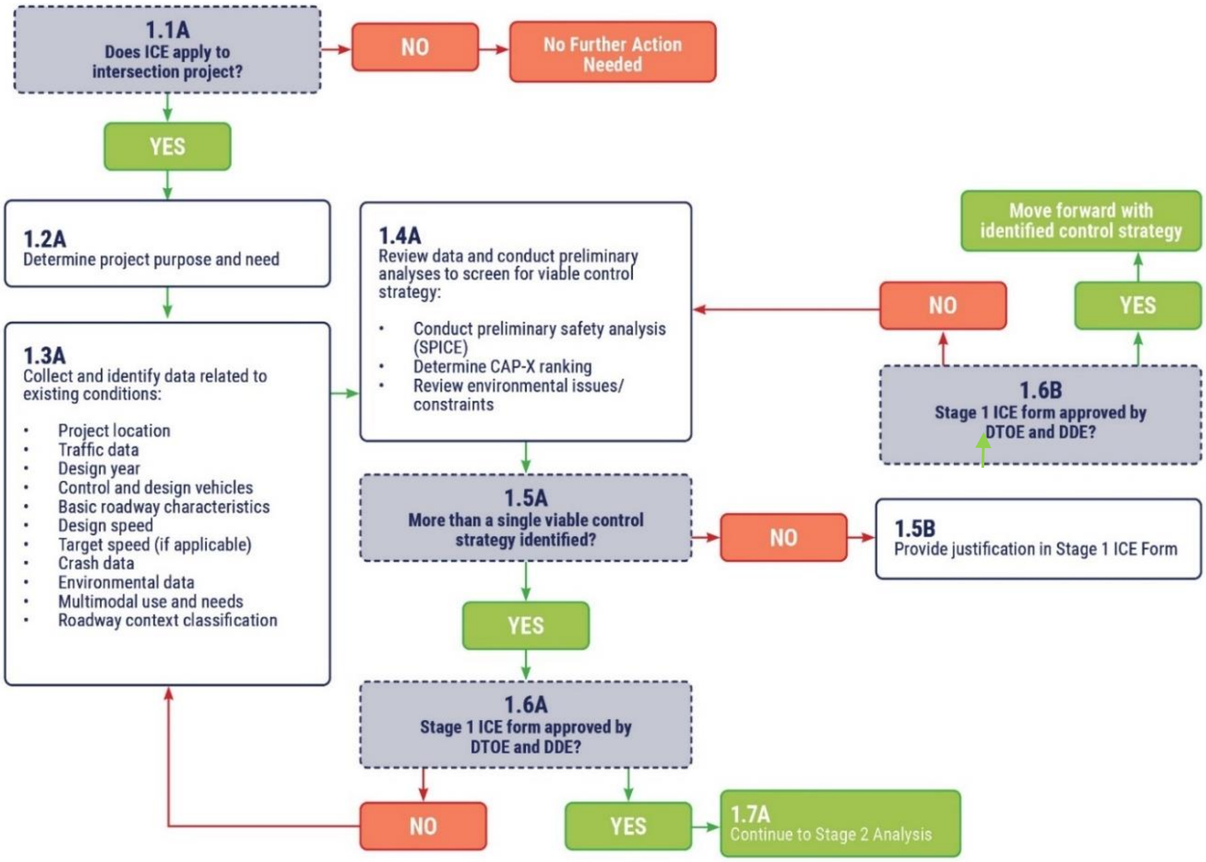
Figure 2-1 illustrates the flowchart of stepwise activities involved in Stage 1. Each step in Stage 1 is discussed below.

Step 1.1A: Does the intersection require an ICE? It refers to determining whether an ICE is required for the study intersection based on the criteria established in the Applicability section (Section 2.2) of this document.

Step 1.2A: Determine project purpose and need. Determine the purpose and need for the project.

Step 1.3A: Collect data on existing conditions. Collect certain minimum information about the existing conditions. This includes the project location, traffic data (including peak hour data), basic roadway characteristics, control and design vehicles, design and target speeds, crash data, environmental data, multimodal use(s), and roadway context classifications. Refer to the Stage 1 Analysis Tools, FDOT ICE Forms, FDOT Project Traffic Forecasting Handbook, and FDOT Traffic Analysis Handbook for specific data requirements. Make a preliminary determination whether there are any environmental or right-of-way factors that may preclude a control strategy from selection. Identify whether the project is federally or non-federally funded.

Figure 2-1. Flowchart of ICE Stage 1 Steps



Step 1.4A: Review data and conduct preliminary analyses to screen for viable control strategies. Conduct operational analysis and pedestrian and bicycle evaluations using CAP-X Tool. Input CAP-X rankings obtained from the CAP-X analysis spreadsheet. Conduct preliminary safety analysis of alternatives for crash prediction using the SPICE Tool and input crash prediction-based rankings into the Stage 1 ICE Form. Also, conduct SSI analysis of alternatives using the SPICE Tool and input SSI-based rankings into the Stage 1 ICE Form. Review environmental issues or constraints. Refer to ***Appendix A*** to determine the viability of a control type. Apply engineering judgement in evaluating these aspects. The volume forecast should be prepared in accordance with the FDOT Project Traffic Forecasting Handbook and with Section 2.7 – Project Traffic Demand Forecasting of the FDOT Traffic Analysis Handbook.

Step 1.5A: More than a single viable control strategy identified? The PE overseeing the evaluation has discretion to determine whether multiple control strategies are still viable based on the screening or preliminary analysis results. It is suggested to coordinate efforts and results with District's Traffic Operations Office and Design Office staff throughout the evaluation to ensure acceptance of the results and conclusions.

Step 1.5B: Provide justification in Stage 1 ICE Form. If a preferred intersection control strategy is identified through preliminary analyses, include the justification in the completed Stage 1 ICE Form. Submit the Stage 1 ICE Form to the DTOE and the DDE for their concurrence and approval. Attach supporting documentation, including CAP-X and SPICE analysis spreadsheet output sheets and analysis data. Factors used for justification include the following:

- Existing safety and congestion issues
- Future anticipated traffic volumes
- Plans for the roadway based on an adopted corridor or PD&E study
- Pedestrian and bicycle usage and needs
- The spacing of nearby intersections or driveways and how they conform to adopted access management guidelines
- Area type (urban, suburban, or rural)
- Breakdown and percentage of types of vehicles
- Design vehicle accommodation
- Sight distance
- Available right of way
- Adjacent environment and land uses (existing and proposed)
- Environmental constraints
- Community goals and objectives
- Support of the local users, local agencies, and local government

Step 1.6A: Stage 1 ICE Form approved by the DTOE and the DDE? This step follows Step 1.5A, i.e., when more than one viable control strategy is identified. If the Stage 1 ICE Form is approved with more than one control strategy for further analysis, prepare the proposed control strategies for Stage 2: Control Strategy Assessment. If the Stage 1 ICE Form is not approved, the DTOE or the DDE may require additional data collection to help identify viable control strategies (return to Step 1.3A).

Step 1.6B: Stage 1 ICE Form approved by the DTOE and the DDE? This Step follows Step 1.5B. If the Stage 1 ICE Form that justifies the selection of a single control strategy is approved by the DTOE and the DDE, proceed to preliminary design for the selected control strategy. If the Stage 1 ICE Form is not approved and the DTOE or the DDE may require additional analysis to determine appropriate viable control strategies, return to Step 1.4A to reconsider the factors involved in Stage 1 analysis and follow the same steps therefrom.

Step 1.7A: Continue to Stage 2 Analysis. If a preferred control strategy is not identified in Stage 1, conduct a more detailed analysis of the remaining control strategies in Stage 2: Control Strategy Assessment.

2.5.2 Stage 2: Detailed Analysis

Stage 2 initiates with the concept development for all potential control strategies selected at the end of Stage 1. These conceptual designs are essential for communicating control strategy concepts to the public and evaluating factors, such as safety, cost, right-of-way impacts, and environmental impact on a site-specific basis. Evaluation of other factors, such as design users, target speed, community preferences, consistency with future land use, roadway's context classification, and transportation plans (see ***Appendix E***) for the surrounding area, should also be done with outreach to local agencies and the public. Stage 2 is typically completed immediately following the project's initial study portion or as part of the project's alternatives and comparative evaluation.

If a PD&E study's level of detail includes a final design component, the Stage 2 evaluation will be incorporated into the PD&E's alternative evaluation process. Traffic operational analysis of the alternative control strategies should be based upon the project's design year traffic volumes and incorporated into the PD&E's PTAR and summarized in the Preliminary Engineering Report (PER). The life cycle safety analysis results from SPICE, including both the crash predictions and the SSI metrics, should also be summarized in the PER. If the project is a combined PD&E and Design project or programmed as a Design-Build project, then full Stage 2 ICE procedures will need to be followed including the DTOE and the DDE approval of the Stage 2 ICE Form.

When an approved PD&E study proceeds to design, then full Stage 2 ICE procedures will need to be followed including the DTOE and the DDE approval of the Stage 2 ICE Form for any impacted intersection meeting the ICE applicability guidance.

2.5.2.1 Stage 2 Analysis Tools

The analysis in Stage 2 may require using the following tools, including:

- FDOT SPICE Tool,
- FDOT ICE Tool, and

- Traffic simulation software (e.g., SYNCHRO, SIDRA).

FDOT SPICE Tool for Stage 2

The crash prediction capabilities of SPICE will be expanded in Stage 2. The CMFs for design elements which have some default values in Stage 1, will now have actual values primarily based on the conceptual design. Also in Stage 2, historical crash data shall be entered to allow application of the Empirical Bayes method in crash prediction. Revised opening and design year total and fatal-and-injury (FI) crash predictions are provided for each control strategy analyzed except for thru-cut and bowtie intersections which need to use the SSI score for the safety analysis. The SSI score does not change between Stages 1 and 2 unless analysts use different values for the input variables in Stage 2. Note that the SSI method is based on several assumptions for each intersection control strategy (see ***Appendix D***), which may not match the conceptual design prepared in Stage 2. Therefore, any variation between the conceptual design and the SSI Method's assumptions for intersection design, operations, or control will not be reflected in the SSI score.

FDOT ICE Tool and Traffic Simulation Software

The FDOT ICE Tool is a modified version of the Life-Cycle Cost Estimating Tool that was developed as part of NCHRP Project 03-110. This macro-based Microsoft Excel spreadsheet tool is intended to be used in the ICE procedure to compare life-cycle cost estimations between different intersection control strategies. The tool incorporates the following costs: safety, vehicular delay, operations and maintenance, design and construction, and right-of-way. If the project does not have federal funds, benefit-cost analysis may not be required in Stage 2.

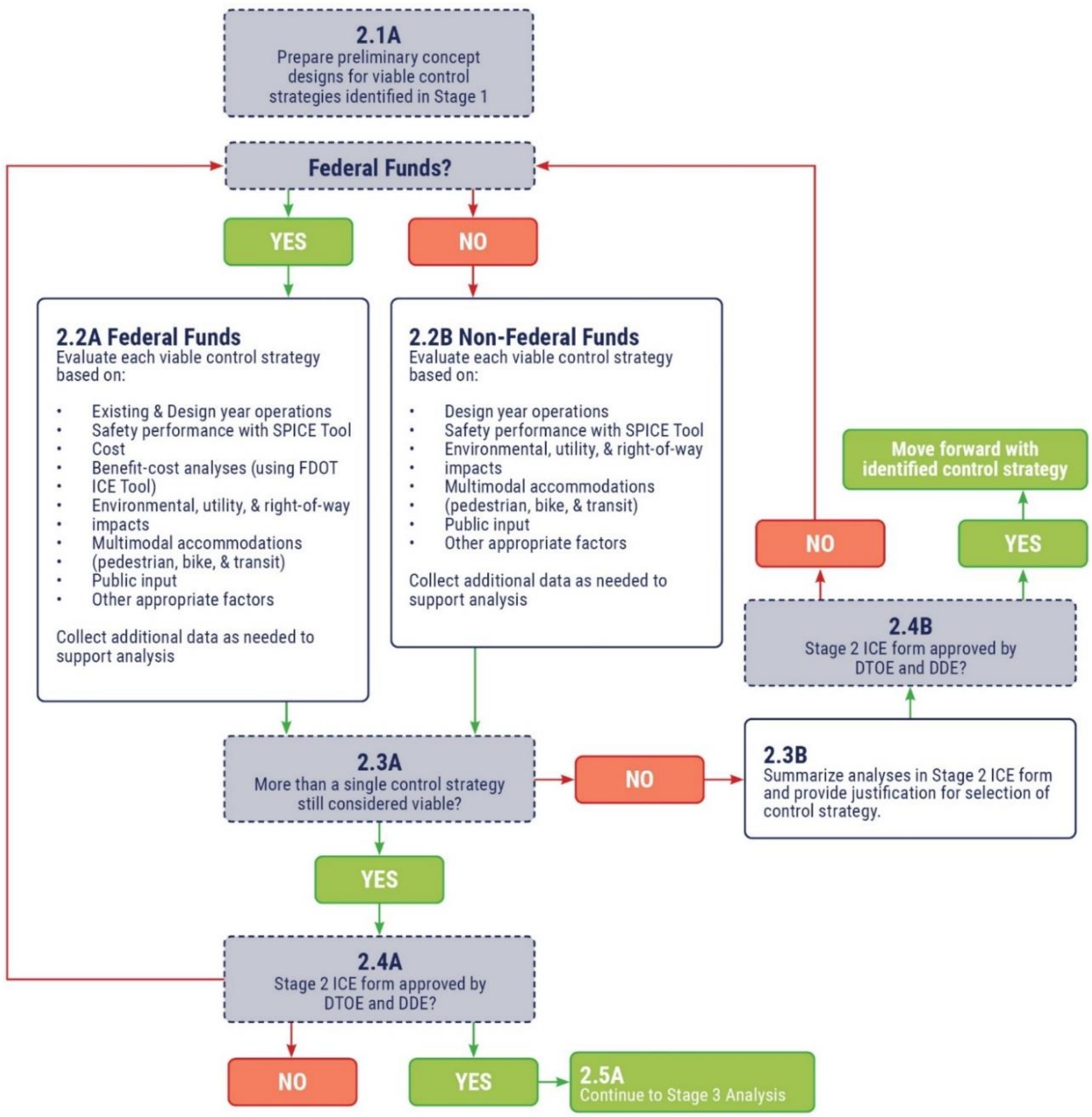
FDOT has published Synchro templates to provide a means for computing delays for innovative intersections. Analysts may also need to use SIDRA INTERSECTION software for estimating delays at roundabouts. The computations for delays at intersections are based on the HCM methodologies (TRB, 2016).

The ICE Tool takes the Synchro- or Sidra-estimated delay values and converts them to an annual delay cost for each control strategy alternative. As the ICE Tool uses the overall intersection average vehicle delay to estimate delay costs, there are delay worksheets for some intersection strategies taking the Synchro movement delay to create overall intersection average vehicle delay. Similarly, the ICE Tool takes the opening and design year crash predictions estimated by the FDOT SPICE Tool and uses FDOT estimated crash costs to develop annualized crash costs for each control strategy. The ICE Tool annualizes the delay and crash costs over the project's life cycle to determine the improvements' benefit. The construction, right-of-way, and design costs for each control strategy alternative are annualized over the same life cycle. From this, the benefit-cost ratios and net present values compared to the base condition are determined.

2.5.2.2 Stage 2 Steps

Figure 2-2 illustrates the flowchart of stepwise activities involved in Stage 2. Each step in Stage 2 is discussed below.

Figure 2-2. Flowchart of ICE Stage 2 Steps



Step 2.1A. Prepare preliminary conceptual designs. Prepare a layout or conceptual plan showing the proposed geometrics for each intersection control strategy. Document changes from the existing conditions in the plan. It is suggested that the operational analysis be conducted concurrently with the concept development. This conceptual design lays the foundation for much of the evaluation in Step 2.2A.

Step 2.2A. Evaluate each control strategy for federally-funded projects. Conduct a more detailed analysis of each control strategy based on the conceptual designs. Areas of analysis include:

- Operations (apply Highway Capacity Manual, Synchro, or other applicable methodologies). Refer to the FDOT Traffic Analysis Handbook for guidance.
- Safety Performance (evaluate control strategies based on anticipated safety performance and SSI metrics using the SPICE Tool)
- Construction, right-of-way, and design costs
- Benefit-Cost Analysis (evaluate using FDOT ICE Tool)
- Environmental impacts
- Utility impacts
- Right-of-way impacts
- Multimodal accommodations (including pedestrian, bike, and transit)
- Agency coordination and public input (if appropriate)

Use the FDOT ICE Tool to identify viable control strategies for the intersection. ***Appendix C*** provides a more detailed discussion on each of these analysis areas. Collect additional data if needed to conduct Stage 2 analysis. Refer to the FDOT Traffic Analysis Handbook for guidance on data collection and operational analysis tools.

Step 2.2B. Evaluate each control strategy for non-federally funded projects. Conduct a more detailed analysis of each control strategy based on the conceptual designs. Areas of analysis include:

- Operations (same as federally funded project except only done for design year critical peak hour)
- Safety Performance (evaluate control strategies based on anticipated safety performance and SSI metrics using the FDOT SPICE Tool)
- Environmental impacts
- Utility impacts
- Right-of-way impacts
- Multimodal accommodations (including pedestrian, bike, and transit)
- Agency coordination and public input (if appropriate)

Use comparison of operational and safety analyses to identify viable control strategies for the intersection. ***Appendix C*** provides a more detailed discussion on each of these analysis areas. Collect additional data if needed to conduct Stage 2 analysis. Refer to the FDOT Traffic Analysis Handbook for guidance on data collection and operational analysis tools.

For non-federally funded projects, the operational analysis is modified to include only the design year's critical peak hour to support the concept development. The Stage 2 SPICE safety analyses will remain the same as that for a federally funded project. Construction and right of way cost estimates are not required unless needed for other reasons. Use of the Stage 2 ICE Tool is not required for benefit-cost analysis unless the Level-of-Service (LOS) worksheets are needed for comparative operational analysis.

Step 2.3A. More than a single control strategy still considered viable? The PE overseeing the ICE analysis uses discretion to determine whether more than one control strategy is still viable based on evaluation of the conceptual designs. Coordinate efforts and results with District's Traffic Operations Office and Design Office staff throughout the evaluation to facilitate acceptance of the results and conclusions. If a preferred control strategy is not selected in the Stage 2 analysis, note the reasons why the selection cannot be made need for them to be studied in Stage 3.

Step 2.3B: Summarize analyses in Stage 2 ICE Form and provide control strategy selection justification. If a preferred traffic control strategy is identified through the analysis of the conceptual designs, submit a completed Stage 2 ICE Form to the DTOE and the DDE. Include the proper justification for the selection or non-selection of each potential control strategy considered in Stage 2 to the Stage 2 ICE Form.

Step 2.4A: Stage 2 ICE Form approved by the DTOE and the DDE? This step follows Step 2.3A, i.e., when more than one viable control strategy is identified. If the Stage 2 ICE Form is approved, proceed to the preliminary design phase for the recommended control strategy. If the Stage 2 ICE Form is not approved, the DTOE or the DDE may require additional analysis and evaluation to identify viable control strategies (return to Step 2.2A).

Step 2.4B: Stage 2 ICE Form approved by the DTOE and the DDE? This step follows Step 2.3B. If the Stage 2 ICE Form is approved, proceed to the preliminary design phase for the recommended control strategy. If the Stage 2 ICE Form is not approved, the DTOE or the DDE may require additional justification or further vetting of potential control strategies (return to Step 2.2A).

Step 2.5A. Continue to Stage 3 Analysis. Conduct a more detailed analysis of the remaining control strategies in Stage 3: Detailed Control Strategy Assessment.

The DTOE's and the DDE's approval of a single control strategy in Stage 2 ICE (or any ICE stage) Form indicates that a preferred control strategy has been selected to be advanced to final design. During final design when more detailed information is available, the preferred alternative may no longer be the best improvement option for many reasons. One such example is the discovery of a contamination site on a parcel needed for right-of-way acquisition, leading to a decision to not acquire the parcel. Another example is a new nearby development approved by local government may impact the intersection's traffic volumes and the preferred control strategy's operations and safety. In cases such as these, the DTOE and/or the DDE may direct ICE analysis to be re-evaluated.

2.5.3 Stage 3: Supplemental Analysis

Stage 3 requires a more in-depth analysis and/or public vetting of control strategy options if a consensus cannot be reached to a single preferred control strategy at the end of Stage 2. This may involve:

- advancement of design plans,
- more detailed traffic analysis,
- more detailed cost estimation and right-of-way need determination,
- additional assessment of environmental impacts,
- additional engagement with the public or local officials,
- additional engagement with road users (e.g., freight industry, school bus operators, adjacent property owners), or
- any other activities necessary to identify the preferred control strategy.

Detailed design plans are necessary only if they assist in evaluating the outstanding issues. For example, community engagement or multimodal needs may determine the preferred control strategy, instead of further technical analysis. When Stage 1 or Stage 2 evaluation does not identify a selected control strategy, analysts may customize Stage 3 activities to address the outstanding issues. For a PD&E project, Stage 3 analysis is not required as the steps taken above are a normal part of the

PD&E process and are documented in the PER, PTAR, and the environmental documentation.

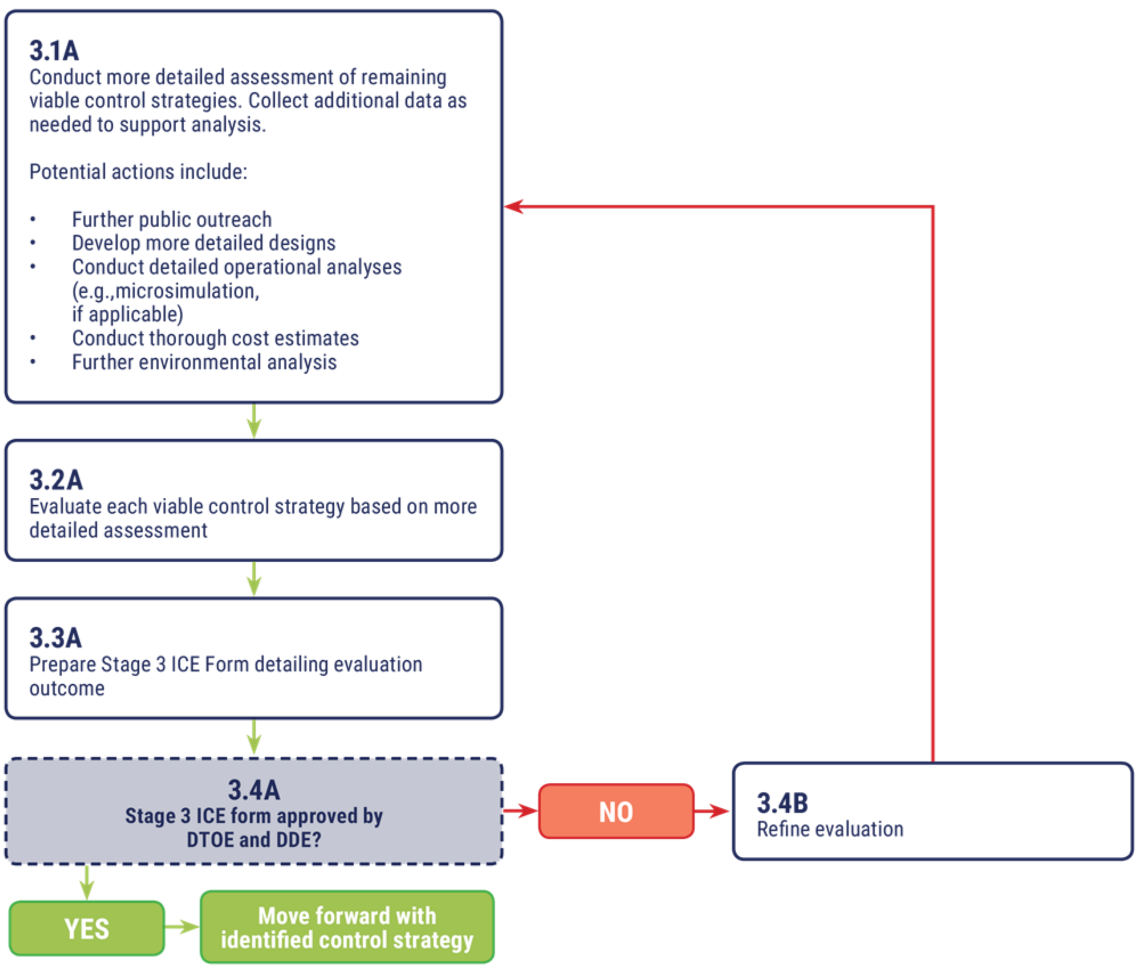
2.5.3.1 Stage 3 Analysis Tools

No separatee analysis tools are required in Stage 3. Analysts can use the Stage 2 tools with more detailed information about the control strategies.

2.5.3.2 Stage 3 Steps

Figure 2-3 illustrates the flowchart of stepwise activities involved in Stage 3. Each step in Stage 3 is discussed below. Stage 3 shall always result in one outcome: a single control strategy.

Figure 2-3. Flowchart of ICE Stage 3 Steps



Step 3.1A: Conduct more detailed assessment of remaining control strategies. Revisit the control strategies that remain after the Stage 2 analysis. Conduct detailed

analyses regarding issues and/or findings that have led a control strategy to not to be selected in Stage 2 (i.e., areas warranting further investigation).

Step 3.2A: Evaluate each viable control strategy based on more detailed assessment. Coordinate efforts and results with FDOT throughout the evaluation to facilitate acceptance of the results and conclusions. However, discretion lies with the PE overseeing the evaluation to determine which control strategy is the most viable alternative for the intersection.

Step 3.3A: Prepare Stage 3 ICE Form detailing evaluation outcome. Prepare a Stage 3 ICE Form detailing or justifying the selected control strategy. Attach supporting documentation to the form.

Step 3.4A. Stage 3 ICE Form approved by the DTOE and the DDE? If the Stage 3 ICE Form obtains approval from the DTOE and the DDE, proceed to preliminary design for the recommended control strategy. If the Stage 3 ICE Form is not approved, incorporate the comments from the DTOE or the DDE into the analysis and justification form. This may include modifications to control strategy designs, operational analyses, or additional evaluations. The party responsible for submitting the ICE Form is required to re-submit the Stage 3 ICE Form after accounting for comments from the DTOE and/or the DDE. Coordinate efforts and results with FDOT throughout the evaluation to avoid unnecessary iterations.

Step 3.4B: Refine design. If the submission of the Stage 3 ICE Form is not approved, the party responsible for submitting the ICE Form must revise their analysis or modify their evaluation based on the comments received from the DTOE and/or the DDE (i.e., repeat Step 3.1A with revisions).

2.6 References

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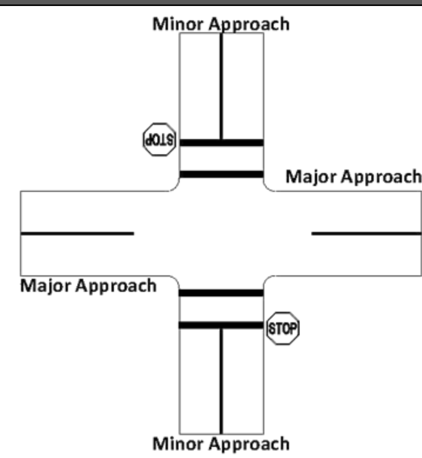
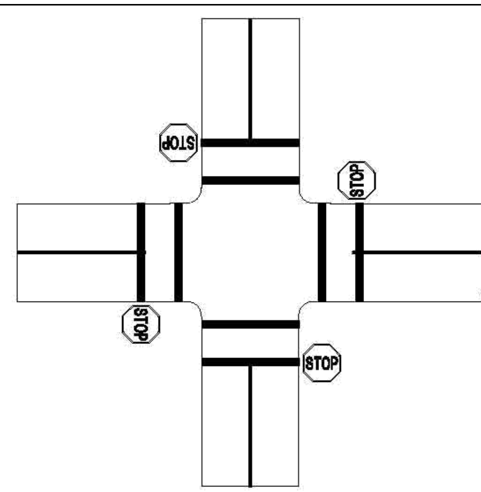
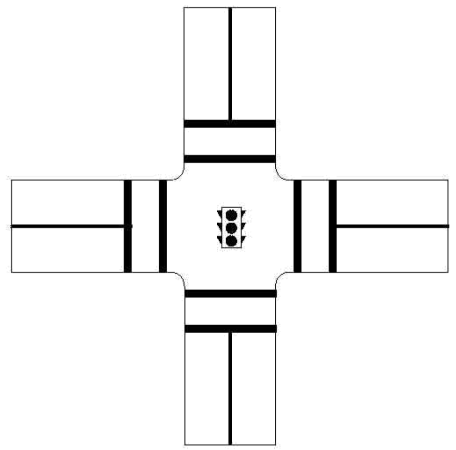
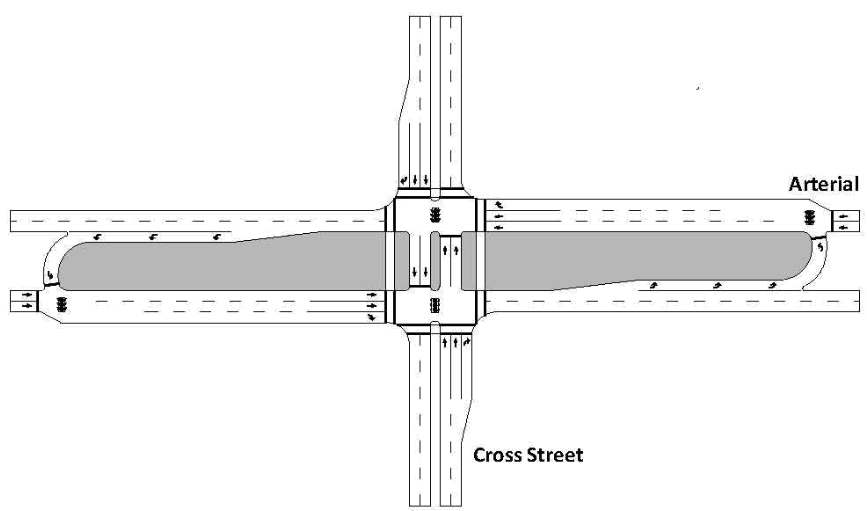
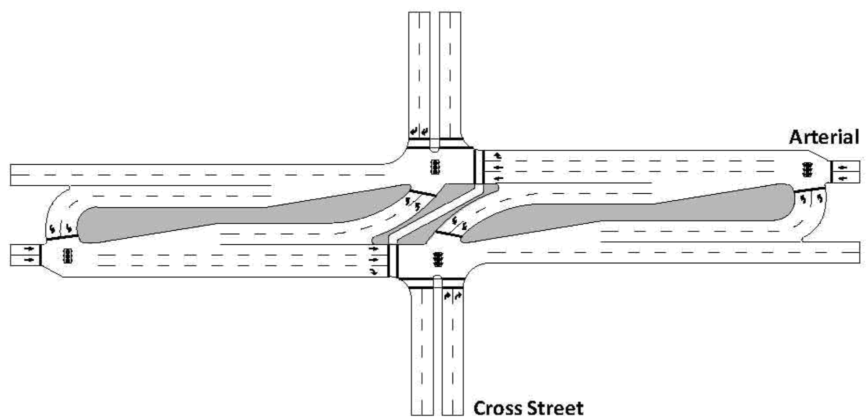
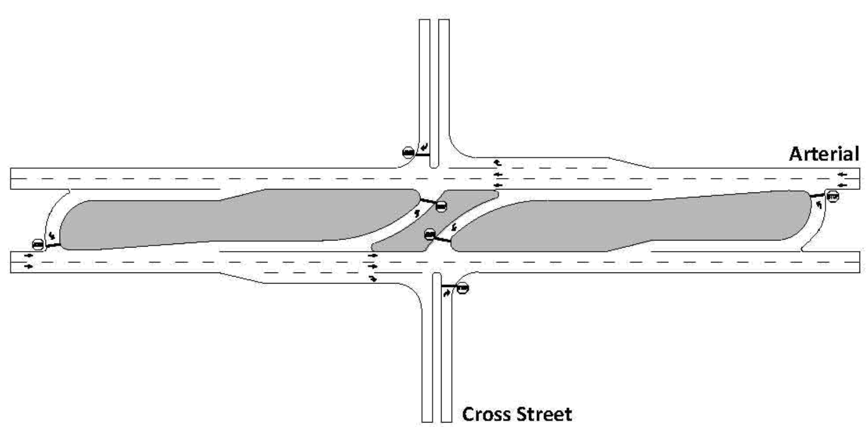
APPENDIX A
INTERSECTION CONTROL STRATEGY DESCRIPTIONS

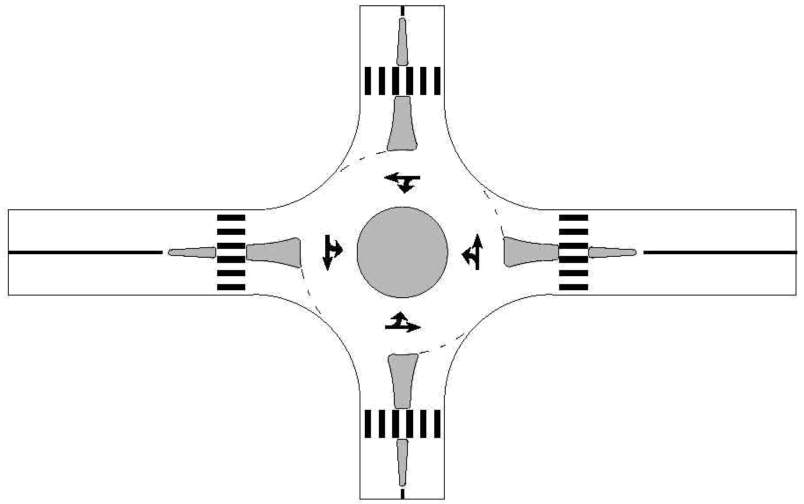
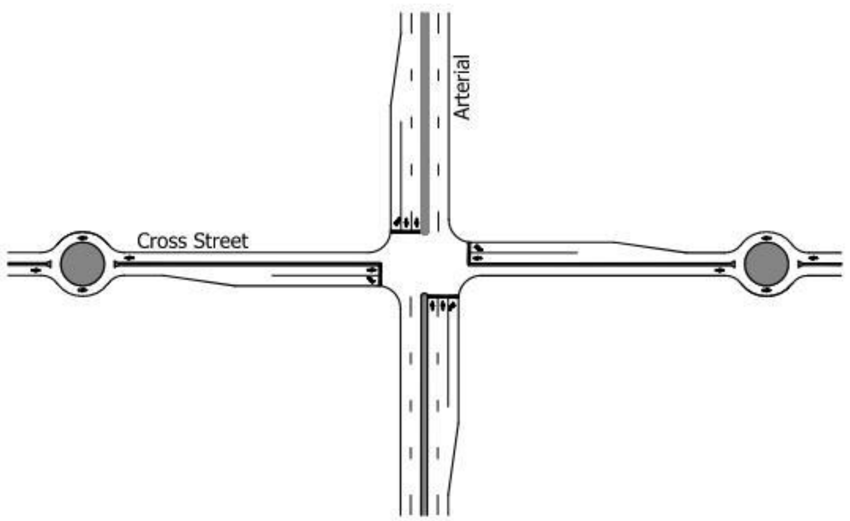
A.1 At-Grade Intersection Control Strategy

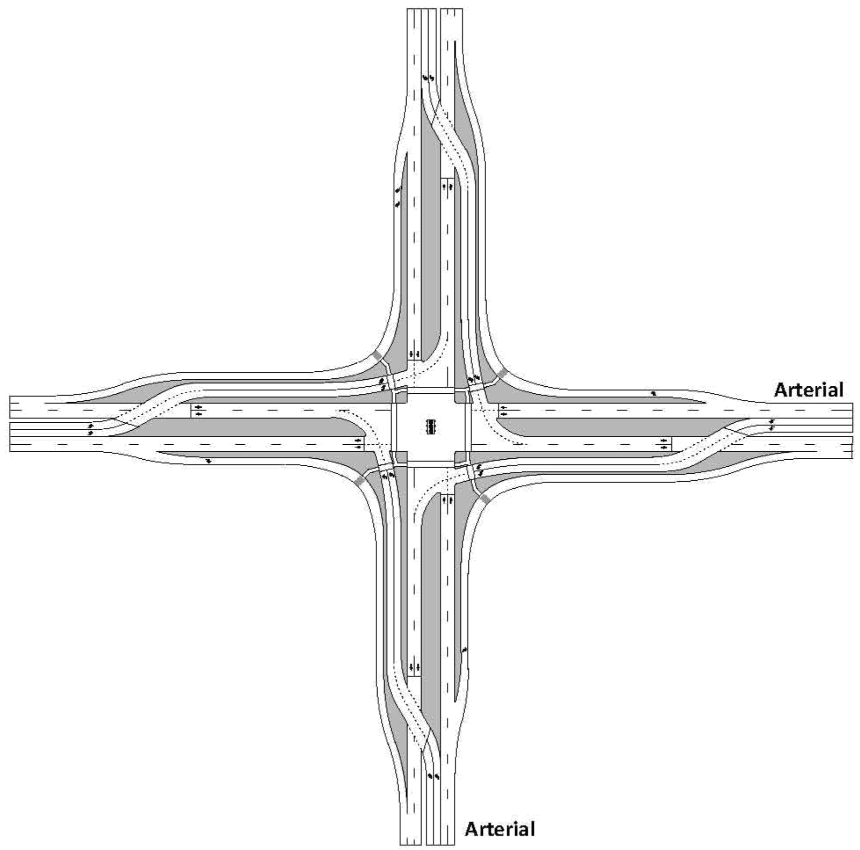
Table A-1. At-Grade Intersection Control Strategy

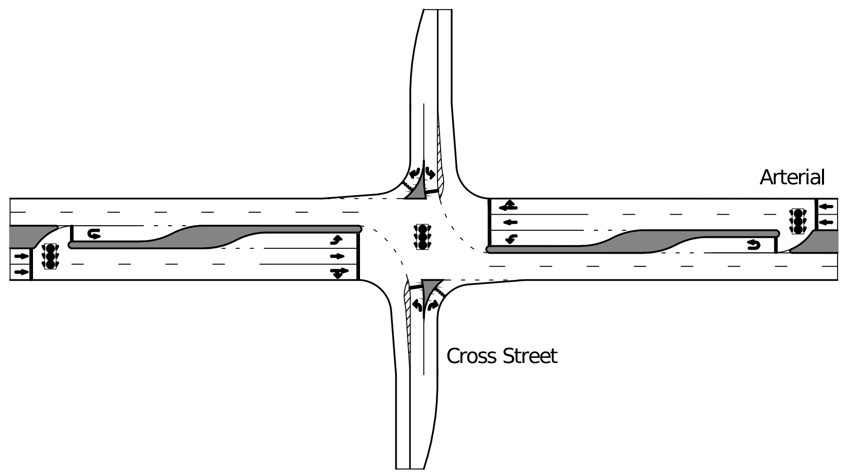
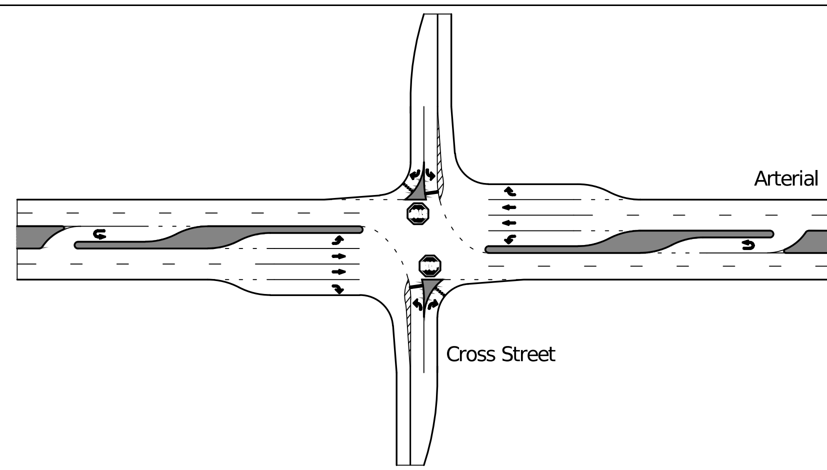
Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Minor Road Stop Control		Conventional intersection control type in which minor street approaches are stop-controlled and major street movements do not encounter any traffic control devices. Advantages: Simple and low-cost. Disadvantages: Not effective in serving higher volumes of traffic.	Through- and right-turn movements on the major street approaches are free-flow movements, while left-turn movements are permissive. All minor street movements must stop before proceeding through the intersection.	Pedestrians crossing the minor street approaches have the right-of-way and are crossing at a stop-controlled location; however, the lack of signalization does not provide any protected pedestrian movement across the major street.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.
All-Way Stop Control		Conventional intersection control type in which every approach is stop-controlled. Advantages: Simple, low-cost, and safe. Disadvantages: Lowest capacity of any intersection type.	All vehicles are required to stop before proceeding through the intersection.	All pedestrian crossings are located at the same place as stop signs	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.

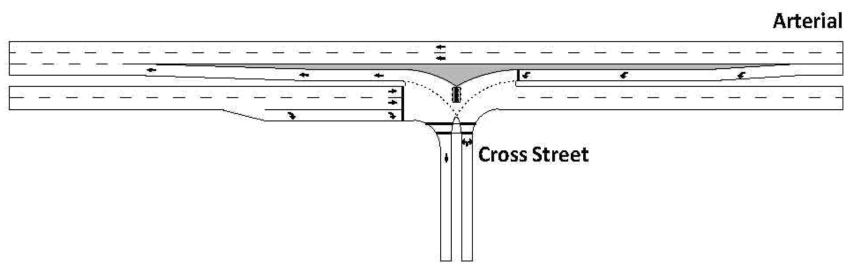
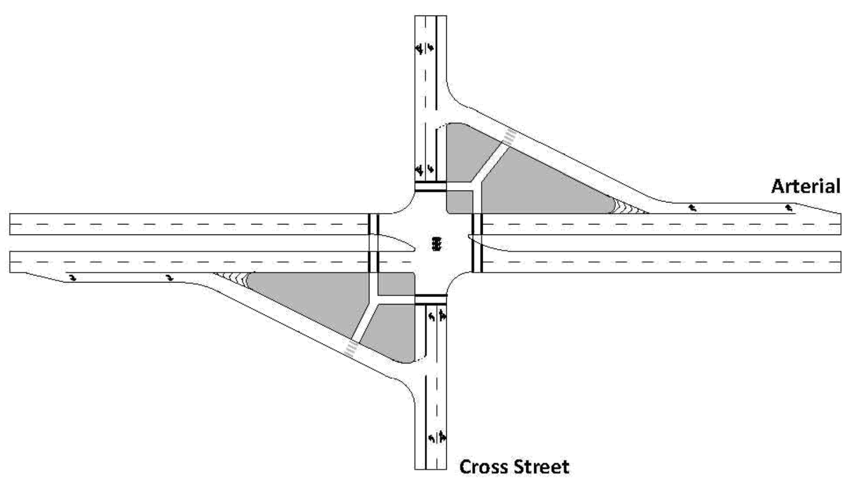
Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Signalized Control		Conventional intersection control type in which each approach is controlled by a traffic signal. Advantages: Most common form of control for higher volume intersections, fully established and understood by all users Disadvantages: Increased delay at high volumes compared to alternative intersections	Vehicular movements on each approach are controlled through protected, permissive, or prohibited lights on the traffic signal.	Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.
Median U-Turn (MUT)		An intersection treatment that eliminates direct left-turns at signalized intersections from major and minor approaches and replaces them with U-turns on the major street. Advantages: Fewer signal phases and conflict points than a conventional signal, better suited for high through volume cross streets than an RCUT Disadvantages: Out of direction travel for left turn movements, requires wide median or outside right-of-way at U-turn crossover.	Drivers desiring to turn left from the major road onto an intersecting cross street must first travel through the at-grade, signal-controlled intersection and then execute a U-turn at the downstream median opening. These drivers then can turn right at the cross street. For drivers on the cross-street desiring to turn left onto the major road, they must first turn right at the signal-controlled intersection and then execute a U-turn at the downstream median opening and proceed back through the signalized intersection.	Larger clearance intervals are required for the cross-street signal phase, and wider medians are often used to accommodate U-turns. When wide medians are used, pedestrian crossings are often two-stage; however, this tends to increase pedestrian delay. Single stage crossings are desirable. Increased right turn volume may lead to more vehicle-pedestrian conflicts and can be mitigated through leading pedestrian intervals. Midblock crossings may be provided at the U-turn location with minimal delay to outbound traffic. Additional guidance is available in NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges. FDOT has published three videos showing different pedestrian treatments at MUTs.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Design techniques for direct left turns are available such as a two-stage bicycle turn box. Increased right turn volume may lead to more vehicle-bicycle conflicts and can be mitigated through leading bicycle intervals. Additional guidance is available in the NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges. FDOT has published three videos showing different bicycle treatments at MUTs.

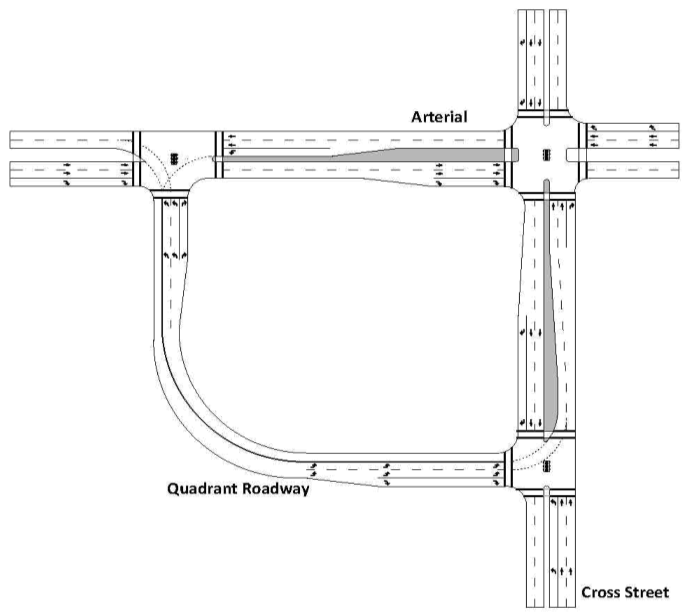
Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Signalized Restricted Crossing U-Turn (RCUT) or Superstreet		An intersection design that restricts left-turn and through movements from cross street approaches as permitted in conventional designs. Advantages: Fewer signal phases and conflict points (if signalized) than a conventional intersection, enables major street to operate as one-way couplet if signalized. Disadvantages: Out of direction travel for cross street left and through movements, requires wide median or outside right-of-way at U-turn crossover.	Left-turn and through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way, signalized median opening desirably 400 to 800 feet after the intersection. The major street effectively operates as a pair of one-way streets because no movement ever crosses both directions of the major street at once.	Pedestrian crossings on the major road are usually accommodated on one diagonal "Z" path from one corner to the opposite corner with signalization. Direct paths across all four legs are also possible. Increased right-turn volumes from the minor street may result in more vehicle-pedestrian conflicts and can be mitigated through prohibiting right-turn-on-red. See NCHRP Report 948 for additional guidance on pedestrian treatments at signalized RCUTs. FDOT has published three videos showing different pedestrian treatments at signalized RCUTs.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Cross street through and left turn movements can use pedestrian crossings to avoid use of U-turn movements Increased right turn volumes from the minor street may result in more vehicle-bicycle conflicts and can be mitigated through prohibiting right turn on red. See NCHRP Report 948 for additional guidance on bicycle treatments at signalized RCUTs. FDOT has published three videos showing different bicycle treatments at signalized RCUTs.
Unsignalized Restricted Crossing U-Turn (RCUT) or J-Turn			Left-turn and through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way, stop-controlled median opening desirably 600 to 1,000 feet after the intersection.	Unsignalized RCUTs are usually located in rural areas and do not typically have pedestrian facilities. If pedestrian demand exists, accommodations should be provided.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Direct crossings from minor street to minor street can be facilitated with a cut-through in the median island.

Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Roundabout		A subset of traffic circles that feature yield control of all entering vehicles, channelized approaches, and horizontal curvature to induce desirable vehicle speeds. Advantages: Typically, reduced fatal and injury crashes and delay compared to signalized control Disadvantages: Typically, higher cost and require more right-of-way than signalized control	Vehicles approaching the intersection must yield to vehicles circulating within the circulatory roadway.	Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length.	Bicyclists may ride in the roadway with vehicles or transition to multi-use paths via bicycle ramps (if present). Bike lanes should not be used at roundabouts
Bowtie		An intersection treatment that eliminates direct left-turns from major and minor approaches and replaces them with U-turns executed via roundabouts on the minor street. The roundabouts can have two or more legs. Advantages: Fewer signal phases and conflict points than a conventional signal, viable for intersections where major street median is not available for U-turns. Disadvantages: Out of direction travel for left turn movements; requires additional right-of-way on minor street.	Drivers desiring to turn left from the major road onto an intersecting cross street must first turn right at the signal-controlled intersection and then execute a U-turn at the downstream roundabout and proceed back through the signalized intersection. For drivers on the cross-street desiring to turn left onto the major road, they must first travel through the signal-controlled intersection and then execute a U-turn at the downstream roundabout. These drivers then can turn right onto the major road.	Increased right turn volume may lead to more vehicle-pedestrian conflicts and can be mitigated through leading pedestrian intervals. Midblock crossings may be provided at the roundabout. Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Design techniques for direct left turns are available such as a two-stage bicycle turn box. Increased right turn volume may lead to more vehicle-bicycle conflicts and can be mitigated through leading bicycle intervals. Bike lanes should not be used at roundabouts

Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Displaced Left-Turn (DLT)		A signalized intersection where one or more left-turn movements are relocated to the other side of the opposing traffic flow. These movements proceed through the intersection simultaneously with the through movements, which eliminates the left-turn phase on the approach. The image shown here has displaced lefts on both streets, but often they are displaced on only one street. Advantages: Fewer signal phases and conflict points than a conventional signal, well-suited for high left-turn volumes. Disadvantages: Footprint of intersection is large.; right-of-way and access management needs are great.	Left-turn movements at the intersection are relocated to the other side of the opposing roadway, eliminating the left-turn phase for the approach at the main intersection. Left-turn movements are brought across the opposing travel lanes via a signalized intersection several hundred feet upstream of the main intersection. Left-turn vehicles then travel on a new roadway parallel to the opposing lanes and execute the left-turn maneuver simultaneously with the through traffic at the main intersection.	Pedestrians may be required to cross more travel lanes than at a conventional intersection, and direction of traffic in those lanes may be counterintuitive to pedestrians. Many DLT intersections are set up for pedestrians to cross in multiple stages with median refuge islands. Aligning crosswalks to land between outbound travel lanes and inbound left turn lanes (as show in image) allows for concurrent movement of pedestrians and left turning vehicles. Aligning crosswalks outside of the inbound left turn lanes may require use of protected left turns to avoid vehicle-pedestrian conflicts. See NCHRP Report 948 for additional guidance on pedestrian treatments at DLTs. FDOT has published three videos showing pedestrian treatments at DLTs.	Bicyclists can be provided on the road using marked bicycle lanes and design techniques for direct left turns are available although this would likely be used only by the most confident bicyclists. Design techniques for direct left turns are available, such as a two-stage bicycle turn box. Shared-use paths and protected bicycle lanes are also options. See NCHRP Report 948 for additional guidance on bicycle treatments at DLTs. FDOT has published three videos showing different bicycle treatments at DLTs.

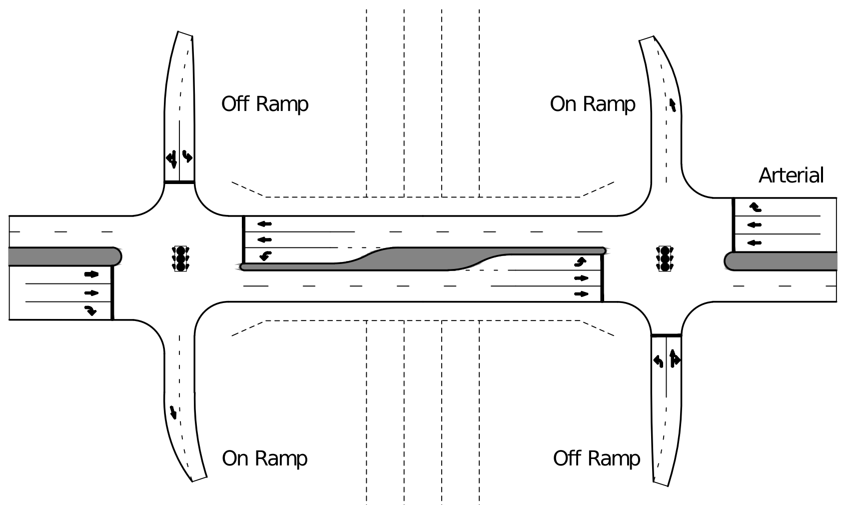
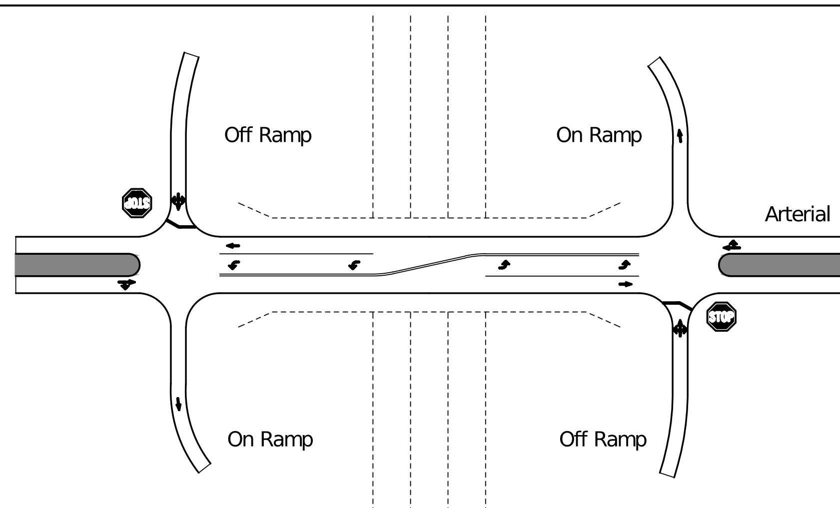
Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Signalized Thru-Cut		An intersection design that restricts through movements from the minor streets as permitted in conventional intersections. Advantages: Protected left turns from the cross street (if signalized) without a four critical phase signal. Disadvantages: Out of direction travel for minor street through movements, requires wide median or outside right-of-way at U-turn crossover.	Through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way median opening 400 to 800 feet downstream of the intersection.	Pedestrian crossings on the major road are usually accommodated by direct paths across all four legs. Increased right turn volumes from the minor street may result in more vehicle-pedestrian conflicts and can be mitigated through prohibiting right turn on red. Consideration should be given to the signal timing configuration to mitigate conflicts between pedestrians and left turning vehicles.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Cross street through and left turn movements can use pedestrian crossings to avoid use of U-turn movements Increased right turn volumes from the minor street may result in more vehicle-bicycle conflicts and can be mitigated through prohibiting right turn on red.
Unsignalized Thru-Cut			Through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way median opening 600 to 1,000 feet downstream of the intersection.	Unsignalized Thru-Cuts are usually located in rural areas and do not typically have pedestrian facilities. If pedestrian demand exists, accommodations should be provided.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Medians wide enough for bicycle storage boxes allow cross street through and left turn movements to cross in two stages.

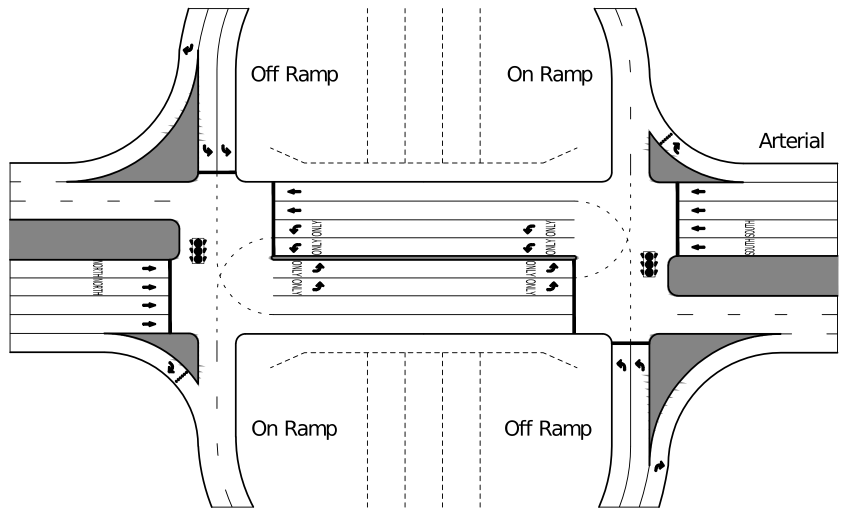
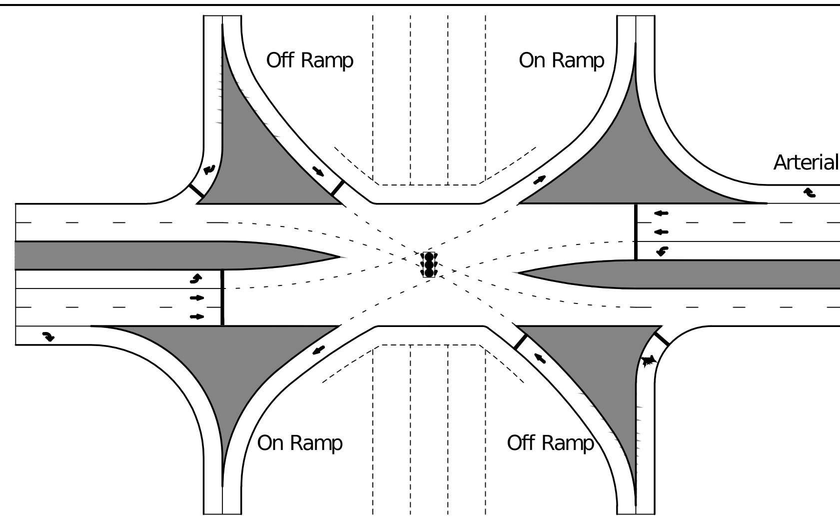
Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Continuous Green T (CGT)		A CGT intersection is a signalized 3-leg intersection that features raised channelization that separates the "top" through movement from the other movements of the intersection, enabling the top through movement to operate unsignalized with no conflicting movement. Advantages: One direction of traffic never has to stop. Disadvantages: No pedestrian crossing of arterial unless full signal is provided.	Minor street left-turn movements are channelized, allowing a continuous green signal to be displayed to the "top" mainline through movement.	Permissive pedestrian crossings are provided across the minor street at the signal. Due to the continuous flowing nature of through movements on one of the major approaches, pedestrian movements across the mainline should be accommodated at an adjacent intersection or via a mid-block crossing, as appropriate.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.
Jughandle		A signalized intersection that uses at-grade ramp connectors between intersecting roadways to facilitate indirect left-turns or U-turns. The image shown has diagonal connectors upstream of the cross street, but loop connectors may also be placed downstream of the cross street. Advantages: Fewer signal phases and conflict points than a conventional signal. Disadvantages: Out of direction travel for left turn movements and additional right-of-way requirements.	Major street vehicles attempting to make a left-turn or U-turn utilize a connector ramp either upstream (short diamond-style ramp) or downstream (loop-style ramp) that connects to the minor street approach upstream of the signal.	Depending on the desired inbound and outbound sidewalks, some pedestrians may be required to cross one additional street compared to a conventional signalized intersection. If pedestrians do not interact with the quadrant where a jughandle is located, there is no notable difference compared to a conventional signalized intersection.	Same as conventional intersection. Additional crossing infrastructure is provided at the ramp connector.

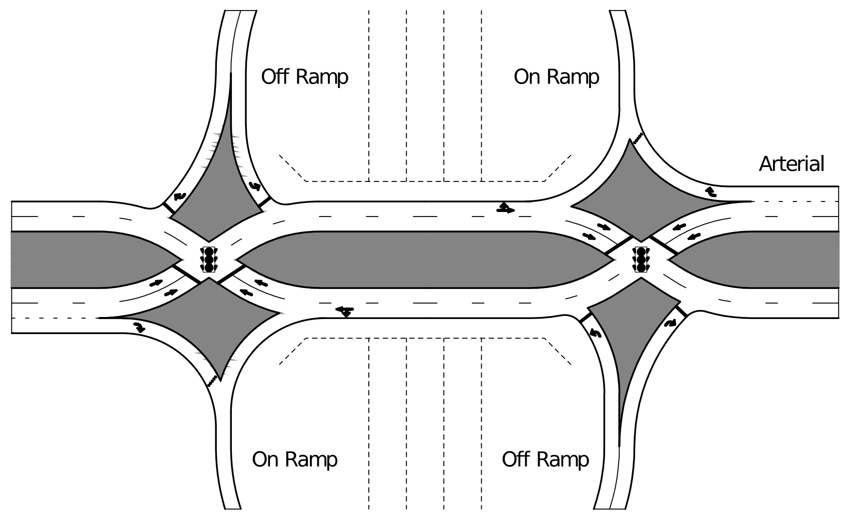
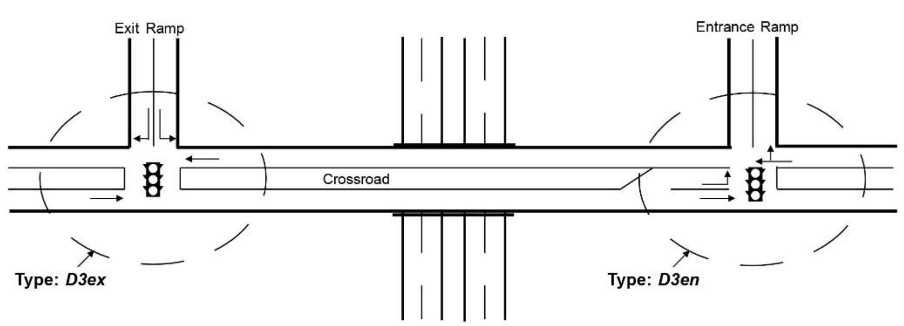
Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Quadrant Roadway (QR)		A QR intersection is intended to eliminate all direct left-turn movements from the main intersection by re-routing them to turns to and from a connector roadway located in one quadrant. Advantages: Reduced signal phases at main intersection. Disadvantages: Out of direction travel for some movements. Footprint of intersection is large, and right-of-way and access management needs are great.	Left-turn movements are rerouted to use a connector roadway (i.e., the quadrant). All left-turn movements at the main intersection are prohibited, allowing for two-phase signal operation at the main intersection.	Depending on the desired inbound and outbound sidewalks, some pedestrians are required to cross an extra street to make their desired movement compared to a conventional signalized intersection. The two-phase signal operation reduces the delay incurred by pedestrians at each crossing of the main intersection. Pedestrian conflicts exist with vehicles making left turns from the stems of the T at the auxiliary intersections. This can be mitigated through exclusive pedestrian phasing.	Similar to conventional intersection. Design techniques for direct left turns are available.

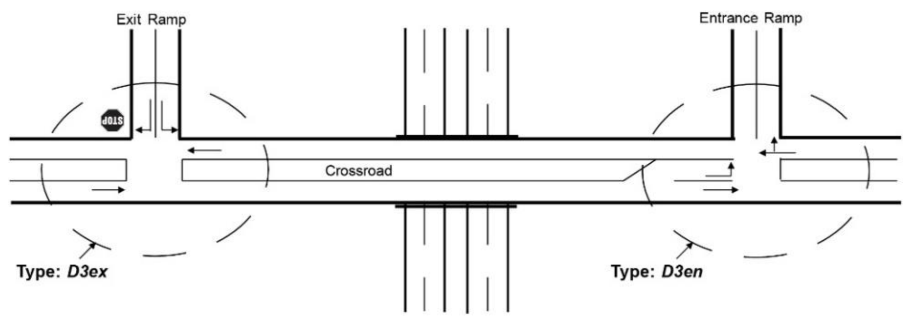
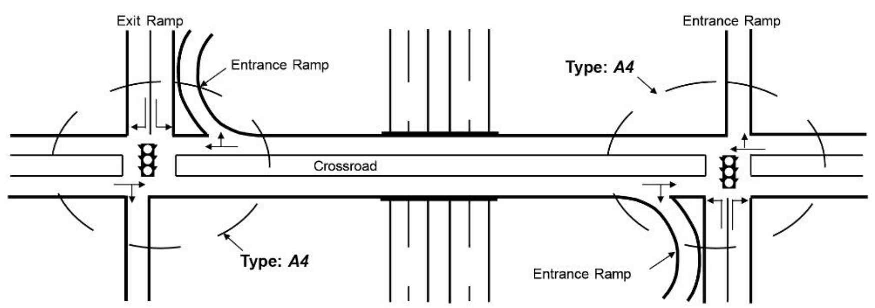
A.2 Ramp Terminal Intersection Control Strategy

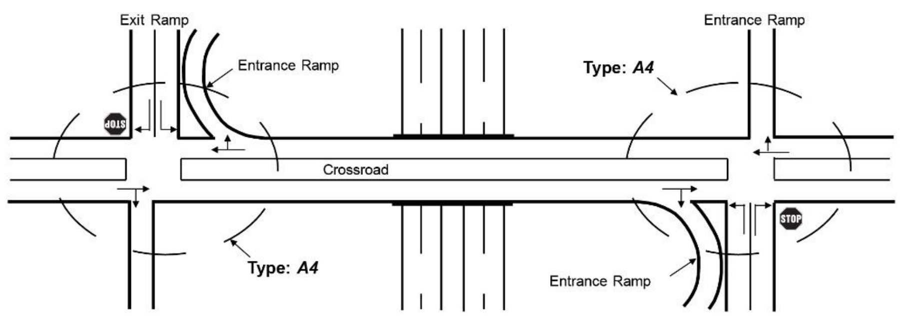
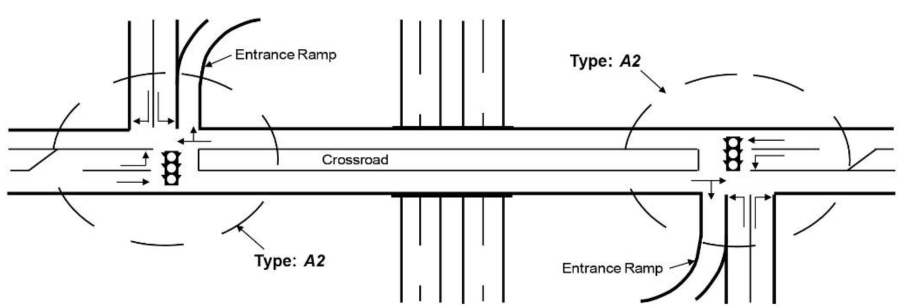
Table A-2. Ramp Terminal Intersection Control Strategy

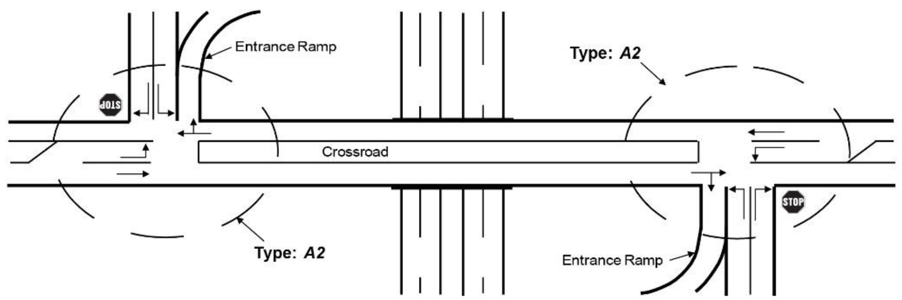
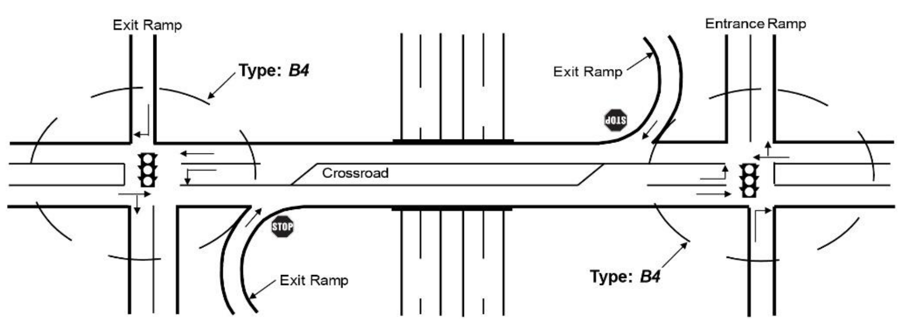
Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Signalized Diamond		Conventional control type in which each approach is controlled by a traffic signal. Advantages: Most common form of control for higher volume intersections, fully and established and understood by all users Disadvantages: Increased delay at high volumes compared to alternative ramp terminal control	Vehicular movements on each approach are controlled through protected, permissive, or prohibited lights on the traffic signal.	Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized. Pedestrian crossings across the cross-street are typically provided on the outside of the ramp terminals. Crossings on the inside of ramp terminals will need additional signal consideration.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.
Unsignalized Diamond		Conventional control type in which the minor street approaches are stop-controlled and major street movements do not encounter any traffic control devices. Advantages: Simple and low-cost Disadvantages: Cannot effectively serve higher volumes of traffic	Through- and right-turn movements on the arterial approaches are free-flow movements, while left-turn movements are yield-controlled. All minor street approaches are stop-controlled.	Pedestrians crossing the minor street approaches have right-of-way and are crossing at a stop-controlled location; however, the lack of signalization does not provide any protected pedestrian movement across the cross-street.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.

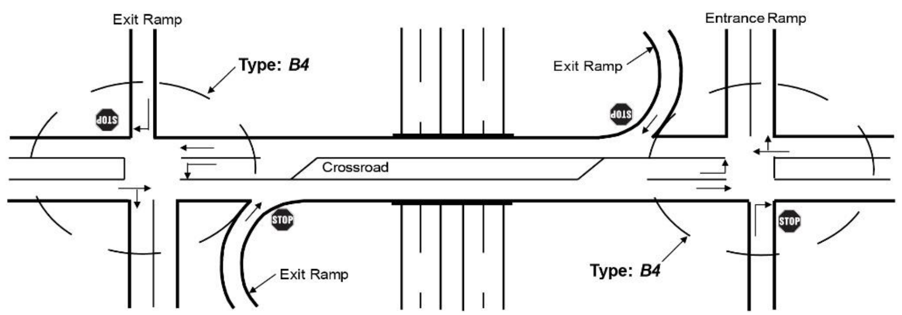
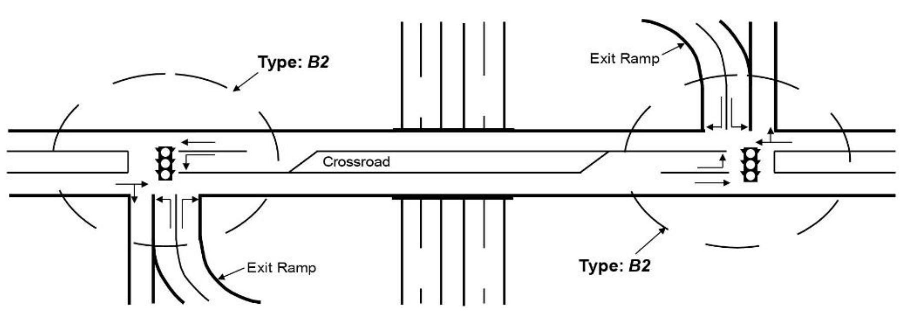
Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Signalized Tight Diamond		A compressed diamond design featuring two closely spaced intersections, approximately 200-400 feet apart. Left turn lanes are developed in advance of the upstream intersection. Advantages: Ability to manage long left turn queues onto the limited access roadway Disadvantages: Require a wider bridge structure	Vehicular movements on each approach are controlled through protected, permissive, or prohibited lights on the traffic signal. Left turn storage for turns onto the limited-access road are developed in advance of the upstream intersection.	Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized. Pedestrian crossings across the cross-street are typically provided on the outside of the ramp terminals. Crossings on the inside of ramp terminals will need additional signal consideration.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.
Single-Point Diamond		Advantages: All movements can be served using a single controller Disadvantages: Require a wider bridge structure	Left- and through-movements on each approach are controlled through protected signal indications. Right- turn movements on the arterial approaches are free flow movements while movements from the limited access roadway are yield-controlled or served through permissive signal indications.	Pedestrians cross the ramp terminals with non-conflicting phases. Exclusive pedestrian phases are necessary if pedestrian crossings across the arterial are provided at the intersection.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.

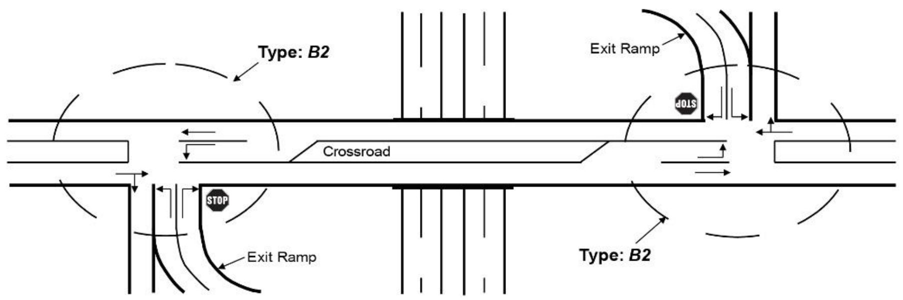
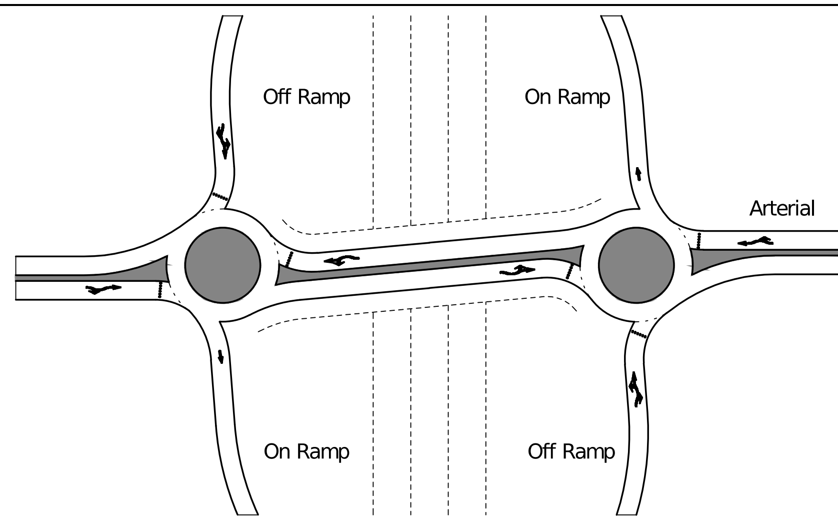
Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Diverging Diamond or Double Crossover		A diamond design in which cross-street through and left turning vehicles are routed onto the left side of the cross-street at the upstream signalized crossover. Advantages: Left turns onto and off of the limited access road turn without crossing through vehicles on the cross-street. Can increase throughput without increasing bridge width. Disadvantages: Redirection onto the left side of the roadway defies driver's expectation. Additional right of way may be needed immediately upstream of crossover to allow for proper alignment through crossover.	Cross-street through vehicles and left turns from the limited access road return to the right side of the cross-street at the downstream signalized crossover. Right turning vehicles can be either free-flowing or signalized.	Pedestrian phases can be built into the signal timing to allow for protected pedestrian crossings into the median pedestrian walk and/or across the on- and off-ramps, depending on the location of the pedestrian facilities. Accessible pedestrian signals and pushbuttons can be utilized. See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 9 for additional guidance on pedestrian treatments at DDIs.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Right side barriers provided for median pedestrian path may provide discomfort for bicyclists on roadway. See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 9 for additional guidance on bicycle treatments at DDIs.
Half-Diamond Signalized		The half-diamond design provides partial access from the crossroad to the freeway by having an entrance ramp and exit ramp in two interchange quadrants. There is one left turn lane on the crossroad to the entrance ramp. Advantage: Generally lower volume due to limited freeway access. Disadvantage: May be confusing to some drivers as full freeway access is not provided.	Vehicular movements on the crossroad approach having the left turn is controlled by protected, permissive, or prohibited traffic signal indications.	Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized. Pedestrian crossings across the cross-street are typically provided on the outside of the ramp terminals. Crossings on the inside of ramp terminals will need additional signal consideration.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.

Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Half-Diamond Stop Control		The half-diamond design provides partial access from the crossroad to the freeway by having an entrance ramp and exit ramp in two interchange quadrants. There is one left turn lane on the crossroad to the entrance ramp. Advantage: Generally lower volume due to limited freeway access. Disadvantage: May be confusing to some drivers as full freeway access is not provided.	Vehicular movements on the crossroad approach having the left turn is uncontrolled. Similarly, the exit ramp has right-turn and left-turn movements controlled by a STOP sign.	Pedestrians crossing the ramp approaches have right-of-way and are crossing at a stop-controlled location; however, the lack of signalization does not provide any protected pedestrian movement across the cross-street.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present.
Four-Quadrant Partial Cloverleaf A Signalized		The partial cloverleaf A interchange has two entrance loop ramps. The four-quadrant partial cloverleaf A interchange crossroad provides free flow access to the two entrance ramps from both crossroad directions. Advantage: The loop ramps take left turn movements out of ramp terminal intersection. Disadvantage: Potential for wrong-way movements at ramp terminal intersection	The ramp terminal intersections will have 2-phase signal operation with one left turn movement. The loop ramps accommodate the crossroad's left turn movement to the freeway. The exit ramp's turning movements are signal controlled.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections should be signalized.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.

Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Four-Quadrant Partial Cloverleaf A Stop Control		The partial cloverleaf A interchange has two entrance loop ramps. The four-quadrant partial cloverleaf A interchange crossroad provides free flow access to the two entrance ramps from both crossroad directions. Advantage: The loop ramps take left turn movements out of ramp terminal intersection. Disadvantage: Potential for wrong-way movements at ramp terminal intersection	Each ramp terminal intersection will have a free flow entrance ramp deleting the need for a left turn movement. The exit ramps are STOP controlled movements.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections having STOP control should have crosswalks.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.
Two-Quadrant Partial Cloverleaf A Signalized		The partial cloverleaf A interchange has two entrance loop ramps. The two-quadrant partial cloverleaf A interchange provides access to each entrance ramp from both crossroad directions. Advantage: The interchange provides full access while only impacting property in two quadrants. Disadvantage: Potential for wrong-way movements at ramp terminal intersection.	Each ramp terminal intersection will have a signalized left turn movement to the entrance ramp. The right turn to the entrance ramp is typically a free flow movement and is not under signal control. The exit ramps are also signalized.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections should be signalized.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.

Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Two-Quadrant Partial Cloverleaf A Stop Control		The partial cloverleaf A interchange has two entrance loop ramps. The two-quadrant partial cloverleaf A interchange crossroad provides free flow access to the two entrance loop ramps whereas access to the two slip ramps require a left turn movement. Advantage: The interchange provides full access while only impacting property in two quadrants. Disadvantage: Potential for wrong-way movements at ramp terminal intersection	Each ramp terminal intersection will have an uncontrolled left turn movement to the entrance ramp. The right turn to the entrance ramp is typically a free flow movement. The exit ramps are STOP controlled.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections having STOP control should have crosswalks.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.
Four-Quadrant Partial Cloverleaf B Signalized		The partial cloverleaf B interchange has two exit loop ramps discharging into the crossroad. The exit ramps' traffic needs to merge with the crossroad traffic before the upcoming ramp terminal intersection. Advantage: The ramp terminal intersection signalization is 2-phase. The potential for wrong-way movements is reduced. Disadvantage: The exit loop ramp merging with the crossroad traffic.	Traffic exiting the freeway will have separate ramps dependent on direction of travel once on crossroad, likely to reduce ramp terminal intersection to be 2 phase signal to accommodate only entrance ramp and through traffic.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections should be signalized.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.

Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Four-Quadrant Partial Cloverleaf B Stop Control		The partial cloverleaf B interchange has two exit loop ramps. The four-quadrant partial cloverleaf B interchange crossroad provides uncontrolled access to the entrance ramps. The exit loop ramp can have a free flow merge with the crossroad for the right turn movement. Advantage: The exit loop ramp removes a left turn movement with the crossroad. Disadvantage: Potential for wrong-way movements at ramp terminal intersection.	The ramp terminal intersections will be STOP controlled for only the exit ramp's right turn movement. The crossroads through movement is uncontrolled. The exit loop ramp's movement is either controlled or uncontrolled and will need to merge with the crossroad's through movement.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections should be signalized.	As noted with pedestrian, consideration should be given to provided separated shared use paths through the interchange area.
Two-Quadrant Partial Cloverleaf B Signalized		The partial cloverleaf B interchange has two exit loop ramps. The two-quadrant partial cloverleaf B interchange crossroad provides signal-controlled access to the entrance ramps. The exit loop ramp can have a free flow merge with the crossroad for the right turn movement. Advantage: The interchange provides full access while only impacting property in two quadrants. Disadvantage: Potential for wrong-way movements at ramp terminal intersection	The ramp terminal intersections will have 3-phase signal operation with two left turn movements. The crossroads through movement is the third phase. The exit ramp's right turn movement will need to merge with the crossroad through movement.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections should be signalized.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.

Ramp Terminal Intersection Control Strategy	Illustration	Description	Mode Accommodations		
			Vehicles	Pedestrians	Bicycles
Two-Quadrant Partial Cloverleaf B Stop Control		The partial cloverleaf B interchange has two exit loop ramps. The two-quadrant partial cloverleaf B interchange crossroad provides uncontrolled access to the entrance ramps. The exit loop ramp can have a free flow merge with the crossroad for the right turn movement. Advantage: The interchange provides full access while only impacting property in two quadrants. Disadvantage: Potential for wrong-way movements at ramp terminal intersection	The ramp terminal intersections will be STOP controlled for only the exit ramp's left turn movement. The crossroads through movement is uncontrolled. The exit ramp's right turn movement is uncontrolled and will need to merge with the crossroad's through movement.	Because of the free flow loop ramps, consideration should be given to separated shared use paths through interchange area. Pedestrian crossing of the loop ramp should have markings and traffic control devices to comply with MUTCD 3B.18. Crossroad pedestrian crossings should be outside the ramp terminal intersections. Pedestrian crossings at the ramp terminal intersections having STOP control should have crosswalks.	As noted with pedestrian, consideration should be given to separated shared use paths through the interchange area.
Roundabout		A subset of traffic circles that feature yield control of all entering vehicles, channelized approaches and horizontal curvature and roadway elements to induce desirable vehicle speeds. Advantages: Typically, reduced crashes and delay compared to signalized control. Disadvantages: Typically, higher cost and require more right-of-way than signalized control.	Vehicles approaching the intersection must yield to vehicles circulating within the circulatory roadway.	Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length.	Bicyclists may ride in the roadway with vehicles or transition to multi-use paths via bicycle ramps (if present). Bike lanes should not be used at roundabouts

APPENDIX B
FDOT ICE FORMS

B.1 General Information

The ICE Forms for Stages 1, 2, and 3 are set up in Excel format to record project and analysis information for submittal to the FDOT's DTOE and DDE for their approval and/or comments. The yellow shaded cells contain pull-down menus to aid the user. In some cases, information will auto populate from one stage to another. **In the "Input" worksheet, the user needs to complete two cells to properly set up the Form** (see **Figure B-1**). The first is "Intersection Type" which has two selections being "At-Grade Intersection" or "Ramp Terminal Intersection". This will set up the Stage 1 Form for the proper analysis condition. It will also create a drop-down menu (shown in **Figure B-1(b)**) to select the at-grade or ramp terminal control strategies evaluated in Stage 1. Select "Yes" to identify the control strategies that are evaluated in Stage 1.

The other cell to set up the Stage 2 Form is the "Project Funding Source" which has two selections "Federal" and "Non-Federal". This sets up the Stage 2 Form for when B/C analysis is or is not conducted.

Figure B-1. Input Worksheet to Set Up ICE Form

Florida Department of Transportation
Intersection Control Evaluation (ICE) Form
Initial Inputs

Intersection Control Evaluation Form 750-010-30

This spreadsheet was developed by FDOT to support the ICE Policy. This spreadsheet tool shall be used to document the findings of the ICE procedure. **Selections must be made in the "Intersection Type" and "Project Funding Source" cells below for the appropriate Stage 1 and Stage 2 forms to fully populate.**

Project Name		FDOT Project #			
Submitted By		Agency/Company		Date	
Email		FDOT District		County	
Project Locality (*City/Town/Village*)					
Intersection Type	At-Grade Intersection	FDOT Context Classification			
Project Funding Source	Non-federal	Project Type			

(a) Upper Portion

At-Grade Control Strategies	To Be Considered?
Two-Way Stop-Control	Yes / No
All-Way Stop-Control	
Signalized Control	
Roundabout (1-lane)	
Roundabout (2-lane)	
Median U-Turn	
Median U-Turn (Partial)	
Restricted Crossing U-turn (Signalized)	
Restricted Crossing U-turn (Unsignalized)	
Jughandle (Forward Ramps)	
Jughandle (Reverse Ramps)	
Displaced Left-Turn (Partial)	
Continuous Green Tee	
Quadrant Roadway	
Thru-Cut (Signalized)	
Thru-Cut (Unsignalized)	
Bowtie	
Other 1 (Type)	
Other 2 (Type)	
Other 3 (Type)	
Other 4 (Type)	
Other 5 (Type)	

Ramp Terminal Control Strategies	To Be Considered?
Diamond Signalized	Yes / No
Diamond Signalized (Alt)	
Diverging Diamond	
Single-Point Diamond	
Diamond Stop Control	
Signalized Tight Diamond	
Roundabout (1-lane)	
Roundabout (2-lane)	
Half Diamond Signalized	
Half Diamond Stop Control	
Two Quadrant Partial Cloverleaf A Signalized	
Two Quadrant Partial Cloverleaf A Stop Control	
Four Quadrant Partial Cloverleaf A Signalized	
Four Quadrant Partial Cloverleaf A Stop Control	
Two Quadrant Partial Cloverleaf B Signalized	
Two Quadrant Partial Cloverleaf B Stop Control	
Four Quadrant Partial Cloverleaf B Signalized	
Four Quadrant Partial Cloverleaf B Stop Control	
Other 1 (Type)	
Other 2 (Type)	
Other 3 (Type)	
Other 4 (Type)	
Other 5 (Type)	

(b) Lower Portion – Two Alternatives based on Selection of Intersection Type

B.2 Stage 1 ICE Form

Figure B-2 shows the screenshots of Stage 1 ICE Form with different panels, including for project information, basic intersection information, crash history, control strategy evaluation, and resolution, for both at-grade Intersection control strategies and ramp terminal control strategies. The only difference in Stage 1 Form inputs between at-grade Intersection and ramp terminal intersection is in the basic intersection information as shown in **Figure B-2(b) and B-2(c).**

Figure B-2. Stage 1 ICE Form

Florida Department of Transportation
Intersection Control Evaluation (ICE) Form
Stage 1: Screening

Intersection Control Evaluation Form 750-010-30

To fulfill the requirements of Stage 1 (Screening) of FDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms are to be submitted to the District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE) for the project's approval.

Project Name		FDOT Project #			
Submitted By		Agency/Company		Date	
Email		FDOT District		County	
Project Locality (*City/Town/Village*)					
Intersection Type		FDOT Context Classification			
Project Funding Source		Project Type			
Project Purpose (*What is the catalyst for this project and why is it being undertaken?*)					
Project Setting Description (*Describe the area surrounding the intersection*)					
Multimodal Context (*Describe the pedestrian, bicycle, and transit activity in the area and the potential for activity based on surrounding land uses and development patterns*)					

(a) Project Information

Major Street Information								
Route #:		Route Name(s)					Milepost	
Existing Control Type			Existing AADT			Design Year AADT		
Design Vehicle			Control Vehicle					
Primary Functional Classification						Design Speed (mph)		
Secondary Functional Classification (if app.)						Target Speed (mph) [if app.]		
Approach #1	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			
Approach #2	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			

Minor Street Information								
Route #:		Route Name(s)					Milepost (if app.)	
Existing Control Type			Existing AADT			Design Year AADT		
Design Vehicle			Control Vehicle					
Primary Functional Classification						Design Speed (mph)		
Secondary Functional Classification (if app.)						Target Speed (mph) [if app.]		
Approach #1	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			
Approach #2	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			
Approach #3	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			

(b) Basic Information for At-Grade Intersection

Cross-Street Information								
Route #:		Route Name(s)					Milepost	
Existing Ramp Control Type			Existing AADT				Design Year AADT	
Design Vehicle			Control Vehicle					
Primary Functional Classification							Design Speed (mph)	
Secondary Functional Classification (if app.)							Target Speed (mph) [if app.]	
Approach #1	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			
Approach #2	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			
Approach #3	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Sidewalks along:		Left-Turn					
	Crosswalk on Approach?		Left-Through					
	On-Street Bike Facilities?		Through		Left		Left	
	Multi-Use Path?		Left-Through-Right		Through		Through	
	Scheduled Bus Service?		Through-Right		Right		Right	
	Bus Stop on Approach?		Right-Turn		Daily Truck %			
Exit Ramp Information								
Route #:		Route Name(s)					Milepost (if app.)	
Existing Ramp Control Type			Existing AADT				Design Year AADT	
Design Vehicle			Control Vehicle					
Primary Functional Classification							Design Speed (mph)	
Secondary Functional Classification (if app.)							Target Speed (mph) [if app.]	
Approach #1	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Crosswalk on Approach?		Left-Turn					
			Left-Through					
			Through		Left		Left	
			Left-Through-Right		Through		Through	
			Through-Right		Right		Right	
			Right-Turn		Daily Truck %			
Approach #2	Direction		Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes	
	Crosswalk on Approach?		Left-Turn					
			Left-Through					
			Through		Left		Left	
			Left-Through-Right		Through		Through	
			Through-Right		Right		Right	
			Right-Turn		Daily Truck %			

(c) Basic Information for Ramp Terminal Intersection

Crash History (Existing Intersections Only)
Append the most recent five-years of crash data for the intersection from the CAR System. If the crash data evidences any issues relating to safety performance, discuss briefly here:

(d) Crash History (Existing Intersection Only)

Control Strategy Evaluation								
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts.								
	CAP-X Outputs				SPICE Outputs			
	V/C Ratio		Ped Accom. Score	Bike Accom. Score	Crash Prediction Rank	SSI Rank	Strategy to be Advanced?	Justification
Control Strategy								

(e) Control Strategy Evaluation

Resolution					
To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer					
Project Determination					
Comments					
DTOE Name		Signature		Date	
DDE Name		Signature		Date	

(f) Resolution

A description of Stage 1 ICE Form items as shown in **Figure B-2** is provided below.

Project Information

Project Name: Enter the project name associated with the project.

FDOT Project #: Enter the FDOT project number assigned to the project. For a project conducting ICE as part of a driveway connection permit, enter "N/A".

FDOT District: Select the appropriate FDOT District in which the project takes place.

County: Select the appropriate county in which the project takes place.

Project Locality (City/Town/Village): Enter the specific city, town, or village in which the project takes place.

Intersection Type: Select the appropriate intersection type from the two choices being "At-Grade Intersection" or "Ramp Terminal Intersection". This should match the selection made on the SPICE spreadsheet Control Strategy tab. *This selection is important to set up the remainder of the Stage 1 Form.*

FDOT Context Classification: Select the appropriate FDOT Context Classification for the project area from the Preliminary Context Classification TDA GIS layer in the FDOT Open Data Hub. If the information is not available, select the most appropriate FDOT Context Classification that best describes the surrounding project area using the information presented in Section 200.4 of the 2024 FDM. A graphical representation of each can be found here: *http://www.flcompletestreets.com/files/FDOT-context-classification.pdf*.

Project Funding Source: Select whether this improvement is to be federally funded or non-federally funded. *This is important to set up the appropriate Stage 2 Form.*

Project Type: Select the project type best describing the proposed project. If the project does not fit any of the project types listed, select "Other (Please type)" and type a more applicable description.

Project Purpose: Describe the catalyst for the project and why it is being undertaken (e.g., a private developer seeking a new access point for their proposed development).

Project Setting Description: Describe the area surrounding the intersection. Be sure to include information pertaining to adjacent land uses, presence of potential constraints (e.g., environmental and right-of-way constraints), and any other pertinent information regarding the study area that may affect the application of some control strategies.

Multimodal Context: Describe pedestrian, bicycle, and transit activity in the area and the potential for activity based on surrounding land uses and development pattern.

Basic Intersection Information – At-Grade Intersection

Major Street Information: Defined as the street normally carrying the higher volume of vehicular traffic.

- Route #: Enter the designated route number(s) for the major street. For streets with dual or overlapping route numbers, be sure to list both (e.g., "US 1/SR 708").
- Route Name(s): Enter the common name of the major street (e.g., "Main Street").
- Milepost: Enter the milepost of the intersection on the major street (e.g., 35.2). This information can be found in the appropriate FDOT Straight Line Diagram.
- Existing Control Type: Select the existing control strategy employed at the intersection. If no intersection currently exists (i.e., the project is proposing a new intersection), select "None/New Intersection".
- Existing AADT: Enter the Annual Average Daily Traffic (AADT) volume carried on the major street. The latest AADT values can be found on FDOT's Florida Traffic Online viewer: *https://tdaappsprod.dot.state.fl.us/fto/*.
- Design Year AADT: Enter volume based on guidance of Section 2.4.2 of this manual.
- Design Vehicle: Select the most appropriate design vehicle for the major street. The design vehicle is defined as the largest vehicle that is accommodated without encroachment on to curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.6 of the 2022 FDM.
- Control Vehicle: Select the most appropriate control vehicle for the major street. The control vehicle is defined as an infrequent vehicle that is accommodated by encroachment into opposing lanes if no median is present and minor encroachment onto curbs and areas within the curb

return (if no critical infrastructure present). For more information on control vehicles, see Section 201.6.1 of the 2022 FDM.

- Primary Functional Classification: Select the functional classification of the major street approach legs. If the classification of the major street changes at the intersection, select the higher order functional classification. Space for secondary classifications is provided in the adjacent cell.
- Design Speed: Enter the design speed for the major street. The design speed is defined as the principal design control that regulates the selection of many project standards and design criteria. For more information on design speed, see Section 201.5. of the 2022 FDM.
- Secondary Functional Classification: If the functional classification of the major street changes at the intersection, select the lower-order functional classification in this cell.
- Target Speed: Enter the target speed for the major street. The target speed is defined as the speed at which vehicles should operate in a specific land use context and consistent with the multimodal activity generated by adjacent land uses. For more information on target speed, see Section 202.2.1 of the 2022 FDM.
- Direction: Select direction of travel for vehicle approach.
- Sidewalks along: Select whether sidewalks are present along one side or both sides of the corresponding major street approach.
- Crosswalks on Approach: Select "Yes" if a crosswalk is present for pedestrians to cross this approach.
- On-Street Bike Facilities?: Check this box if on-street bike facilities (e.g., protected bike lanes) are present along the major street.
- Multi-Use Path?: Check this box if a multi-use path is present along one or more sides of the major street.
- Scheduled Bus Service?: Check this box if scheduled bus services operate along the major street and through the intersection. A bus stop does not need to be located at the intersection to check this box. Presence of a bus stop can be indicated in the adjacent cell.
- Bus Stop on Approach?: Check this box if a bus stop serving a scheduled bus line is located along major street within 1,000 feet of the center of the intersection.
- Number of Lanes: Enter the number of lanes for the movements described in the form.
- Study Period Traffic Volumes: Use the pull-down menu to describe time period for traffic volumes provided in cells below. Enter hourly volumes for

each movement in appropriate cells. Also, enter daily truck % for major street.

Minor Street Information: Defined as the street carrying the lower volume of vehicular traffic. If a third approach is present (e.g., a five-leg intersection), the information for all minor street legs should be input under this same section.

- Route #: Enter the designated route number(s) for the minor street. For streets with dual or overlapping route numbers, be sure to list both (e.g., “SR 200/SR 500”).
- Route Name(s): Enter the common name of the minor street (e.g., “Main Street”).
- Milepost (if applicable): Enter the milepost of the intersection on the minor street (e.g., 35.2). If the minor street is a local road, a milepost will not be applicable.
- Existing Control Type: Select the existing control strategy employed at the intersection. If no intersection currently exists (i.e., the project is proposing a new intersection), select “None/New Intersection
- Existing AADT: Enter the Annual Average Daily Traffic (AADT) volume carried on the minor street. The latest AADT values can be found on FDOT’s Florida Traffic Online viewer*: https://tdaappsprod.dot.state.fl.us/fto/*
- Design Year AADT: Enter volume based on guidance of Section 2.4.2 of this manual.
- Design Vehicle: Select the most appropriate design vehicle for the minor street. The design vehicle is defined as the largest vehicle that is accommodated without encroachment on to curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.6 of the 2022 FDM.
- Control Vehicle: Select the most appropriate control vehicle for the minor street. The control vehicle is defined as an infrequent vehicle that is accommodated by encroachment into opposing lanes if no median is present and minor encroachment onto curbs and areas within the curb return (if no critical infrastructure present). For more information on control vehicles, see section 201.6.1 of the 2022 FDM.
- Primary Functional Classification: Select the functional classification of the minor street approach legs. If the classification of the minor street changes at the intersection, select the higher order functional classification. Space for secondary classifications is provided in the adjacent cell.
- Design Speed: Enter the design speed for the minor street. The design speed is defined as the principal design control that regulates the selection

of many project standards and design criteria. For more information on design speed, see Section 201.5 of the 2022 FDM.

- Secondary Functional Classification: If the functional classification of the minor street changes at the intersection, select the lower-order functional classification in this cell.
- Target Speed: Enter the target speed for the minor street. The target speed is defined as the speed at which vehicles should operate in a specific land use context and consistent with the multimodal activity generated by adjacent land uses. For more information on target speed, see Section 202.2.1 of the 2022 FDM
- Direction: Select direction of travel for vehicle approach.
- Sidewalks along: Select whether sidewalks are present along one side or both sides of the corresponding minor street approach.
- Crosswalks: Select “Yes” if a crosswalk is present for pedestrians to cross this approach.
- On-Street Bike Facilities?: Check this box if on-street bike facilities (e.g., protected bike lanes) are present along the minor street.
- Multi-Use Path?: Check this box if a multi-use path is present along one or more sides of the minor street.
- Scheduled Bus Service?: Check this box if scheduled bus services operate along the minor street and through the intersection. A bus stop does not need to be located at the intersection to check this box. Presence of a bus stop can be indicated in the adjacent cell.
- Bus Stop on Approach?: Check this box if a bus stop serving a scheduled bus line is located along minor street within 1,000 feet of the center of the intersection.
- Number of Lanes: Enter the number of lanes for the movements described in the form.
- Study Period Traffic Volumes: Use the pull-down menu to describe time period for traffic volumes provided in cells below. Enter hourly volumes for each movement in appropriate cells. Also, enter daily truck % for minor street.

Basic Intersection Information – Ramp Terminal Intersection

This is very similar to the entry information for the At-Grade Intersection. This section will only discuss the differences.

Cross Street Information: Cross street is defined as the surface street crossing through the interchange area. The Ramp Terminal Intersection is formed by the intersection of the limited access facility ramps and the cross street. The entries are the same as previously described in Major Street.

Exit Ramp Information: Defined as the exit ramps from the limited access facility to the cross street.

- Route #: Enter the designated route number(s) for the limited access roadway where the exit ramps originated. For roadways with dual or overlapping route numbers, be sure to list both (e.g., “I-4/SR 400”).
- Route Name: Enter the common name of the limited access roadway (e.g., “I-95”).
- Milepost: Enter the milepost of the ramp terminal intersection based on the mainline of the limited access roadway (e.g., 35.2).
- AADT: Enter the Annual Average Daily Traffic (AADT) volume carried on the limited access roadway’s exit ramp.
- Primary Functional Classification: Select the functional classification of the limited access roadway from the pull-down menu. The classifications are urban or rural interstate or freeway/expressway facilities. If the classification of the limited access roadway changes at the interchange, select the higher order functional classification.
- Secondary Functional Classification: Select the secondary functional classification of the limited access roadway from the pull-down menu. If the functional classification of the roadway changes at the interchange, select the lower-order functional classification in this cell.
- Direction: Select the direction of vehicular travel along the exit ramp.

Crash History

This section of the Form is for existing intersections only. After reviewing the five most-recent years of crash data from the Crash Analysis Reporting System or Signal Four Analytics, summarize any trends or patterns in the crash history at the intersection. It is especially important to note the numbers of angle and left turn crashes at the existing intersection.

Control Strategy Evaluation

Apply the FDOT-expanded versions of the CAP-X and SPICE tools to determine the ranking of each control strategy based on its ability to provide adequate capacity and its anticipated safety performance, respectively. Based on these rankings and the qualitative factors analyzed in Stage 1, a determination should be made for each control strategy on whether or not it is to be advanced. Justification should be provided for each control strategy as to why it was advanced or not.

<u>CAP-X Ranking:</u> Enter the V/C Ratio, Ped Accommodation Score, and Bike Accommodation Score from the CAP-X analysis. The lower V/C Ratios indicate better vehicular operations. The higher Ped and Bike Accommodation Scores indicate better multimodal conditions.

<u>SPICE Outputs:</u> SPICE does safety analysis using two different methods. The first is the crash prediction method using the HSM predictive methods. The second is the Safe System for Intersections (SSI) method providing a score for each control strategy based on traffic volume, operating speed, and the number of conflicts. The Stage 1 Form shows the comparative ranking of each control strategy with a ranking of “1” considered the best.

- Crash Prediction Rank: Enter the relative ranking of each control strategy based on the SPICE’s crash prediction analysis. The control strategy having a ranking of “1” is considered to be the safest alternative with respect to crash predictions.
- SSI Rank: Enter the relative ranking of each control strategy based on the SPICE’s SSI analysis. The control strategy having a ranking of “1” is considered the safest alternative with respect to the SSI analysis.

<u>Strategy to be Advanced?:</u> Select whether the control strategy is to be advanced for further evaluation based on the analyses conducted in Stage 1. If only a single control strategy is proposed to be advanced (i.e., Stage 1 analysis illustrates a single, preferred control strategy) only a single “Yes” should be entered on the Form.

<u>Justification:</u> Provide brief justification as to why a control strategy was selected to be advanced or not. It is possible for a control strategy to have a high crash prediction ranking and a low SSI ranking. The project’s purpose and need should be considered to determine if a control strategy should advance. For example, if the project type and project purpose are multimodal based, then SSI’s nonmotorized score from SPICE’s SSI Results tab should be considered in making this determination.

Resolution

This section is to be filled out by the FDOT DTOE and DDE only.

B.3 Stage 2 ICE Form

Figure B-3 shows the screenshots of Stage 2 ICE Form with different panels for project information; operational analyses; safety performance; costs and benefit/cost ratios; multimodal accommodations; environmental, utility, and right-of-way impacts; public input/feedback, control strategy evaluation, and resolution. One difference in Stage 2 Form inputs between federally-funded projects and non-federally-funded projects is in the operational analyses panel as shown in **Figure B-3(a) and B-3(b).** Expectedly, a federally-funded project requires more input for operational analyses. Another difference is that costs and benefit/cost ratios panel needs to be filled out for a federally-funded project (see **Figure B-3(d)**).

Figure B-3. Stage 2 ICE Form

Florida Department of Transportation
Intersection Control Evaluation (ICE) Form
Stage 2: Initial Control Strategy Assessment

Intersection Control Evaluation Form 750-010-30

To fulfill the requirements of Stage 2 (Intersection Control Strategy) of FDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms are to be submitted to the District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE) for the project's approval.

Project Name		FDOT Project #		Date	
Submitted By		Agency/Company		Email	
List all viable intersection control strategies identified in Stage 1 (Screening):					

(a) Project Information

Operational Analyses									
Summarize the results of the peak hour analysis performed for each control strategy. Select analysis year based on guidance in the ICE procedures document. Refer to Exhibit 19-8 of the *Highway Capacity Manual, 6th Edition* (HCM6) to determine the appropriate LOS based on intersection delay (*hover over this cell for Exhibit 19-8*).									
Design Vehicle				Control Vehicle					
Opening Year									
Control Strategy	Peak Hour			Peak Hour			Peak Hour		
	LOS	Delay (sec.)	All Queues Accommodated?	LOS	Delay (sec.)	All Queues Accommodated?	LOS	Delay (sec.)	All Queues Accommodated?
Design Year									
Control Strategy	Peak Hour			Peak Hour			Peak Hour		
	LOS	Delay (sec.)	All Queues Accommodated?	LOS	Delay (sec.)	All Queues Accommodated?	LOS	Delay (sec.)	All Queues Accommodated?
Provide any additional discussion necessary regarding the results of the operational analysis:									

(b) Operational Analyses for Federally-Funded Projects

Operational Analyses				
Summarize the results of the peak hour analysis performed for each control strategy. Select analysis year based on guidance in the ICE procedures document. Refer to Exhibit 19-8 of the *Highway Capacity Manual, 6th Edition* (HCM6) to determine the appropriate LOS based on intersection delay (*hover over this cell for Exhibit 19-8*).				
Design Vehicle		Control Vehicle		
Design Year				
Control Strategy	Critical Peak Hour			
	LOS	Delay (sec.)	All Queues Accommodated?	
Provide any additional discussion necessary regarding the results of the operational analysis:				

(c) Operational Analyses for Non-Federally-Funded Projects

Safety Performance							
Enter the most recent five (5) years of crash data from the CAR System.				Most recent year of crash data available			
Crash Type							Total
Combined	Total						
	Fatal/Injury						
	PDO						
Single-Vehicle	Total						
	Fatal/Injury						
	PDO						
Multi-Vehicle	Total						
	Fatal/Injury						
	PDO						
Vehicle-Pedestrian	Fatal/Injury						
Vehicle-Bicycle	Fatal/Injury						
Total	All						

Apply the FDOT SPICE Tool to model anticipated safety performance of each control strategy. For intersection types not accommodated in the tool, manually apply crash modification factors detailed in the ICE procedures document or qualitatively describe anticipated safety impacts.

Control Strategy	Anticipated Impact on Safety Performance	Opening Year			Design Year		
		Predicted Total Crashes	Predicted Fatal+Injury Crashes	SSI Score	Predicted Total Crashes	Predicted Fatal+Injury Crashes	SSI Score

(d) Safety Performance

Costs and Benefit/Cost Ratios						
Remaining cognizant of the current level of detail of each control strategy's conceptual design, provide a cost estimate for each. You may want to include costs for preliminary engineering, required right-of-way acquisitions, construction, and a contingency. Apply the FDOT ICE Tool to determine the delay benefit-cost ratio (B/C), safety B/C, overall B/C, and net-present value for each control strategy.						
			FDOT ICE Tool Outputs			
Control Strategy	ROW Costs ($)	Construction Costs ($)	Delay B/C	Safety B/C	Overall B/C	Net Present Value

(e) Costs and Benefit/Cost Ratios

Multimodal Accommodations			
Note the existing/anticipated level of pedestrian/bicyclist activity at the study intersection during a typical day. After filling in the daily number of pedestrians crossing, the activity level field will auto-populate.			
Daily # of peds. crossing (all approaches.):		Pedestrian Volume by Activity Level	
Daily # of bicyclists crossing (all approaches):			
Summarize the ability of each viable control strategy to accommodate the existing/anticipated level of:			
Control Strategy	Pedestrians and Bicyclists	Transit Services	Freight Needs

(f) Multimodal Accommodations

Environmental, Utility, and Right-of-Way Impacts	
Summarize any issues related to environmental, utility, or right-of-way (including relocation) impacts specific to each control strategy. Be sure to consider the NEPA requirements for each control type.	

(g) Environmental, Utility, and Right-of-Way Impacts

Public Input/Feedback (if appropriate)
Summarize any agency or public input regarding the control strategies:

(h) Public Input/Feedback

Control Strategy Evaluation		
Provide a brief justification as to why each of the following is either viable or not viable. If a single control strategy is recommended, select it as the only strategy to be advanced.		
Control Strategy	Strategy to be Advanced?	Justification

(i) Control Strategy Evaluation

Resolution					
To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer					
Project Determination					
Comments					
DTOE Name		Signature		Date	
DDE Name		Signature		Date	

(j) Resolution

A description of Stage 2 ICE Form items is provided below.

Project Information

All fields in the "Project Information" section of the Form will be auto-populated from information input to the Stage 1 Form. No changes to this information are necessary, unless the person responsible for submitting the Form has changed between stages.

Operational Analyses

Design Vehicle: Select the most appropriate design vehicle for the major street. The design vehicle is defined as the largest vehicle that is accommodated without encroachment onto curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.6 of the 2022 FDM.

Control Vehicle: Select the most appropriate control vehicle for the major street. The control vehicle is defined as an infrequent vehicle that is accommodated by encroachment into opposing lanes if no median is present and minor encroachment onto curbs and areas within the curb return (if no critical infrastructure present). For more information on control vehicles, see Section 201.6.1 of the 20122 FDM.

Opening Year: Enter the anticipated opening year for the improvement. Space is provided to enter the analysis results of two peak hours for the opening year.

- Peak Hour: Enter the appropriate peak hour being analyzed (e.g., weekday a.m. peak hour, weekday p.m. peak hour). For a non-federally funded project, the opening year peak hour analysis is not required.

- LOS: Enter the overall intersection LOS or LOS for the critical approach (if overall intersection LOS not applicable) for each control strategy. This is a Synchro and Sidra output value.
- Delay: Enter the overall intersection delay or delay for the critical approach (if overall intersection delay not applicable) for each control strategy. This is a Synchro and Sidra value. To obtain the overall intersection delay for the Two-way Stop Control, DLT, MUT, RCUT, Thru-Cut, and Bowtie intersections, the delay tab of the FDOT ICE Tool provides a worksheet to do this calculation.
- All Queues Accommodated?: Select “Yes” or “No” to reflect whether the forecasted 95th percentile queues for all approaches are accommodated by the storage provided by each control strategy. Be sure to account for queue spillback to adjacent intersections. If queues are not accommodated, it may be worthwhile to discuss queuing in the space provided at the end of the “Operational Analysis” section of the Form.

<u>Design Year:</u> Space is provided to enter the analysis results of two peak hours under design year conditions. For the appropriate design year, please refer to Section 201.3 of the 2022 FDM.

- Peak Hour Analyzed: Enter the appropriate peak hour being analyzed (e.g., weekday a.m. peak hour, weekday p.m. peak hour). For a non-federally funded project, only the design year critical peak hour analysis is required.
- LOS: Enter the overall intersection LOS or LOS for the critical approach (if overall intersection LOS not applicable) for each control strategy. This is a Synchro and Sidra output value.
- Delay: Enter the overall intersection delay or delay for the critical approach (if overall intersection delay not applicable) for each control strategy. To obtain the overall intersection delay for the Two-way Stop Control, DLT, MUT, RCUT, Thru-Cut, and Bowtie intersections, the delay tab of the FDOT ICE Tool provides a worksheet to do this calculation.
- All Queues Accommodated?: Select “Yes” or “No” to reflect whether the forecasted 95th percentile queues for all approaches are accommodated by the storage provided by each control strategy. Be sure to account for queue spillback to adjacent intersections. If queues are not accommodated, it may be worthwhile to discuss queuing in the space provided at the end of the “Operational Analysis” section of the Form.

<u>Provide any additional discussion necessary regarding the results of the operational analysis</u>: If any additional clarification is required regarding the opening and design

year operational analyses, describe here. In particular, note if additional operational metrics were evaluated that may help justify/refute the validity of a particular control strategy.

Safety Performance

Anticipated Impact on Safety Performance: After applying the FDOT SPICE tool, describe the anticipated impact of each control strategy on crash frequency.

Predicted Total Crashes: Enter the predicted number of total crashes (opening and design year) from the FDOT SPICE tool for each control strategy.
Predicted Fatal + Injury Crashes: Enter the predicted number of fatal and injury crashes (opening and design year) from the FDOT SPICE tool for each control strategy.

Safe System for Intersection (SSI) Score: Enter the overall intersection SSI score (opening and design year) from the FDOT SPICE tool for each control strategy.

Costs and Benefit-Cost Ratios

ROW Cost ($): Enter the estimated right-of-way costs required to implement each control strategy. This value is not required for a non-federally funded project.

Design & Construction Costs ($): Enter the estimated design and construction costs required to implement each control strategy. This value is not required for a non-federally funded project.

Delay B/C: After applying the FDOT ICE Tool, enter the delay B/C estimated for each control strategy. B/C analysis is not required for a non-federally funded project.

Safety B/C: After applying the FDOT ICE Tool, enter the safety B/C estimated for each control strategy. B/C analysis is not required for a non-federally funded project.

Overall B/C: After applying the FDOT ICE Tool, enter the overall B/C estimated for each control strategy. B/C analysis is not required for a non-federally funded project.

Multimodal Accommodations

Daily # of pedestrian crossing (all approaches): Enter the average number of pedestrians that cross the intersection on a daily basis.

Daily # of bicyclists crossing (all approaches): Enter the average number of bicycle bicyclists that cross the intersections on a daily basis.

Level of pedestrian activity: Select the appropriate level of pedestrian activity identified in the FDOT SPICE Tool.

Environmental, Utility, and Right-of-Way Impacts

Summarize any impacts of the proposed control strategy to the surrounding environment or adjacent properties. These need to focus on social, natural, or physical environment impacts which may preclude the advancement of a particular alternative control strategy. It should also contain considerations for acquiring right-of-way due to costs or environmental impacts. This is also the location to document impacts to major utilities which may be impacted by implementing a control strategy.

Public Input/Feedback

Summarize the feedback received from relevant agencies and the public during outreach efforts, even if that feedback does not present a preferred alternative.

Control Strategy Evaluation

Strategy to be Advanced?: Select whether the control strategy is to be advanced for further evaluation based on the analyses conducted in Stage 1 and Stage 2. If only a single control strategy is proposed to be advanced (i.e., Stage 2 analysis illustrates a single, preferred control strategy), only a single “Yes” should be entered on the Form.

Justification: Provide brief justification as to why a control strategy was selected to be advanced or not.

Resolution

This section is to be filled out by the FDOT DTOE and DDE only.

B.4 Stage 3 ICE Form

Figure B-4 shows the screenshot of Stage 3 ICE Form with different panels, including project information, additional analysis, public input/feedback, control strategy evaluation, and feedback.

Figure B-4. Stage 3 ICE Form

Florida Department of Transportation
Intersection Control Evaluation (ICE) Form
Stage 3: Detailed Control Strategy Assessment

Intersection Control Evaluation Form 750-010-30

To fulfill the requirements of Stage 3 (Detailed Control Strategy Assessment) of FDOT's ICE procedures, complete the following form and append all supporting documentation, which may include detailed design plans of each control strategy analyzed. Completed forms are to be submitted to the District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE) for the project's approval.

Project Name		FDOT Project #		Date	
Submitted By		Agency/Company		Email	
List all viable intersection control strategies identified in Stage 2 (Initial Control Strategy Assessment):					

(a) Project Information

Additional Analysis	
What issues and/or findings to date have led to a control strategy NOT being selected in Stage 2?	
Category	Description of Issues/Findings
Describe specific evaluation activities undertaken in Stage 3 analysis to identify a preferred control strategy and discuss the findings:	
Category	Description of Issues/Findings

(b) Additional Analysis

Public Input/Feedback
If not discussed as a part of the preceding section, summarize public input received or stakeholder considerations regarding the control strategies:

(c) Public Input/Feedback

Control Strategy Evaluation		
Provide a brief justification as to why each of the following was either selected or not selected after conducting the additional analysis. ICE Stage 3 activities should result in a single control strategy being selected.		
Control Strategy	Control Strategy Selected?	Justification

(d) Control Strategy Evaluation

Resolution					
To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer					
Project Determination					
Comments					
DTOE Name		Signature		Date	
DDE Name		Signature		Date	

(e) Resolution

A description of Stage 3 ICE Form items is provided below.

Project Information

All fields in the "Project Information" section of the Form will be auto-populated from information input to the Stage 1 Form. No changes to this information are necessary, unless person responsible for submitting the Form has changed between stages.

Additional Analysis

Category: Select the analysis area where additional analysis was conducted. This should be an analysis area needing further investigation to help differentiate the remaining control strategies.

Description of Issues/Findings: Describe the issues/previous findings from Stage 1 and Stage 2 related to the analysis category. Be sure to discuss why this category is being investigated further (e.g., preliminary operational analyses did not identify a preferred control strategy; so, more rigorous evaluation methodologies are being employed).

Description of Additional (Stage 3) Analysis: Describe the additional analyses undertaken in Stage 3 for each of the categories. Be sure to describe assumptions, methodologies and software used, results of the analyses, and any other pertinent information.

Public Input/Feedback

If public input/feedback was not discussed under “Additional Analysis” section, describe the additional outreach efforts made during Stage 3 analysis.

Control Strategy Evaluation

Strategy to be Advanced?: Select whether the control strategy is to be advanced to for further evaluation based on the analyses conducted in Stages 1, 2, and 3. Only a single control strategy should be advanced.

Justification: Provide brief justification as to why a control strategy is selected or not.

APPENDIX C
PEDESTRIAN AND BICYCLE EVALUATIONS IN CAP-X

With the 2023 FDOT ICE Manual update, the multimodal scoring capability of CAP-X has been changed. The new CAP-X version has a Multimodal Ped tab and a Multimodal Bike tab to calculate separate scores for each mode. ***Note that the multimodal analysis has been developed for four-leg intersections only.*** This section explains the data requirements for these assessments.

C.1 Multimodal Ped Tab

The *Multimodal Ped* worksheet contains previously provided user inputs and default values for conducting the assessment of pedestrian accommodation. Default values are prepopulated for most inputs in the tab with the exception of roadway speeds. The pedestrian analysis will not provide results until the roadway operating speeds are entered. For each row, the analyst can use drop-down menus or direct inputs to override default values.

Previously provided user inputs in the CAP-X workflow, which are auto-populated in the *Multimodal Ped* worksheet, include:

- Number of lanes (per crossing)
- Vehicle volume (per crossing)

Default input values include for the following items:

- Out of direction travel (per intersection)
- Multistage crossing (per intersection)
- Conflicting vehicle type (per crossing)
- Marking type (per crossing)

New user inputs require for the following item:

- Roadway speeds (per crossing)

Default Crossing Locations and Markings

Each intersection has a default number of crossings, where a crossing is the path between any two curbs either at the edge of the roadway or along a median. This can be overridden as discussed in the *Customizing Crossings* section. The location of each default crossing can be seen in the image which appears when hovering over the cells of the "Sheet" column accompanying the "Type of Intersection" column. This image also provides the default conflicting vehicle type (coded by color) and the marking type (coded by crosswalk shading style). Note the images are static and will not update with a change to inputs such as lane numbers. These images are also available at the end of this Appendix. A legend is provided at the top of the *Multimodal Ped* worksheet (see **Figure C-1**).

Figure C-1. Crosswalk Marking Legend

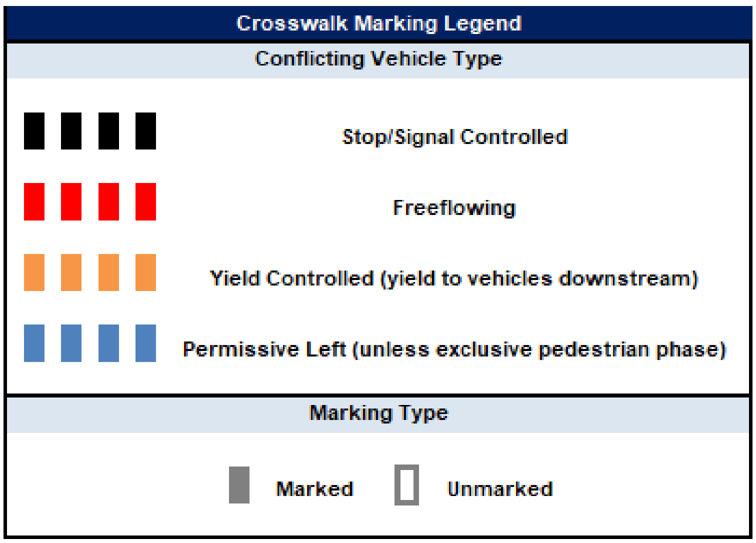


Figure C-2 depicts the default crossing assignments, conflicting vehicle types, and marking types for the east-west Two-Way Stop Control design. Note that directionality is important due to the importation of volumes that were entered earlier in the CAP-X workflow. This intersection design is assumed to have four crosswalks. The major street crosswalks, crossings 1 and 3, are assumed to conflict with free-flowing traffic (red) and are unmarked (hollow shading). The minor street crosswalks, crossings 2 and 4, are assumed to conflict with permissive left turns from the major street (blue) and are marked (solid shading). Further explanation of the selection of default crossing types is provided in the Inputs section below.

Figure C-2. Example of Crossing Assignments, Conflicting Vehicle Types, and Marking Types

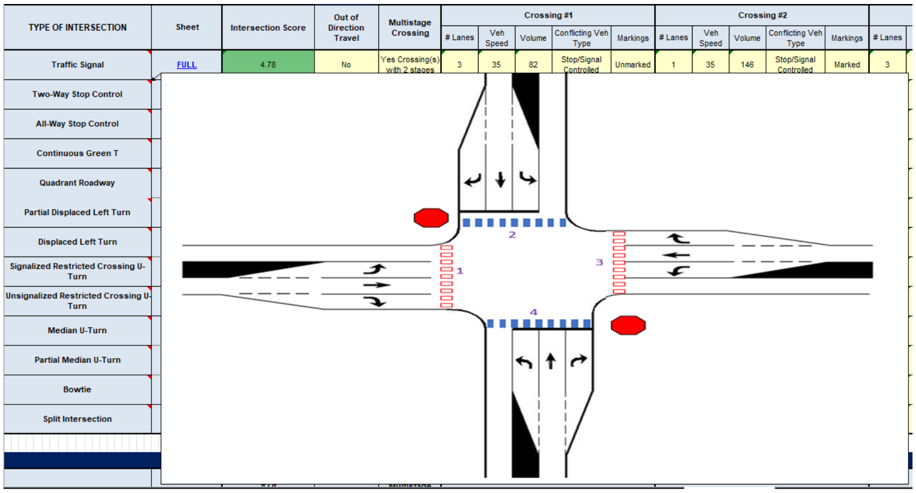


Figure C-3 shows the default values for crossings 1 and 2 entered into the *Multimodal Ped* worksheet.

Figure C-3. Multimodal Ped Worksheet Inputs (partial)

TYPE OF INTERSECTION	Sheet	Intersection Score	Out of Direction Travel	Multistage Crossing	Crossing #1					Crossing #2				
					# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings	# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings
Traffic Signal	FULL	4.78	No	Yes Crossing(s) with 2 stages	3	35	82	Stop/Signal Controlled	Unmarked	1	35	146	Stop/Signal Controlled	Marked
Two-Way Stop Control	E-W	2.40	No	No	4	45	1324	Free Flowing	Unmarked	4	35	228	Permissive Left	Marked

Default values can always be reset using the “Reset Default Values” button located at the top of the worksheet (see **Figure C-4**).

Figure C-4. Reset Default Values Button.

Inputs

<u>Roadway Operating Speeds & Vehicle Speeds</u>

Default roundabout speeds are prepopulated, but input by the user is required for the major and minor street speed limits. Edits are made by direct input. Input overrides must be positive integers and divisible by 5. Once provided in the *Roadway Speeds* input table (see **Figure C-5**), the *Vehicle Speed* cell for each crossing in each row will auto-populate. *Vehicle Speeds* can be overwritten at the cell level as necessary.

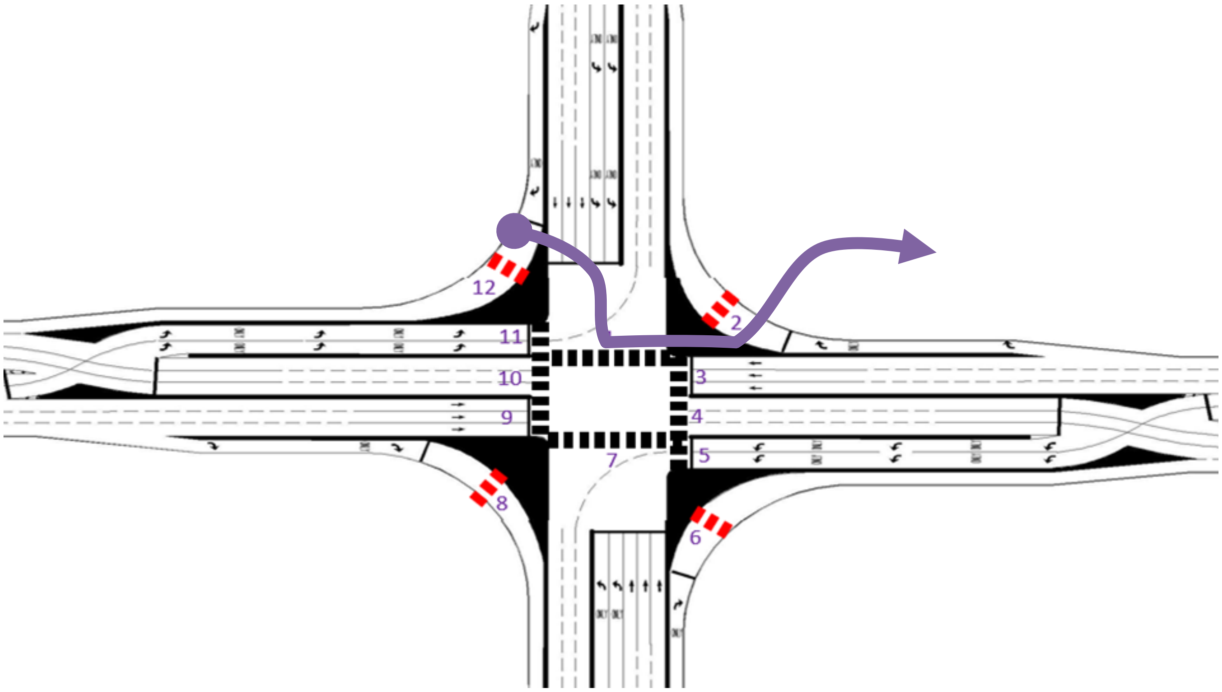
Figure C-5. Roadway Speed Inputs

Roadway Operating Speeds (MPH)	
Major Street Speed Limit	45
Minor Street Speed Limit	35
Mini Roundabout Entry & Exit Speed	20
1-Lane Roundabout Entry & Exit Speed	25
2-Lane Roundabout Entry & Exit Speed	30

Out of Direction Travel

Out of direction travel is gathered at the intersection level and prepopulated by default for all intersections. Edits are made using the drop-down menu. Input overrides must be a categorical value of either "yes" or "no". This factor considers the desire of pedestrians to cross an intersection in the most direct path possible. It should be flagged as yes if one or more pedestrian paths between adjacent quadrants deviates significantly from a straight line. For example, for the east-west Partial Displaced Left Turn intersection, the out of direction travel is assumed to be "yes" because a pedestrian crossing from the northwest quadrant to the northeast quadrant must first travel south, then east, then back north to complete the crossing (see **Figure C-6**).

Figure C-6. Example of Pedestrians' Out of Direction Crossing Direction using Marked Crosswalks



Multistage Crossing

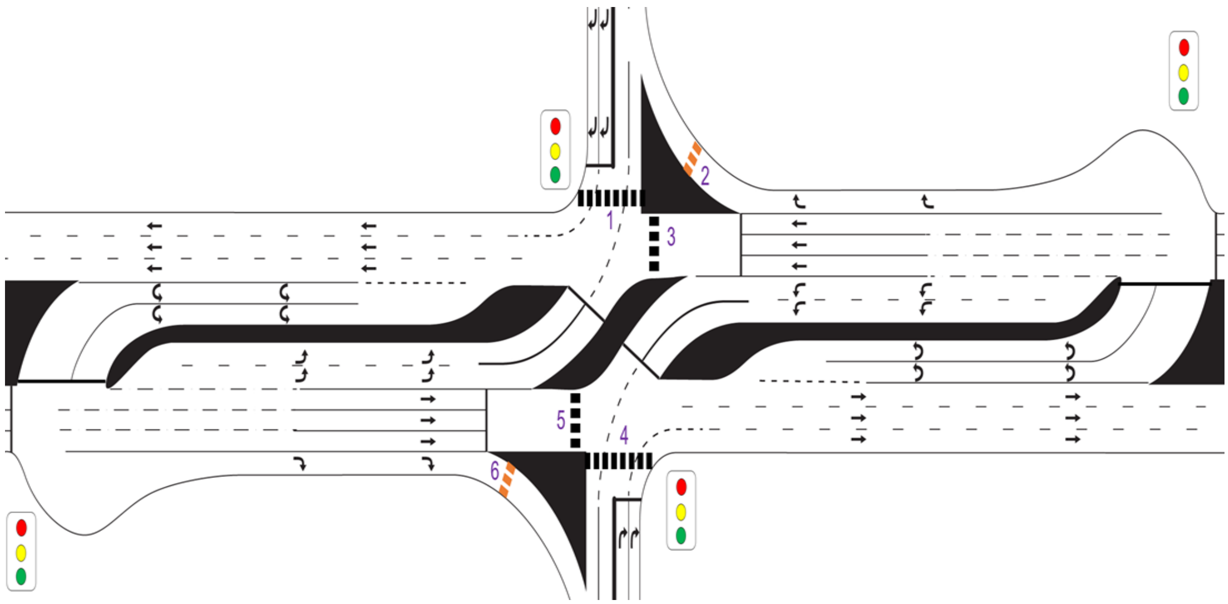
Multistage crossing is gathered at the intersection level and prepopulated for all intersections. Edits are made using the drop-down menu. The consideration of multistage crossings is by movement between adjacent quadrants, even if the design does not feature a direct path between two quadrants. For example, the RCUT design shown in **Figure C-7** does not have a direct path provided between the southeast and northeast quadrant, but the analyst should still consider how a pedestrian desiring to go from the southeast to the northeast quadrants would travel. In this example, it would require four stages (using crosswalks 4, 5, 3, and 2).

Input overrides must be one of the following categorical values:

- Yes, crossing(s) with 3+ stages – select if at least one movement between adjacent quadrants is completed in three or more stages.
- Yes, crossing(s) with 2 stages – select if at least one movement between adjacent quadrants is completed in two stages, but no movement is completed in three stages. A movement that features a median refuge but for which the signal timing allows the movement to be completed in one stage should be considered as two-stage crossing.

- No – select if all movements between adjacent quadrants are completed in one stage.

Figure C-7. Crosswalk Assignments for RCUT



Number of Lanes
Number of lanes is gathered at the crossing level and is directly collected from prior user inputs on the *Alt Num Lanes Input* worksheet. Any override input must be a positive integer. This factor totals the number of approach and departure lanes intersecting the associated crossing.

Vehicle Volume
Vehicle volume is gathered at the crossing level and is directly collected from prior user inputs on the *Volume Input* worksheet. Any override input must be a positive integer. This factor totals the number of vehicles intersecting the crossing either as they approach or depart the intersection.

Conflicting Vehicle Type
Conflicting vehicle type is gathered at the crossing level and is prepopulated by default based on typical control at each intersection form. Edits are made using the drop-down menu. This factor considers the most severe vehicle movement to intersect the crossing. The categorical conflicting vehicle types from least to most severe are:

- Stop/signal controlled - select when all vehicle movements intersecting the crossing are either stop controlled or have protected signal control. This could also be selected if a yield-controlled movement, such as a channelized right turn, features a design element (e.g., a raised crosswalk) that reduces vehicle speeds to near 0 mph.
- Permissive left – select when the most severe vehicle movement intersecting the crossing is a permissive left. If no pedestrians conflict with the permissive left because the pedestrians are moving under an exclusive pedestrian phase, stop/signal controlled can be selected.
- Yield controlled – select when the most severe vehicle movement intersecting the crossing yields to oncoming traffic immediately after the pedestrian crossing, such as at a channelized turn lane. These vehicles are likely decelerating unlike free-flowing vehicles. “Yield controlled” should not be used for crossings where an otherwise free flowing vehicle must yield to a pedestrian in a crossing.
- Free flowing – select when the most severe vehicle movement intersecting the crossing is free flowing, such as the uninterrupted leg of a two way stop controlled intersection.

<u>Markings</u>

Marking type is gathered at the crossing level and is prepopulated by default, per the drawings at the end of this chapter. Edits are made using the drop-down menu. Input overrides must be the categorical values of either “marked” or “unmarked”. This factor considers whether the crossing is marked or unmarked. Note that while the legend and assumed crossing assignment diagrams feature zebra style crosswalk markings, the presence of any style marking qualifies as “marked”. Regardless of marking presence, each intersection is assumed to have crossings on the major and minor streets for intersections or the crossroad and ramps for interchanges. At intersection control strategies where a crossing is not typically provided, the tool still assumes it is present and unmarked. This results in a decreased pedestrian score due to the lack of formal crossing availability.

Customizing Crossings

The default crosswalk locations and markings are intended to align with typical concept-level layouts of the intersection designs. However, it is possible that local design guidelines, prior project decisions, or emerging concepts for newer intersection designs result in different crossing quantities or locations. This is most likely to occur due to presence or absence of a median or channelized turn lanes and local practices regarding pedestrian facility designs for specific intersection types.

When eliminating or adding a crossing, the pedestrian volumes and the number of lanes in the remaining crossings are usually impacted, and so, the user will need to manually input (or manually rewrite cell formulas for) the values for the impacted crossings.

To reset the spreadsheet to the default values, click the “Reset Default Values” button at the top of the tab. This ensures the spreadsheet has the default number of crossings for each intersection type and the cells reflect the correct default values or formulas.

<u>Example: Eliminating a Crossing</u>
Following is an example of modifying the traffic signal evaluation to eliminate the median refuge island on the northern approach. **Figure C-8**Figure C-8 shows the default crossing locations of which there are eight. This layout assumes a median refuge island exists at each approach. (Note: because the images in the *Multimodal Ped* worksheet are static, median refuge islands are not shown but implied due to the presence of two crossing assignments). The modified locations are shown in **Figure C-9**. Note that crossing 2 has been removed.

Figure C-8. Default Crossing Locations and Markings at Traffic Signal

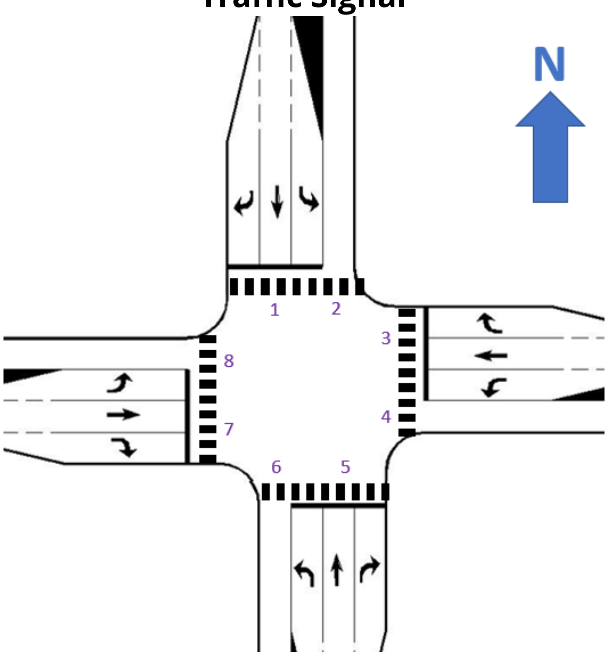


Figure C-9. Modified Crossing Locations and Markings at Traffic Signal

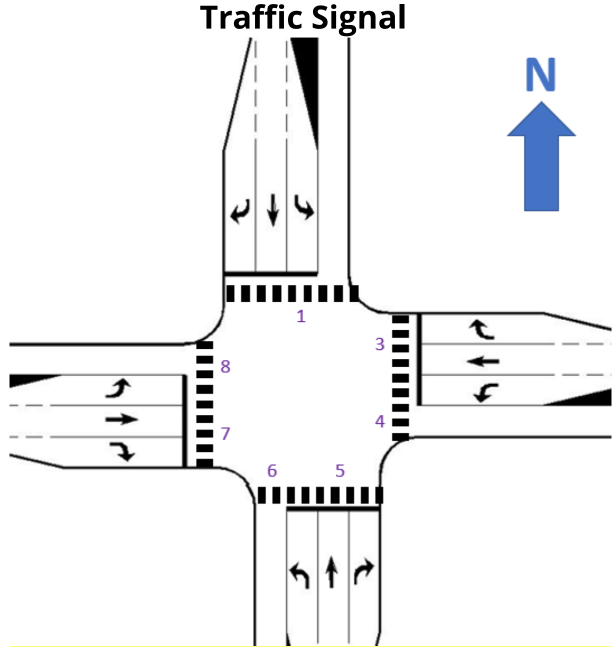


Figure C-10 and **Figure C-11** show the default and modified inputs corresponding to default and modified crossing locations, respectively. Note that the number of lanes and volume from the default Crossings 1 and 2 were combined for the modified Crossing 1. When calculating the overall intersection score, the tool will ignore Crossing 2 because the cells are empty.

Figure C-10. Default Inputs for Traffic Signal

TYPE OF INTERSECTION	Sheet	Intersection Score	Out of Direction Travel	Multistage Crossing	Crossing #1					Crossing #2				
					# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings	# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings
Traffic Signal	FULL	4.78	No	Yes Crossing(s) with 2 stages	3	35	82	Stop/Signal Controlled	Unmarked	1	35	146	Stop/Signal Controlled	Marked

Figure C-11. Modified Inputs for Traffic Signal

TYPE OF INTERSECTION	Sheet	Intersection Score	Out of Direction Travel	Multistage Crossing	Crossing #1					Crossing #2				
					# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings	# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings
Traffic Signal	FULL	4.65	No	Yes Crossing(s) with 2 stages	4	35	228	Stop/Signal Controlled	Unmarked					

Scores

Each crossing receives a crossing score. The intersection score is a combination of each crossing score as well as scores for the intersection-based inputs of out of direction travel and multistage crossing. A higher score indicates a safer design with the highest possible score being 6 and the lowest possible score being 0.9.

<u>Crossing Score</u>

The score for crossing *i* (C_i) is a combination of the factor scores for number of lanes (F_L), vehicle speed (F_S), vehicle volume and conflicting vehicle type (F_{VC}), and presence of markings (F_M). These scores are shown in the following pages.

$$C_i = \frac{F_L + F_S + F_{VC} + F_M}{4}$$

<u>Intersection Score</u>

The intersection score is a combination of all *n* crossing scores (C_i) and the factor scores for out of direction travel (F_T) and the multistage crossing (F_C). These scores are shown in the following pages. The out of direction travel and multistage crossing factors are inputs to the intersection score rather than crossing score because one out of direction travel or multistage crossing experience occurs over multiple crossings. Averaging the square root of the crossing scores incentivizes improving poor performing crossings over making high performing crossings marginally better.

$$Intersection\ Ped\ Score = \left[\frac{\sum_{i=1}^{n}\sqrt{C_i}}{n}\right]^2 F_T F_C$$

Factor Scores

Number of Lanes (F_L): As shown in Table C-1, the score for the number of lanes ranges from 5 (best) to 1 (worst). It is based on the commonly accepted belief that the more lanes a pedestrian must cross, the more likely the pedestrian is to experience a crash due to increased workload. This is confirmed by focus group data that pedestrians prefer crossing fewer lanes (NASEM, 2021).

Table C-1. Number of Lanes Score

Number of Lanes	Score
1	5
2	4
3	3
4	2
5+	1

Vehicle Speed (F_S): The score for the vehicle speed ranges from 5 (best) to 1 (worst) and is shown in **Table C-2**. It is based on the findings in the Tefft (2013) study.

Table C-2. Vehicle Speed Score

Speed (mph)	Score
≤ 25	5
26-34	4
35-40	3
41-50	2
51+	1

Vehicular Volume and Conflicting Vehicle Control Type (F_{VC}): The score for the vehicle volume and conflicting vehicle control type ranges from 5 (best) to 1 (worst) and is shown in **Table C-3**. The volume thresholds are based on the relationship between AADT and pedestrian crashes as reported in the *Temporal Analysis of Predictors of Pedestrian Crashes* study (Guerra et al., 2020), which shows pedestrian-vehicle crashes tend to increase as AADT increases until 100,000 vehicles and then level off on average across all time periods. To generate hourly volumes, it is assumed that the typical hour K value is 9% and the volumes are identical across all four approaches. This yields an hourly volume of 1,500 vehicles, which is set as the threshold for a rating between 1 and 2. In assigning scores for the various conflicting vehicle control types, the separation of movements by time under protected stop/signal control results in the driver having fewer traffic streams to focus on and increasing the likelihood of identifying a pedestrian. So, all volumes for stop/signal controlled will receive a score of 5. Permissive and yield-controlled movements are similar in driver behavior such that the driver is looking for a gap in oncoming vehicles, and therefore, the scores are the same for those two conflicting vehicle types. Finally, free-flowing vehicles received the lowest scores because drivers typically are not anticipating yielding to other users, whether vehicle or pedestrian. At higher volumes, the gaps available to pedestrians are smaller in size; therefore, all volumes will receive a score of 1 when the free-flowing volume is above 450 veh/hr.

Table C-3. Vehicular Volume and Conflicting Vehicle Control Type Score

Volume (vph)	Conflicting Vehicle Control Type			
	Stop/Signal	Permissive Left	Yield	Free Flowing
≤ 225	5	5	5	3
226-450	5	4	4	2
451-1,350	5	3	3	1
1,351-2,250	5	2	2	1
>2,250	5	1	1	1

Presence of Markings (F_M): The score for the presence of crosswalk markings is a binary of 5 (best) and 1 (worst) and is shown in **Table C-4**. Crosswalk markings at the intersection reduce the likelihood of right turning vehicles encroaching on the crossing. This also creates an additional disincentive for designs that fail to provide full access to pedestrians across major and minor streets (intersections) or ramps and crossroads (major intersections). Failure to mark a crosswalk does not result in a lack of pedestrian attempts to cross.

Table C-4. Presence of Markings Score

Marking	Score
Present	5
Absent	1

Out of Direction Travel (F_T): The score for out of direction travel is a binary of 1 (best) and 0.9 (worst) and is shown in **Table C-5**. It is based on the finding that pedestrians experiencing delay are more likely to exhibit risky behavior (TRB, 2016).

Table C-5. Out of Direction Travel Score for Pedestrians

Out of Direction Travel	Score
No	1.0
Yes	0.9

Multistage Crossing (F_C): The score for the multistage crossing ranges from 1.2 (best) to 0.8 (worst) and is shown in **Table C-6**. It is based on the FHWA report, *Safety Effects of Marked vs Unmarked Crosswalks at Uncontrolled Locations,* which found the presence of raised medians reduced pedestrian crashes by 46% (Zegeer et al., 2002). This suggests a two-stage crossing improves pedestrian safety. However, surveys and focus groups of pedestrians found three or more stages to be confusing (NASEM, 2021).

Table C-6. Multistage Crossing Score

Number of Stages	Score
1	1.0
2	1.2
3+	0.8

C.2 Multimodal Bike Tab

The *Multimodal Bike* worksheet contains previously provided user inputs, new user inputs, and default values for conducting the assessment of bicycle facilities. Two new user inputs must be added for valid bicycle scores. The analyst can use drop-down menus or direct inputs to override default values.

Previously provided user inputs in the CAP-X workflow, which are auto-populated in the *Multimodal Bike* worksheet, include:

- Number of adjacent thru lanes (per leg)
- Leg AADT (calculated from previous volume entry)
- Roadway speeds (entered by user on the *Multimodal Ped* worksheet)

Default values include for the following items:

- Conflicting control type (per leg)
- Out of direction travel (per leg)
- Riding between travel lanes (per leg)
- Riding across free flow ramp (per leg)

New user inputs require for the following item:

- Major and minor street bicycle facility type

Leg Assignment

The *Multimodal Bike worksheet* considers approach legs of an intersection. For most intersections, there are four or fewer (e.g. continuous green T) legs. However, some intersections have more than four legs due to the presence of auxiliary intersections. A description of the assignment of any additional leg, noted in the spreadsheet as "[Direction] 2" can be found by hovering over that intersection's "Type of Intersection" cell.

Inputs

<u>Facility Types</u>
The Facility type for both the major and minor roadways is a required input to the bicycle methodology. It is found at the top of the worksheet and serves as an input

to all intersection types. Edits are made using the drop-down menu. Categorical inputs include:

- **Shared with vehicles** – select if bicycles and vehicles will use the same space on the roadway, such as a motor vehicle travel lane with no other bicycle facility provided.
- **On-street lane** – select if a dedicated bicycle space is provided adjacent to the motor vehicle travel lane. This includes parking separated or bollard separated bicycle lanes. This facility type can still be selected if vehicle and bicycle paths cross at points near the intersection (e.g., for the opening of an exclusive right turn lane).
- **Shared use path** – select if an off-street facility is provided for bicycles. This includes facilities which are at the same elevation of the motor vehicle facilities but physically and continuously separated (e.g., by a continuous median or curb).

The *Facility Type* input table in CAP-X (see **Figure C-12**) is found at the top of the worksheet and serves as an input to all intersection types.

Figure C-12. Facility Type Inputs

Facility Type	
Major Street Facility Type	Shared with Vehicles
Minor Street Facility Type	On-Street Lane

Leg AADT

AADT is gathered at the leg level and is directly collected from prior user inputs on the *Volume Input* tab. Any override input must be a positive integer. This factor considers the vehicular AADT adjacent to the bicyclist. Weekday K factors were calculated for each hour of the day by averaging the K factor for 7 different roadway classifications found in the FDOT ICE Tool. The highest hourly K factor was then used to convert hourly volumes provided on the *Volume Input* worksheet into AADTs.

Roadway Operating Speeds

Default roadway operating speeds are prepopulated from the *Multimodal Ped* tab. Edits should be made on the Multimodal Ped worksheet so that pedestrian and bicycle analysis is conducted with the same roadway operating speeds. The *Roadway*

Speeds input table in CAP-X (see **Figure C-13**) is found at the top of the worksheet and serves as an input to all intersection types.

Figure C-13. Roadway Speed Inputs

Roadway Operating Speeds (MPH)	
Major Street Speed Limit	45
Minor Street Speed Limit	35
Mini Roundabout Entry & Exit Speed	20
1-Lane Roundabout Entry & Exit Speed	25
2-Lane Roundabout Entry & Exit Speed	30

Number of Adjacent Thru Lanes

The Number of lanes is gathered at the leg level and is directly collected from prior user inputs on the *Alt Num Lanes Input* tab. Any override input must be a positive integer. This factor considers the number of through lanes a bicyclist would need to cross to move into the left turn lane. It totals the number of through lanes traveling in the same direction as the bicyclist on the same approach leg. If two stage left turn boxes or some other method of turning left will be provided, the input should be set to 1. For the minor legs of the signalized and unsignalized restricted crossing U-turn intersections, this factor considers the number of adjacent through lanes on the major leg after the bicyclist has made the right turn from the minor leg.

Conflicting Control Type

Conflicting vehicle type is gathered at the leg level and is prepopulated by default. Edits are made using the drop-down menu. This factor considers the dominant control type for vehicular traffic moving perpendicular to the direction of the bicyclist. The categorical conflicting control types are:

- **Stop/signal controlled** - select when the conflicting vehicles operate under stop or signal control. This can still be selected if a right turning movement operates under yield control.
- **Yield controlled** – select when the conflicting vehicles operate under yield control, such as at roundabouts.

- **Free Flowing** – select when the conflicting vehicles are free flowing, such as the uninterrupted leg of a two way stop controlled intersection.

Out of Direction Travel
Out of direction travel is gathered at the leg level and prepopulated by default for all intersections. Edits are made using the drop-down menu. Input overrides must be a categorical value of either “yes” or “no”. This factor considers the desire of bicyclists to travel in the most direct path possible. It should be flagged as yes if any movement by a bicyclist on that leg results in vertical or horizontal out of direction travel. For example, the minor legs of the Restricted Crossing U-Turn intersection *Out of Direction Travel* is assumed to be “yes” because a bicyclist desiring to go straight or turn left must turn right and travel to the downstream U-turn. It is assumed at Median U-Turns that bicyclists will perform a two-stage left turn even if no pavement marking for such is provided.

Riding Between Opposing Travel Directions
Riding between travel lanes moving in two opposite directions is gathered at the leg level and prepopulated for all intersections. Edits are made using the drop-down menu. Input overrides must be a categorical value of either “yes” or “no”. This factor considers instances where a bicyclist is traveling between opposing directions of motor vehicle traffic, such as at the displaced left turn.

Riding Across Free Flow Ramp or Channelized Turn Lane
Riding across free flow ramp is gathered at the leg level and is prepopulated by default. Edits are made using the drop-down menu. Input overrides must be the categorical values of either “yes” or “no”. This factor considers whether a bicyclist traveling along the leg must cross a free-flowing vehicle movement. This most often occurs when a bicyclist crosses the downstream end of a channelize turn lane or the up- or downstream end of a loop ramp.

Scores

Each crossing receives a leg score which is then combined with all other leg scores at the intersection. The intersection score is a combination of each leg score. A higher score indicates a safer design with the highest possible score being 5 and the lowest possible score being 1.

Leg Score

The score for Leg *i* (L_i) is a combination of the factor scores of facility type, leg AADT, and speed (F_{FAS}), number of adjacent thru lanes (F_A), conflicting control type (F_C), out of direction travel (F_T), riding between travel lanes (F_B), and riding across free flow ramps (F_R). The scores for these values are shown later in this document.

$$L_i = \frac{F_{FAS} + F_A + F_C + F_T + F_B + F_R}{6}$$

Intersection Score

The intersection score is a combination of all *n* leg scores (L_i). Averaging the square root of the leg score incentivizes improving poor performing legs over making high performing legs marginally better.

$$Intersection\ Score = \left[\frac{\sum_{i=1}^{n} \sqrt{L_i}}{n}\right]^2$$

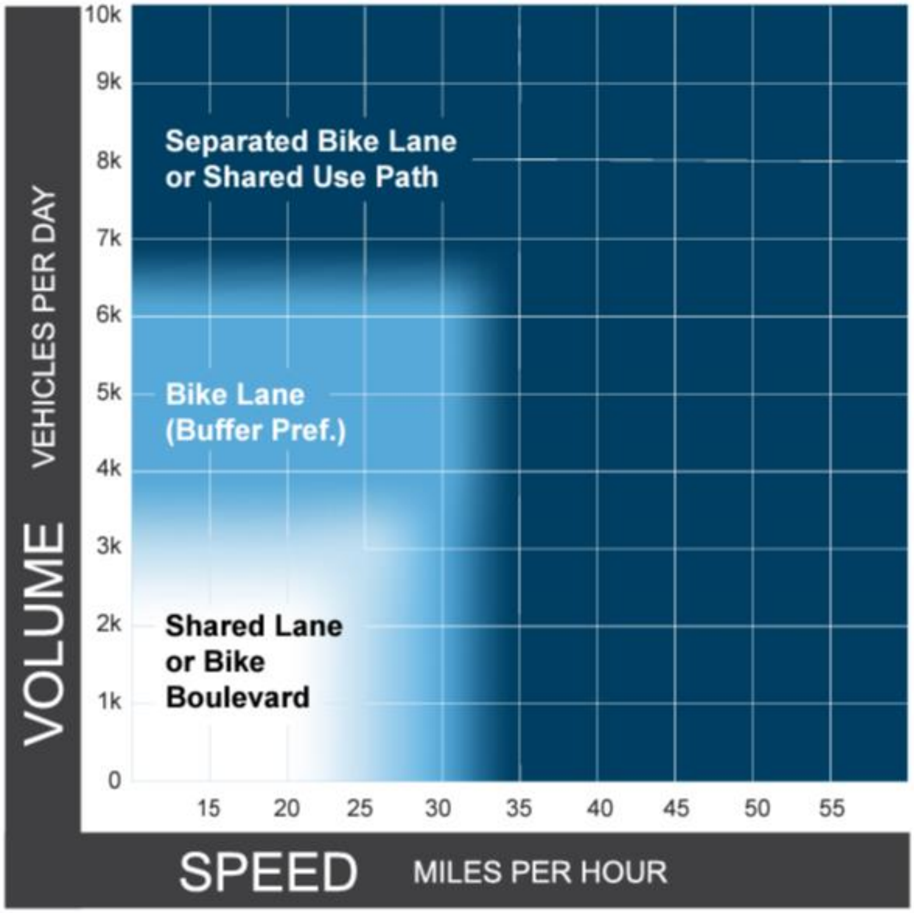
Factor Scores

Facility Type, Leg AADT, and Roadway Speeds (F_{FAS}): The score for the facility type, leg AADT, and roadway speeds ranges from 5 (best) to 1 (worst) and is shown in **Table C-7**. Grouping of facility type and vehicle speeds, as well as AADT thresholds of 3,000 and 7,000 veh/day were selected based on the FHWA Bikeway Selection Guide preferred bikeway types shown in **Figure C-14** (Schultheiss et al., 2019). Assigned scores for shared use paths were set to 5 due to the bicycle-vehicle interaction being limited to designated crossings.

Table C-7. Leg AADT and Roadway Operating Speed Score for Various Bike Facilities

Bike Facility Type	Leg AADT (vpd)	Operating Speed (mph)			
		≤ 25	26-30	31-39	≥ 40
Shared Use Path	≤ 3,000	5	5	5	5
	3,001 - 7,000	5	5	5	5
	>7,000	5	5	5	5
On-Street Bike Lane	≤ 3,000	5	4	4	2
	3,001 - 7,000	4	4	4	2
	>7,000	3	2	2	1
Shared with Vehicle Lane	≤ 3,000	5	4	3	2
	3,001 - 7,000	3	3	2	1
	>7,000	2	1	1	1

Figure C-14. Preferred Bikeway Type for Urban, Urban Core, Suburban, and Rural Town Contexts (Source: Schultheiss et al., 2019)



Assigned scores for on-street lanes and shared lanes are guided by Level of Traffic Stress (LTS) scoring tables shown in **Figure C-15.** For on-street lane facilities, the mixed traffic criteria table is used (**Figure C-15a**). Where the LTS tables provided more granular scoring (e.g., sub-classification of AADTs), average values across all LTS are used. For example, in considering the score for on-street lanes with operating speeds between 26 and 30 mph and AADT less than or equal to 3,000 veh/day, all LTS scores which meet those criteria (highlighted in red) are averaged. For bike lane facilities, the “bike lanes and shoulders not adjacent to a parking lane” table is used (**Figure C-15b**). LTS for “1 thru lane per direction, or unlaned” is used to determine scores for AADTs less than or equal to 3,000 veh/day. LTS for “2 thru lanes per direction” is used to determine scores for AADTs between 3,000 and 7,000 veh/day. In both instances, LTS values are averaged across speed and bike lane width as necessary. LTS values for “3+ lanes per direction” is used to determine scores for AADTs greater than 7,000 veh/day (Furth, 2017).

Figure C-15. Level of Traffic Stress Criteria for Road Segments, Version 2.0 (Source: Furth, 2017)

Mixed traffic criteria

Number of lanes	Effective ADT*	Prevailing Speed ≤ 20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50+mph
Unlaned 2-way street (no centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 1	LTS 1	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4
	1501-3000	LTS 2	LTS 2	LTS 2	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
1 thru lane per direction (1-way, 1-lane street or 2-way street with centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4
	1501-3000	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
2 thru lanes per direction	0-8000	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	8001+	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4
3+ thru lanes per direction	any ADT	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4

* Effective ADT = ADT for two-way roads; Effective ADT = 1.5*ADT for one-way roads

(b) Mixed Traffic Criteria

Bike lanes and shoulders not adjacent to a parking lane

Number of lanes	Bike lane width	Prevailing Speed ≤ 25 mph	30 mph	35 mph	40 mph	45 mph	50+ mph
1 thru lane per direction, or unlaned	6+ ft	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
2 thru lanes per direction	6+ ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
3+ lanes per direction	any width	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4

Notes 1. If bike lane / shoulder is frequently blocked, use mixed traffic criteria.
2. Qualifying bike lane / shoulder should extend at least 4 ft from a curb and at least 3.5 ft from a pavement edge or discontinuous gutter pan seam
3.Bike lane width includes any marked buffer next to the bike lane.

(c) Bike Lanes and Shoulders not Adjacent to a Parking Lane

Number of Adjacent Thru Lanes (F_A): The score for the number of adjacent thru lanes ranges from 5 (best) to 1 (worst) and is shown in **Table C-8**. It considers the number of lanes a bicyclist must cross to move from the right side of the road when making a left turn. Each movement across a lane is a potential interaction with at least one motor vehicle driver. Additional lanes result in increased interactions and therefore receive lower scores.

Table C-8. Number of Adjacent Thru Lanes Score

Number of Lanes	Score
1	5
2	4
3	2
4+	1

Conflicting Control Type (F_C): The score for the vehicle volume and conflicting vehicle type ranges from 5 (best) to 1 (worst) and is shown in **Table C-9**. In assigning scores for the various conflicting vehicle types, the separation of movements by time under protected stop/signal control results in additional protection for the bicyclist and therefore is given a score of 5. Yield controlled movements, found at roundabouts, receive a score of 4 because drivers have a slightly higher workload but are still actively looking for roadway users. Finally, free flowing vehicles receive the lowest score 1 because drivers are not anticipating the need to yield to bicyclists and bicyclists must look for a gap in traffic.

Table C-9. Conflicting Control Type Score

Conflicting Control Type	Score
Stop/Signal	5
Yield	4
Free Flowing	1

Out of Direction Travel (F_T): The score for out of direction travel is a binary of 5 (best) and 1 (worst) and is shown in **Table C-10**. It is based on the commonly accepted belief that bicyclists experiencing additional delay for out of direction travel are more likely to exhibit risky behavior.

Table C-10. Out of Direction Travel Score for Bicyclists

Out of Direction Travel	Score
No	5
Yes	1

Riding Between Opposing Travel Directions (F_B): The score for riding between travel lanes is a binary of 5 (best) and 1 (worst) and is shown in **Table C-11**. Bicyclists in focus groups confirmed riding between travel lanes increases discomfort due to being unable to maneuver away from an errant motor vehicle. Additionally, riding between travel lanes almost always results in bicycle and motor vehicle paths crossing at least once.

Table C-11. Riding Between Travel Lanes Score

Riding Between Travel Lanes	Score
No	5
Yes	1

Riding Across Free Flow Ramp or Channelized Lane (F_R): The score for riding across free flow ramps is a binary of 5 (best) and 1 (worst) and is shown in **Table C-12**. Vehicles making a free flow movement are typically not expected to yield to another user, so bicyclists crossing such a movement are at increased risk as compared to a bicyclist continuing to move parallel to motor vehicles.

Table C-12. Riding Across Free Flow Ramp Score

Riding Across Free Flow Ramp	Score
No	5
Yes	1

C.3 References

Furth, P.G. (2017) Level of Traffic Stress Criteria for Road Segments Version 2.0. Available in: https://peterfurth.sites.northeastern.edu/2014/05/21/criteria-for-level-of-traffic-stress/. Accessed October 31, 2023.

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Tefft, B. (2013). Impact Speed and a Pedestrian's Risk of Severe Injury or Death. *Accident Analysis and Prevention*, 50, pp. 871-878. https://doi.org/10.1016/j.aap.2012.07.022.

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Zegeer, C.V., Stewart, J.R., Huang, H.H. and Lagerwey, P.A. (2002). *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines*. Report No. FHWA-RD-01-075. Federal Highway Administration, McLean, VA.

C.4 Pedestrian Default Crossing Locations and Marking Images

Figure C-16. Traffic Signal

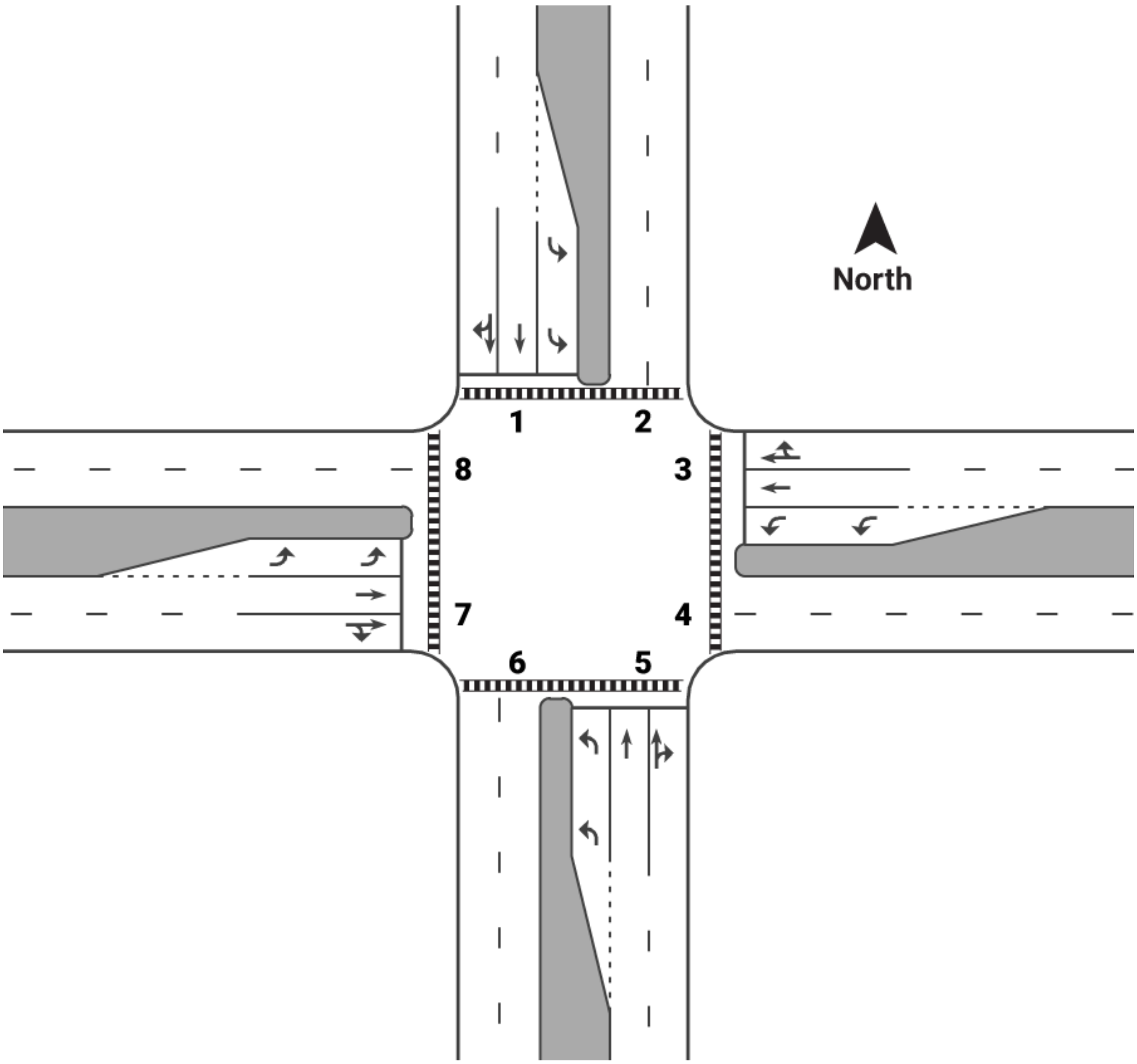


Figure C-17. Two-Way Stop Control (N-S)

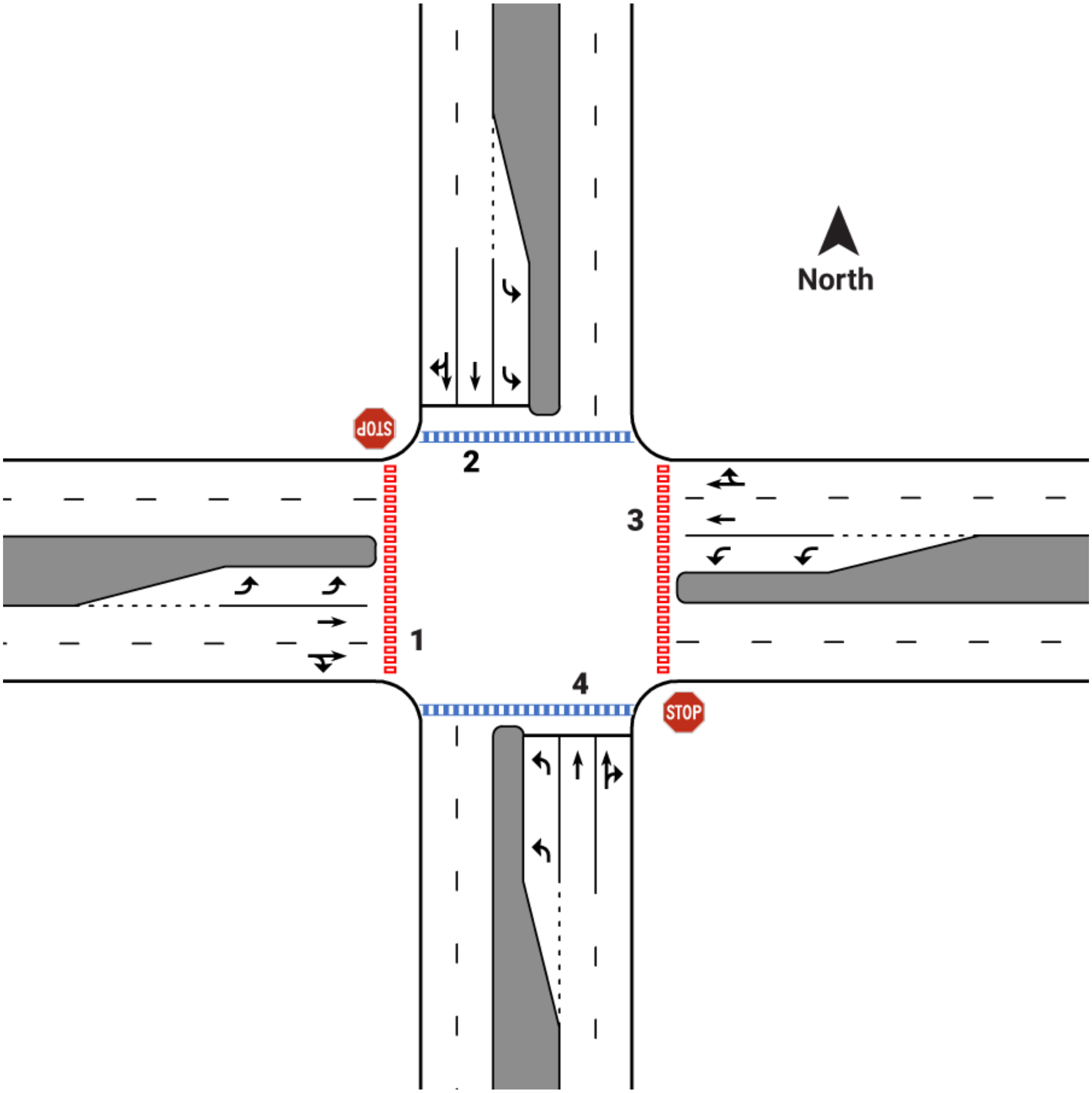


Figure C-18. Two-Way Stop Control (E-W)

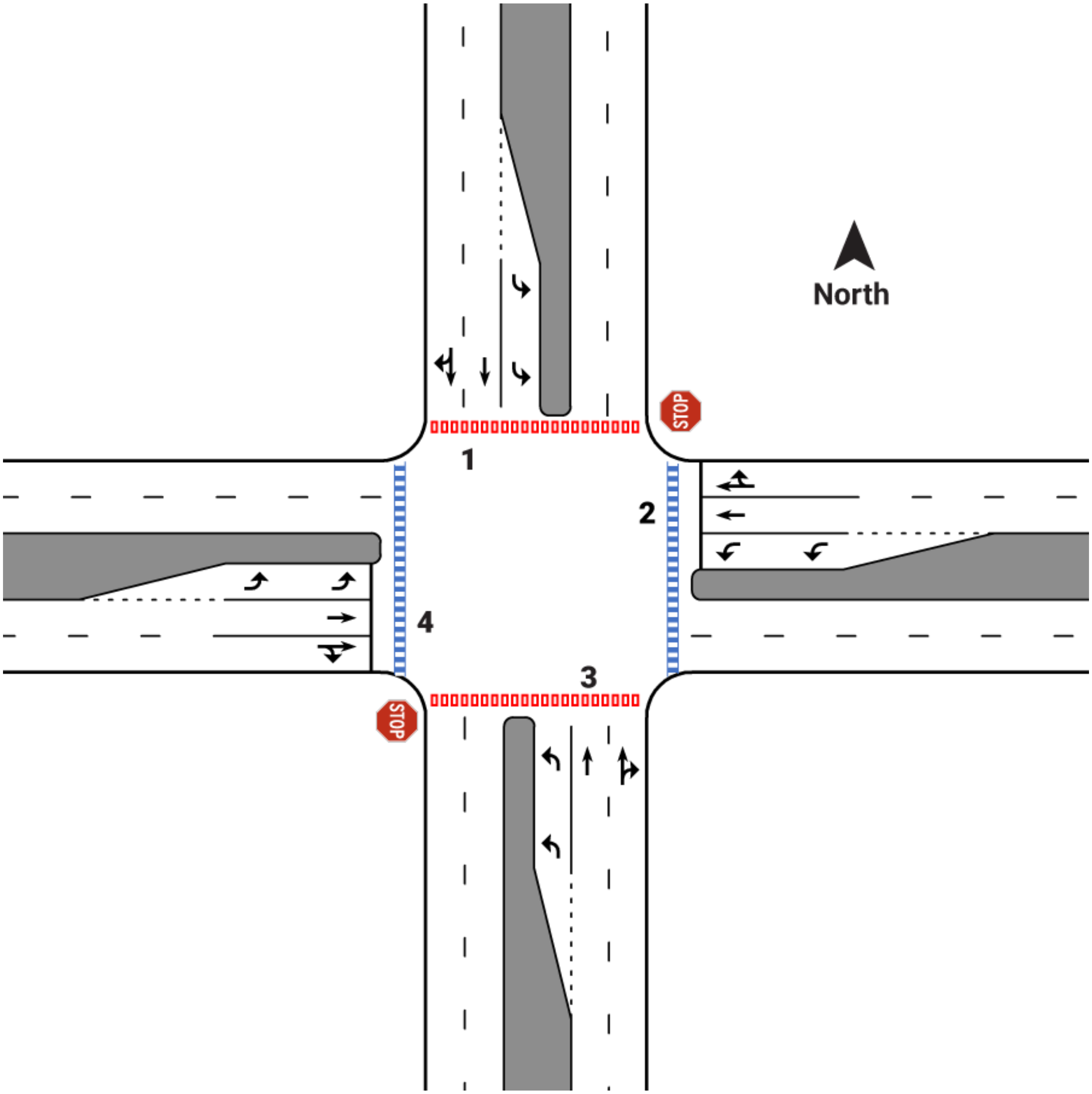


Figure C-19. All-Way Stop Control

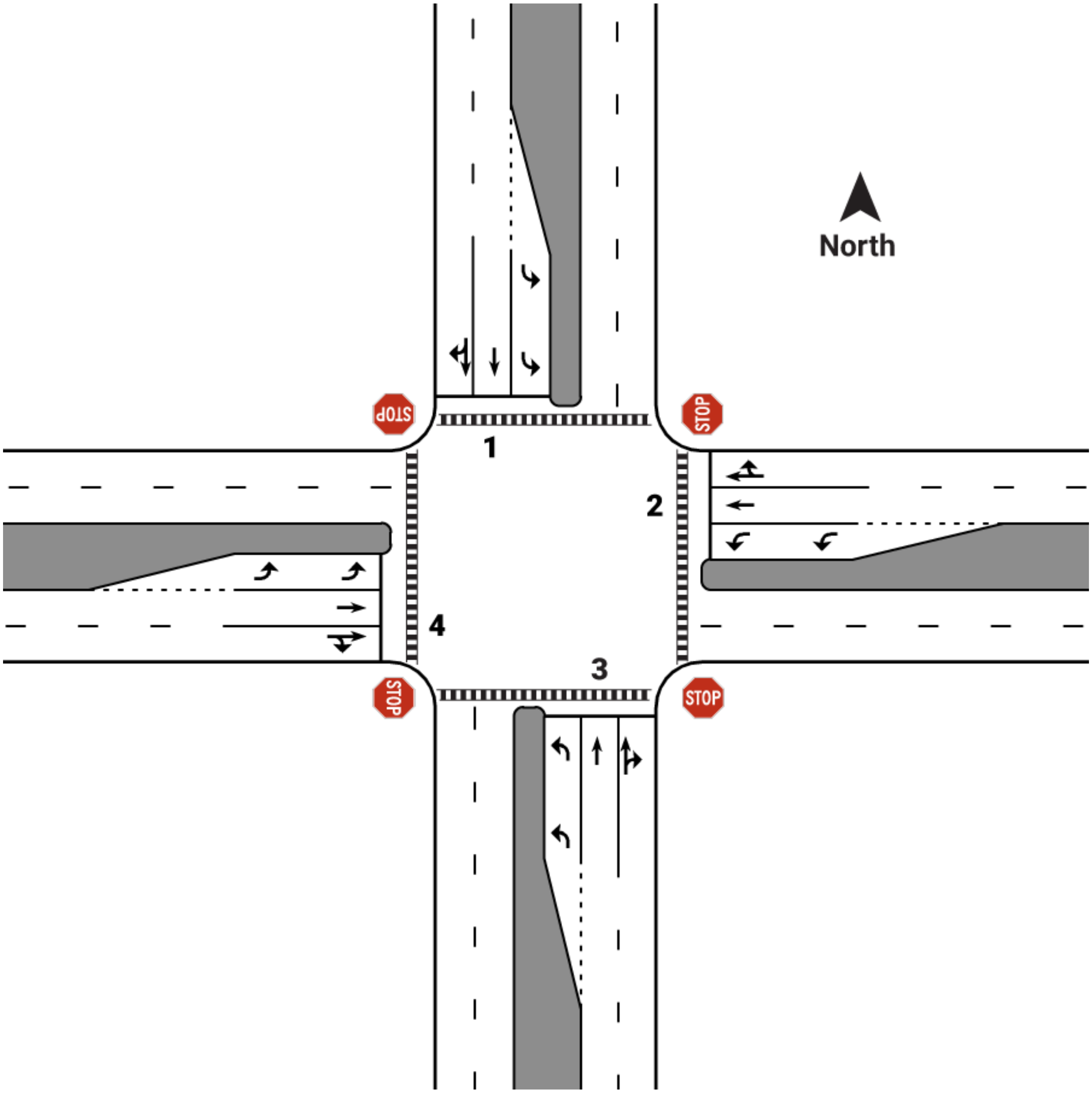


Figure C-20. Continuous Green T (W)

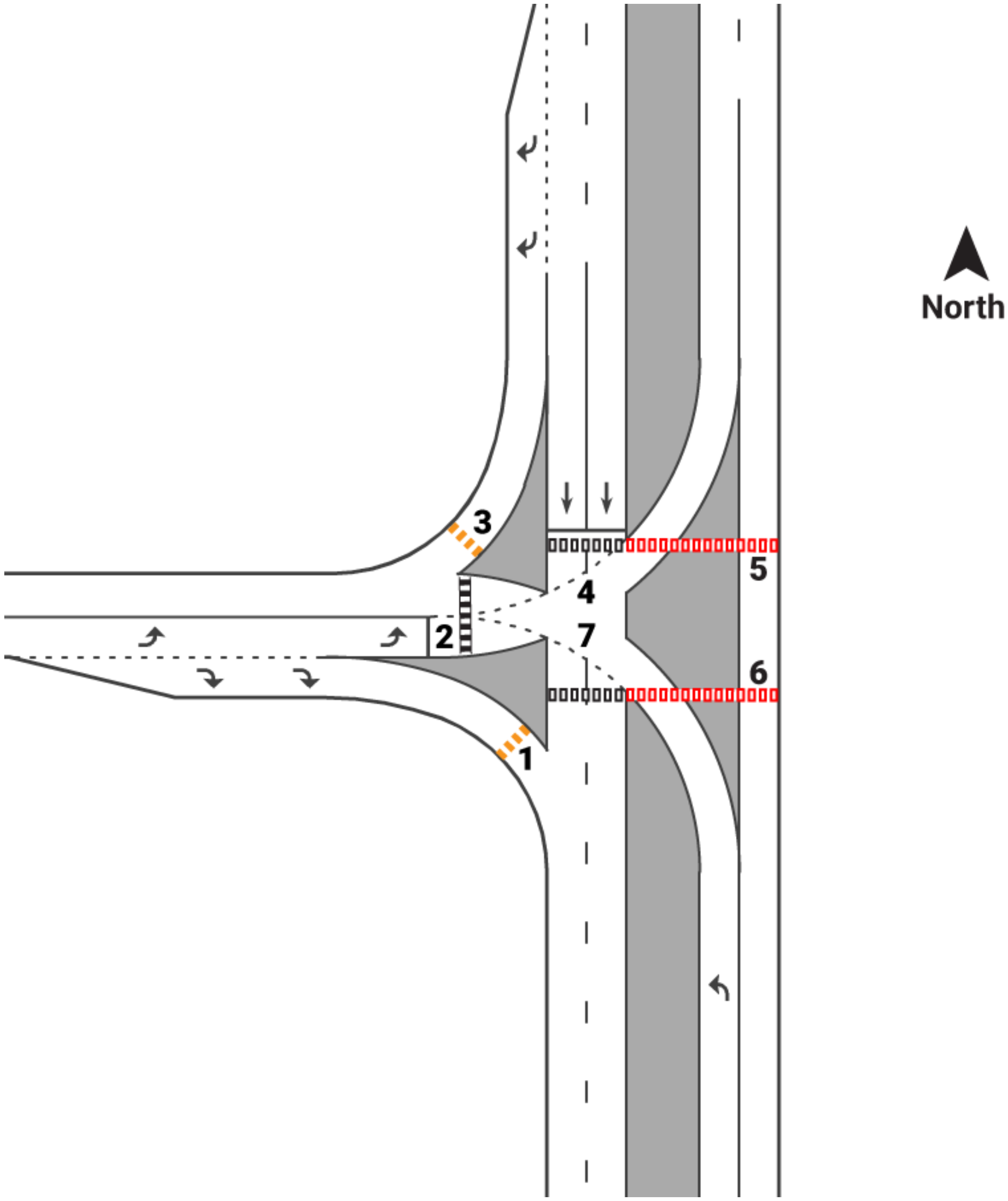


Figure C-21. Continuous Green T (N)

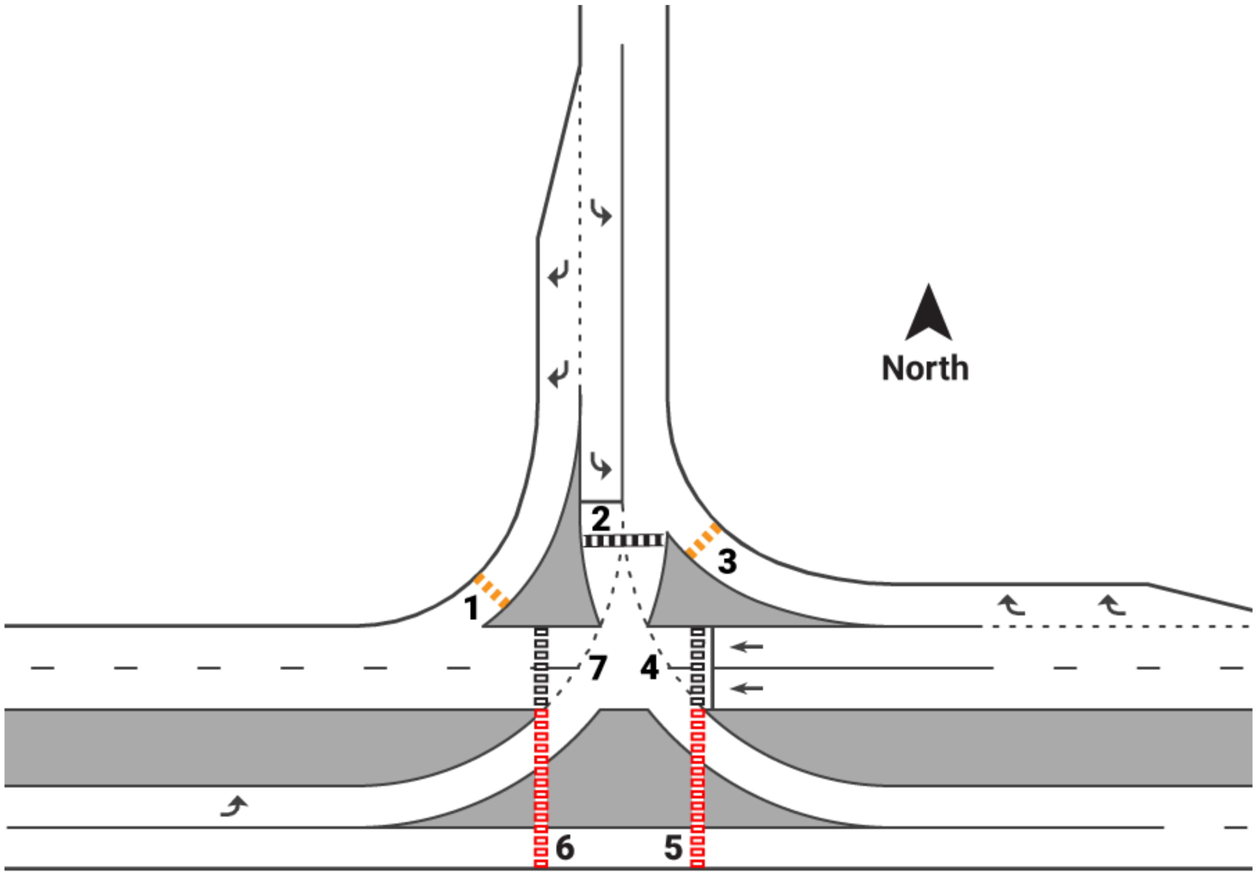


Figure C-22. Continuous Green T (E)

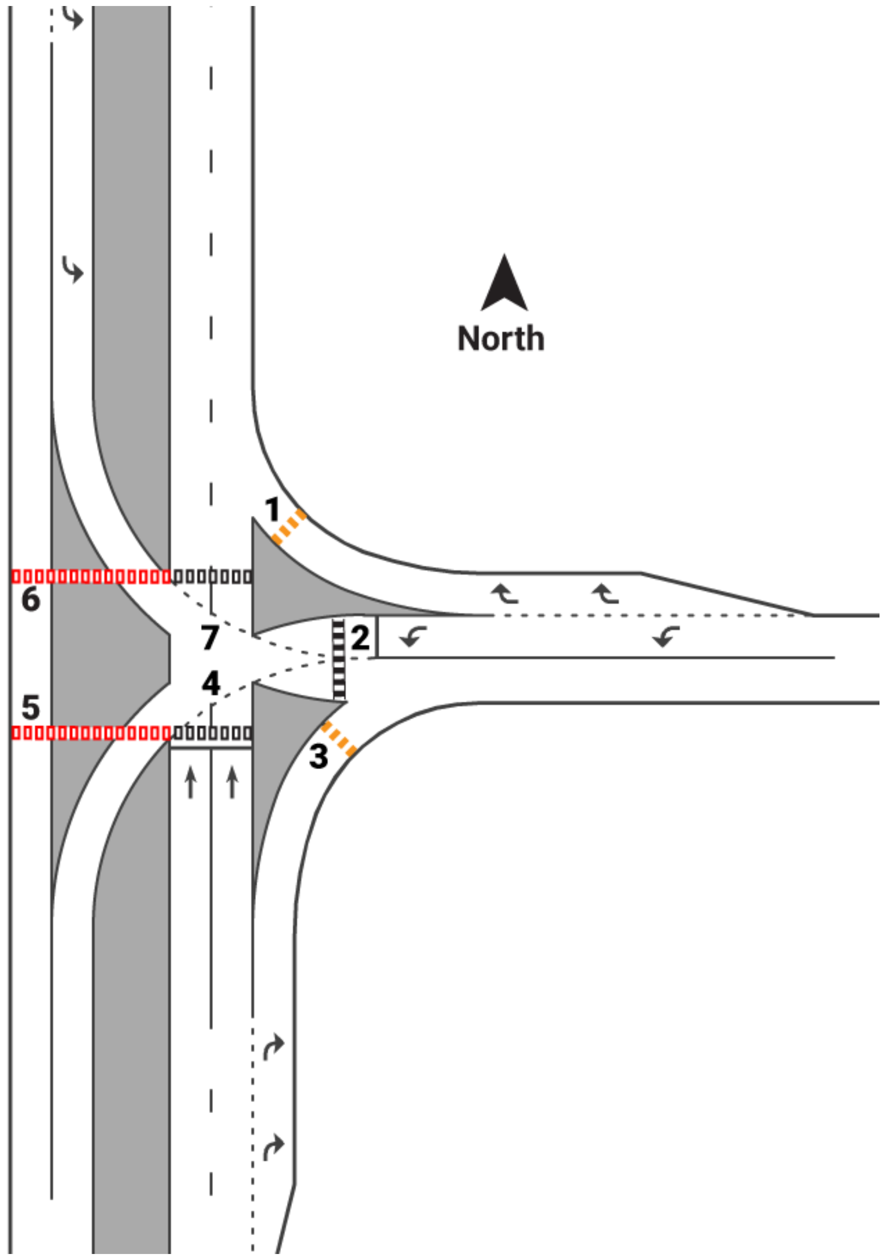


Figure C-23. Continuous Green T (S)

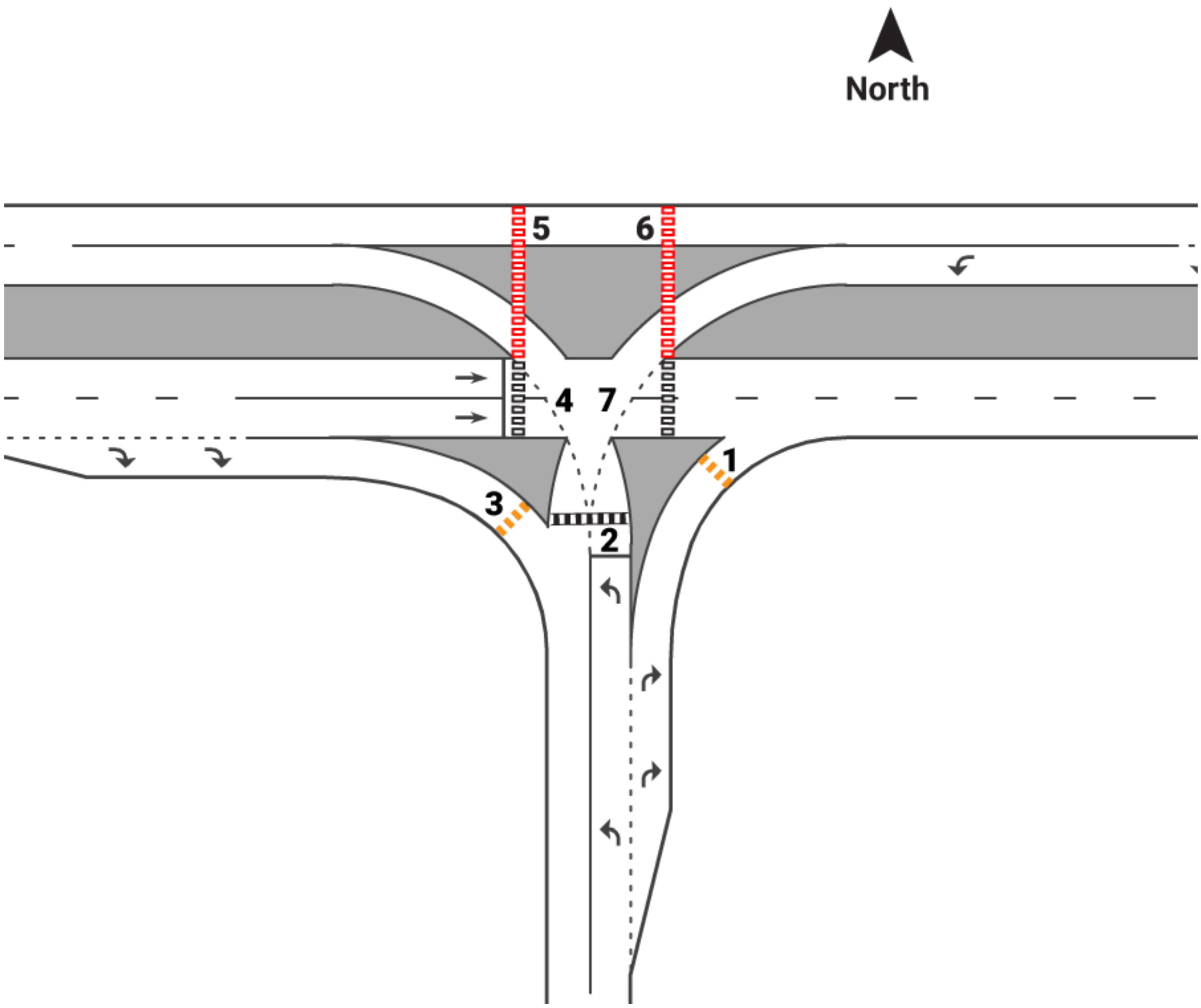


Figure C-24. Quadrant Roadway (S-W)

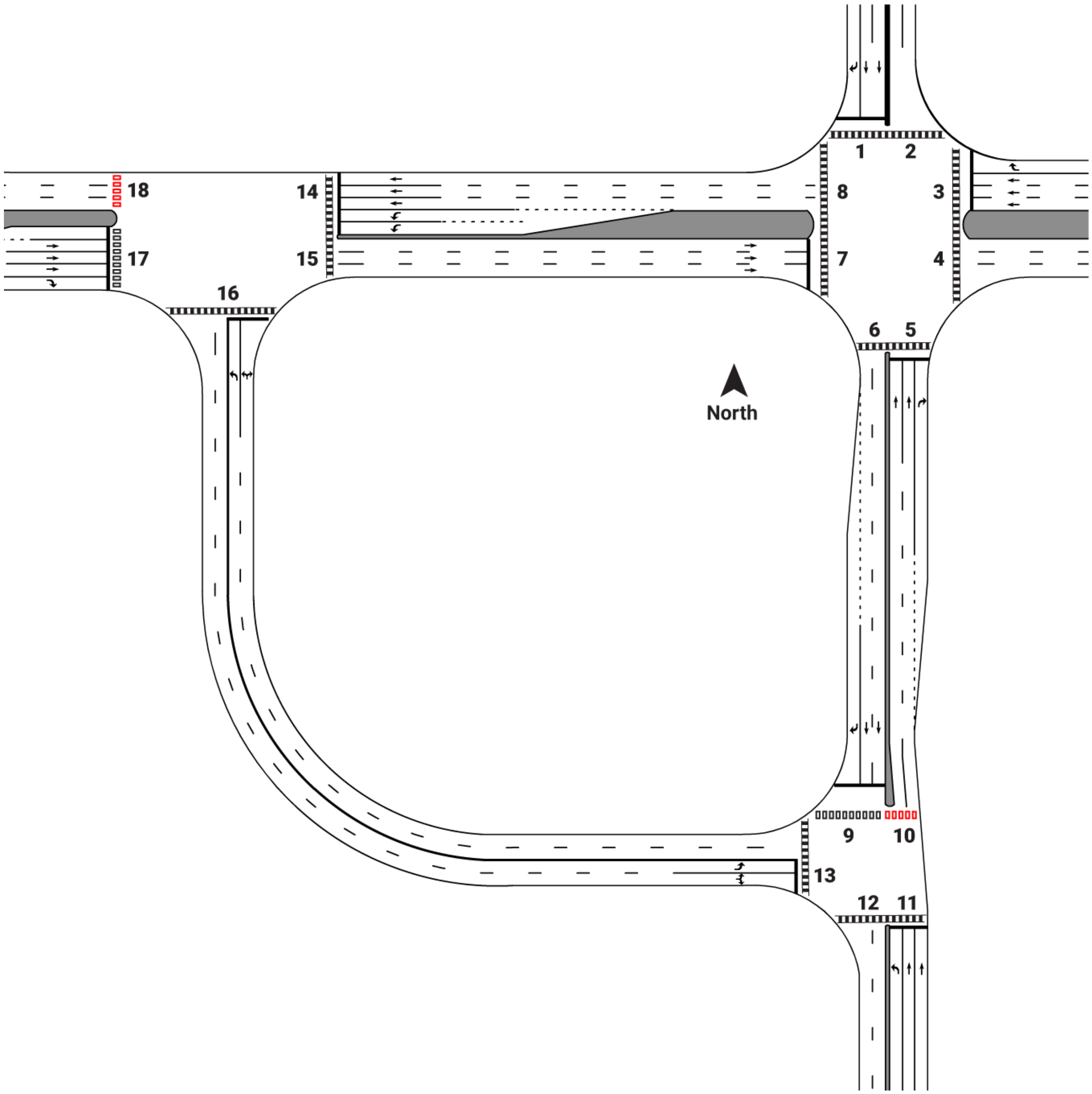


Figure C-25. Quadrant Roadway (N-E)

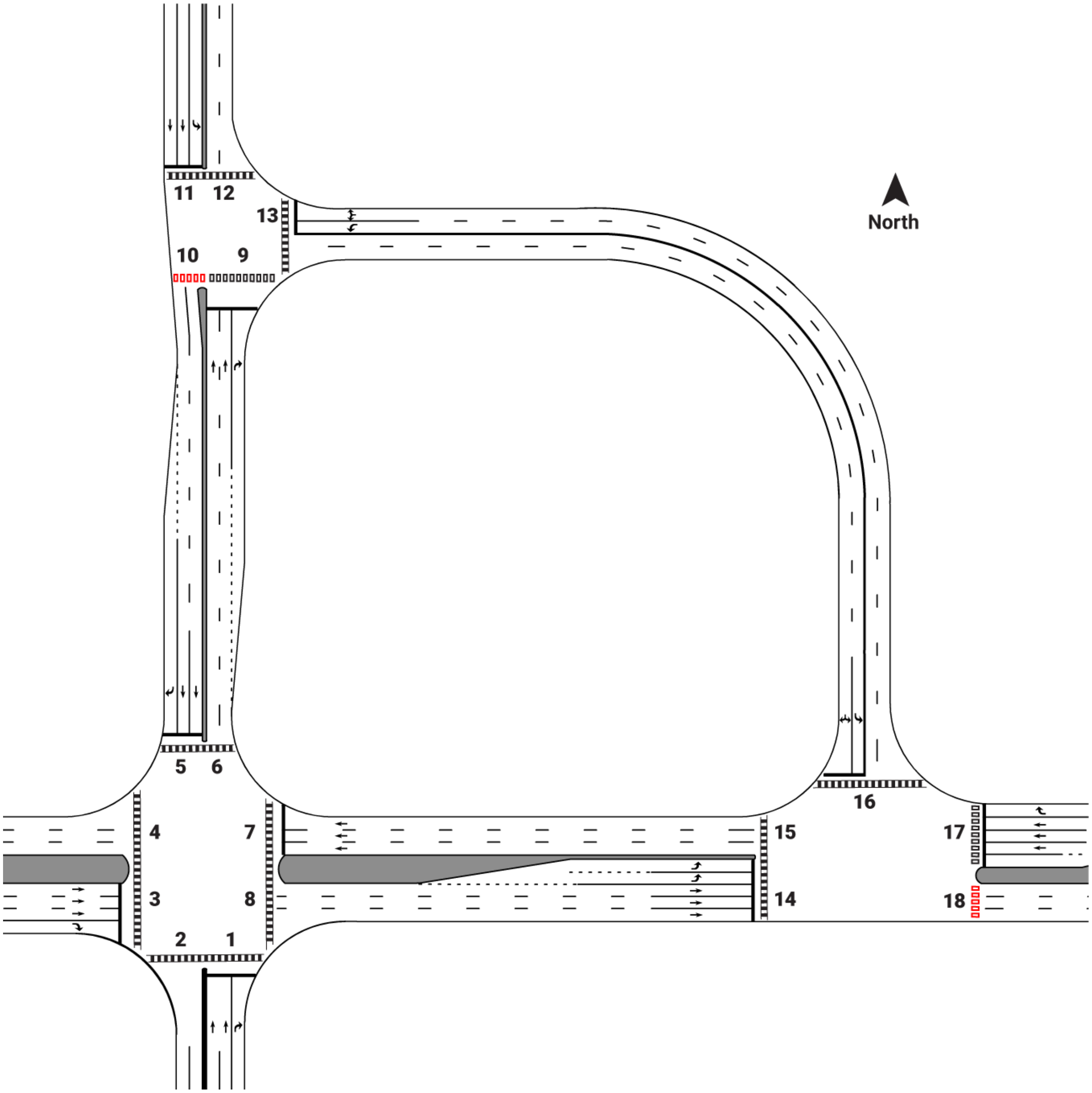


Figure C-26. Quadrant Roadway (S-E)

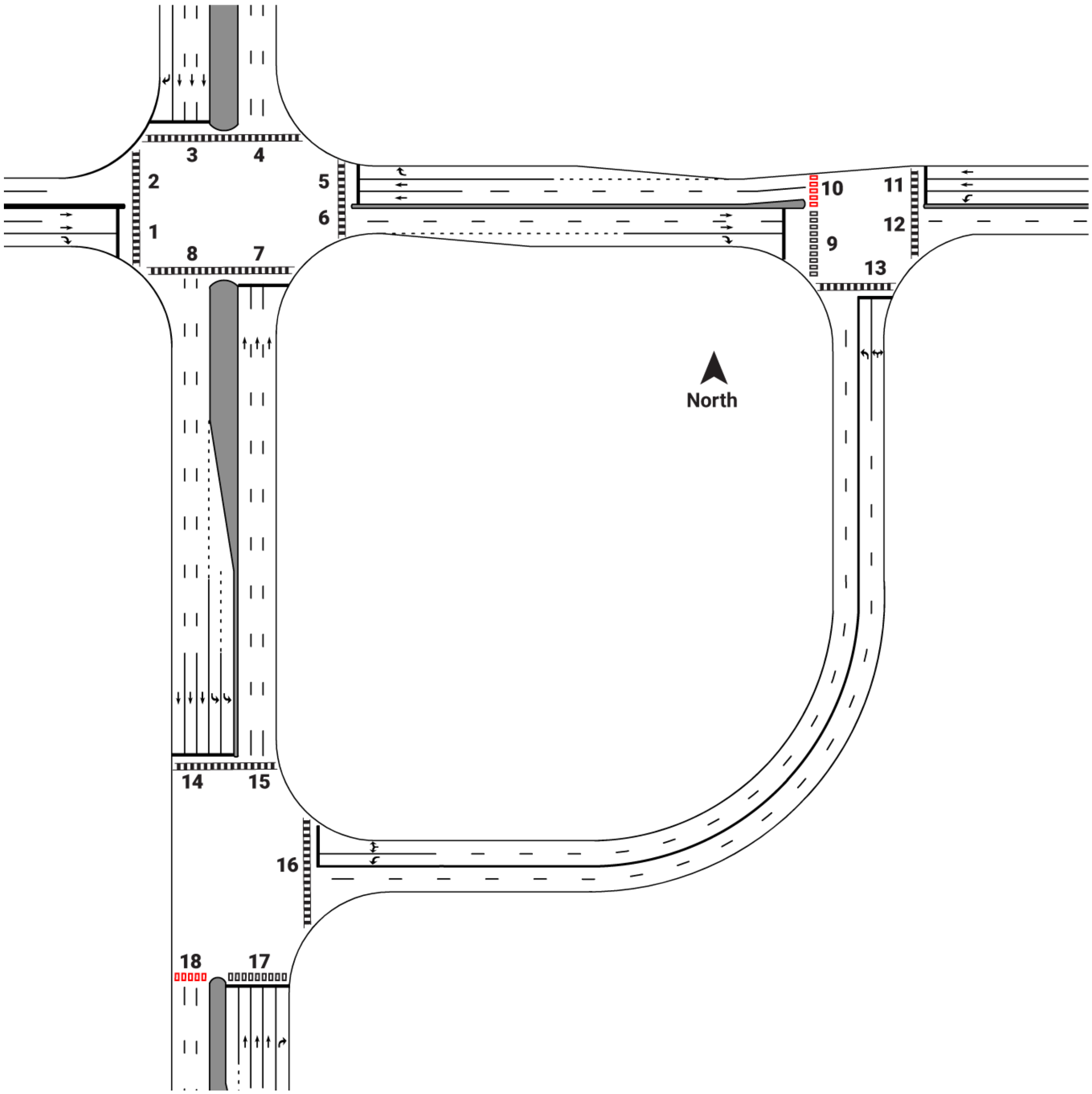


Figure C-27. Quadrant Roadway (N-W)

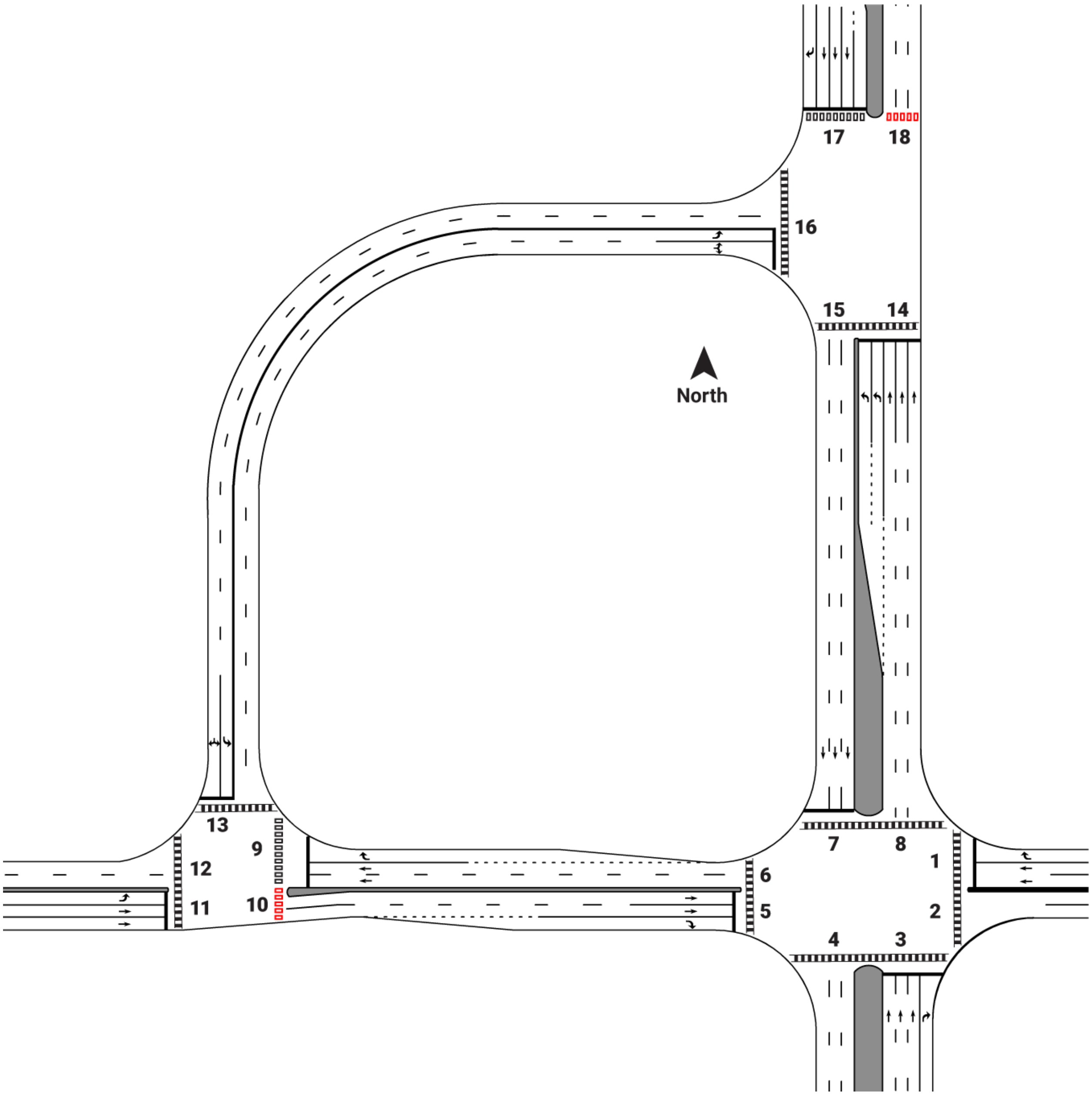


Figure C-28. Partial Disaplced Left Turn (N-S)

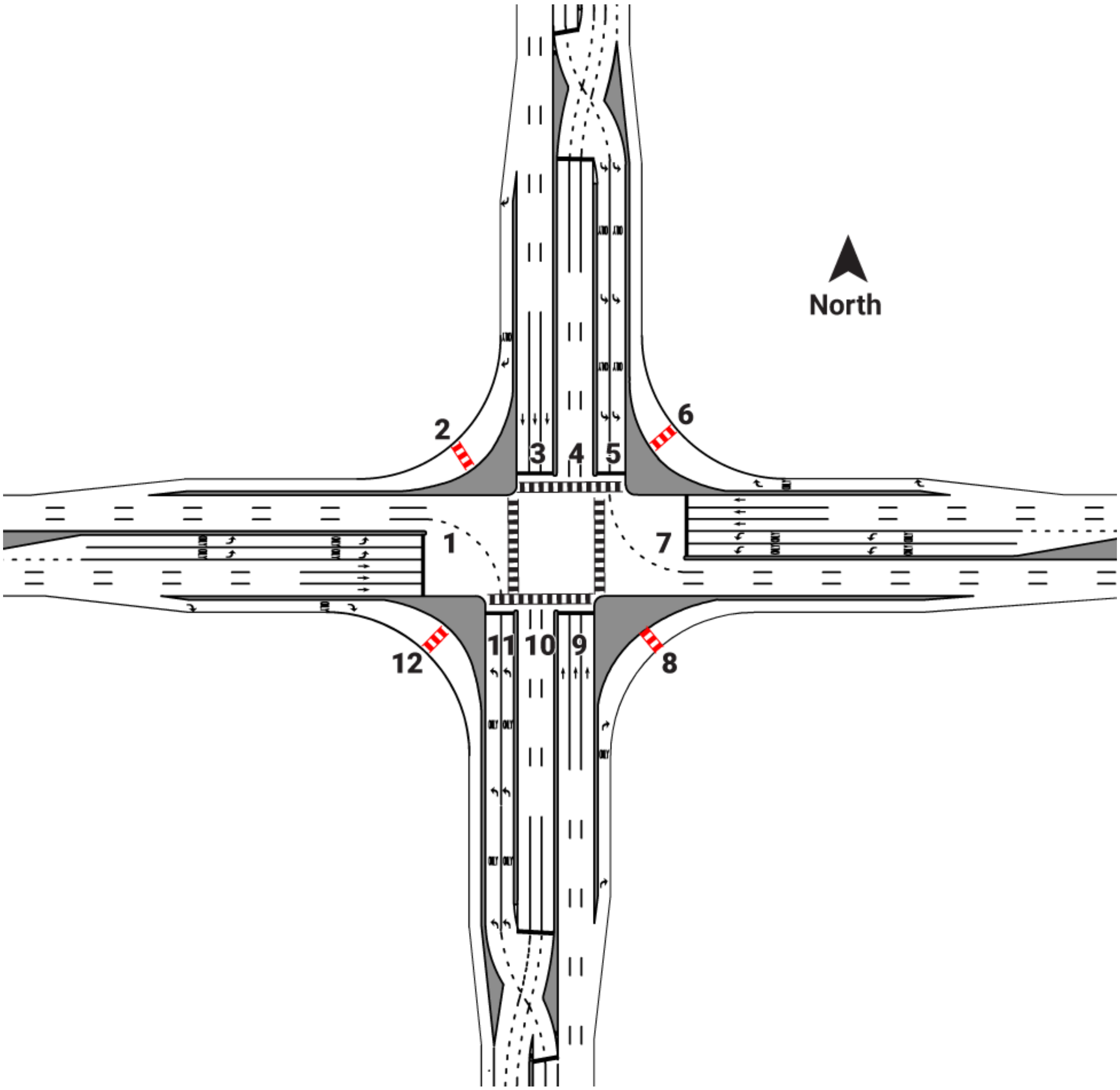


Figure C-29. Partial Disaplced Left Turn (E-W)

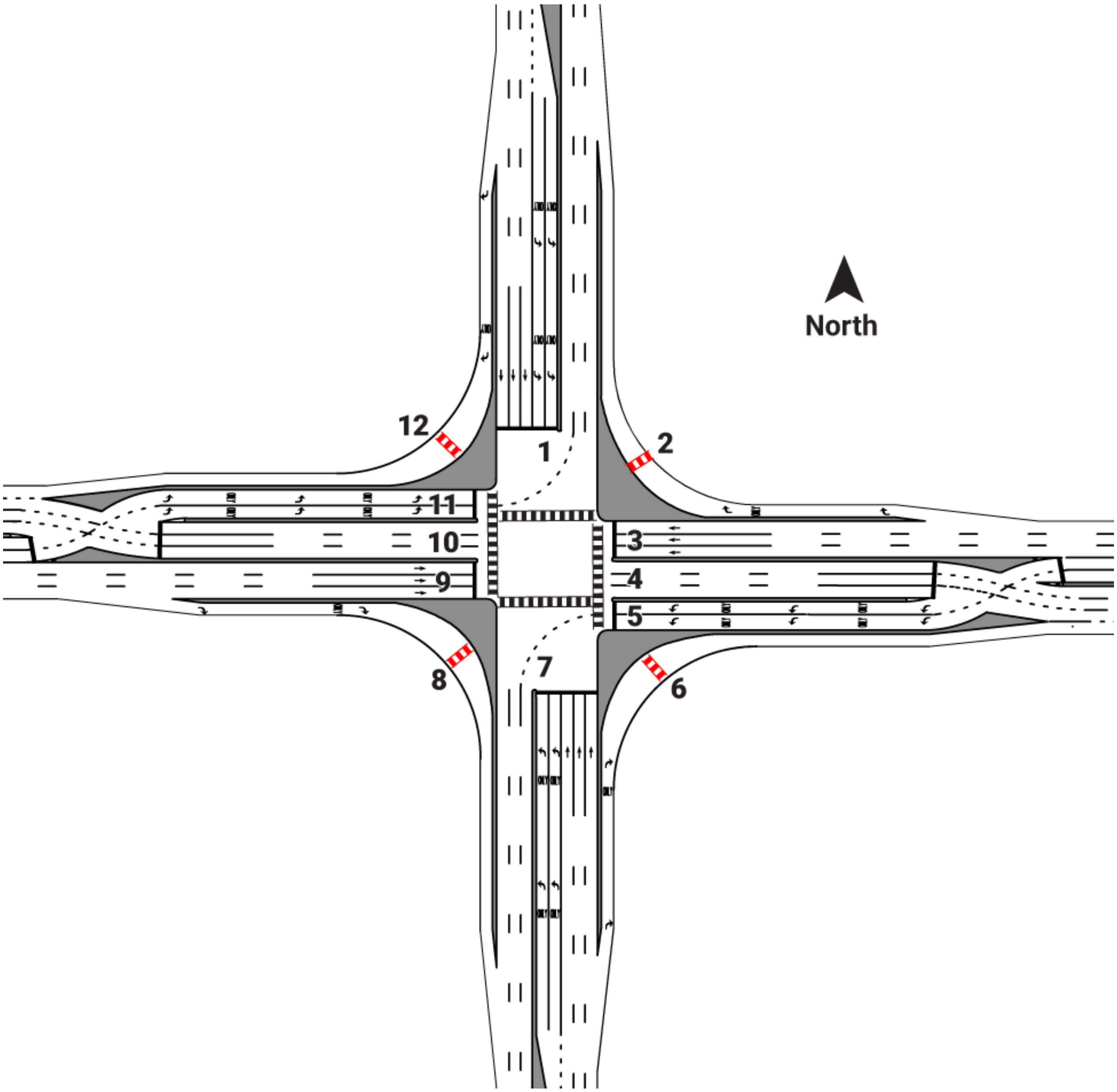


Figure C-30. Full Displaced Left Turn

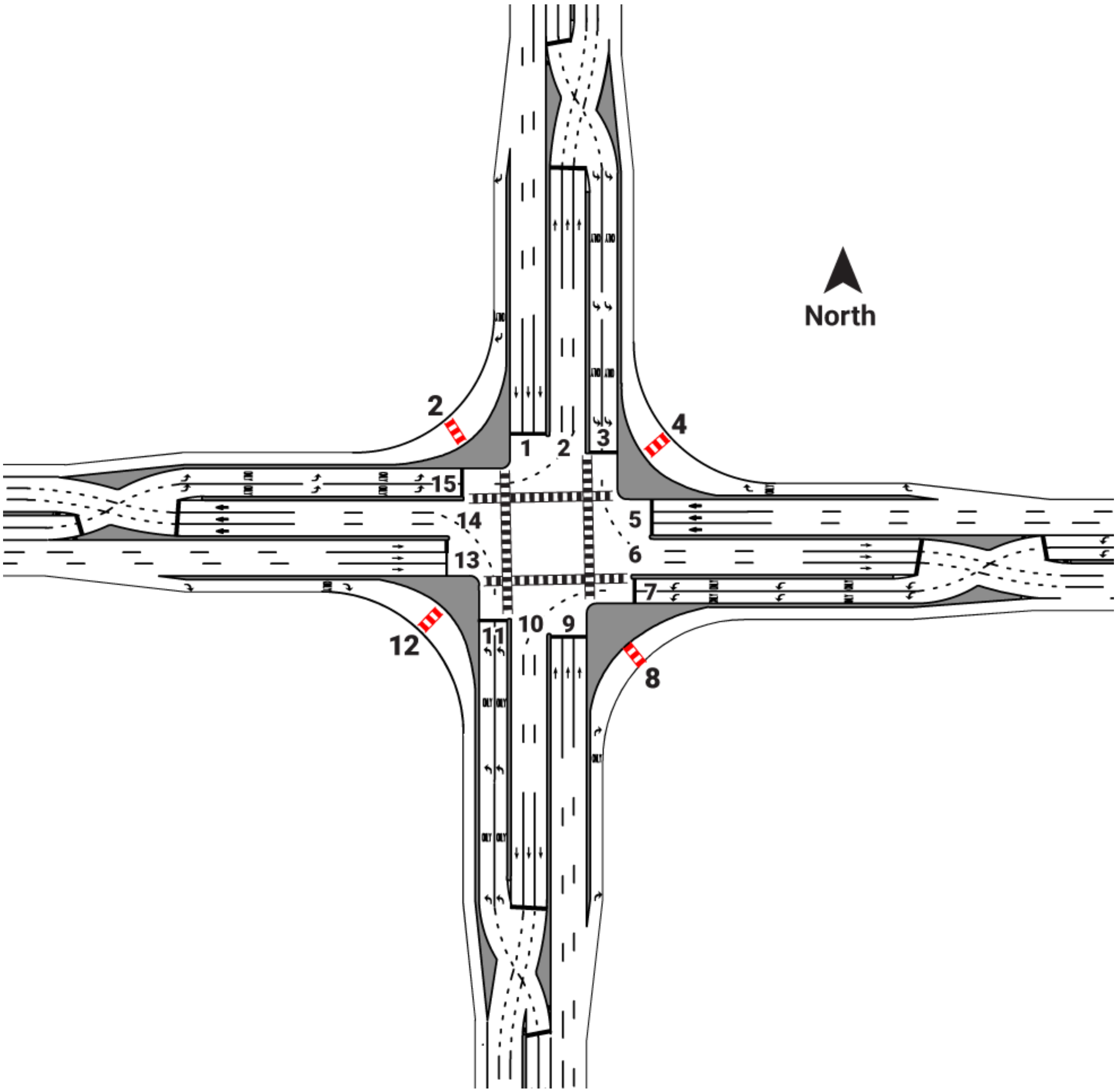


Figure C-31. Signalized Restricted Crossing U-Turn (N-S)

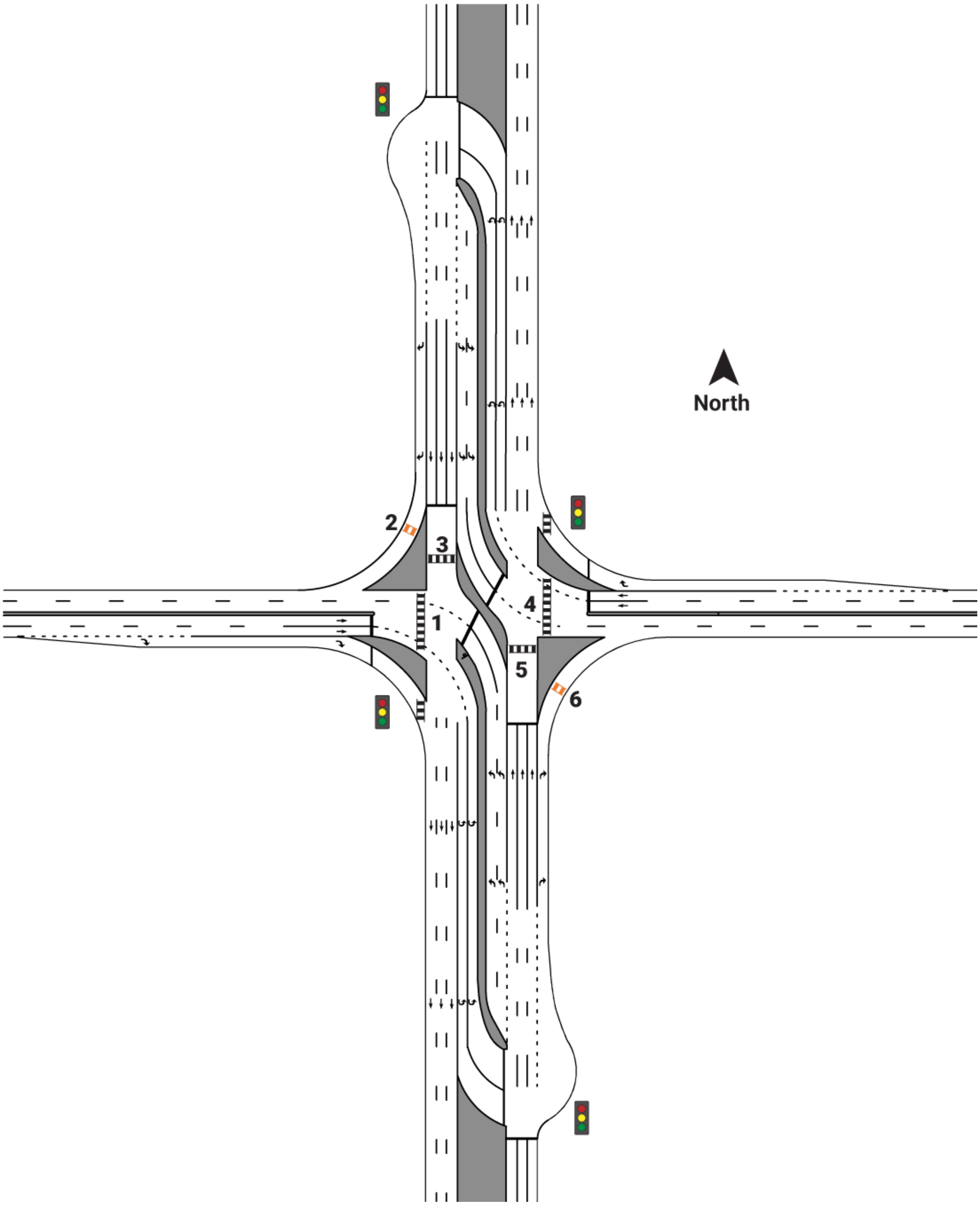


Figure C-32. Signalized Restricted Crossing U-Turn (E-W)

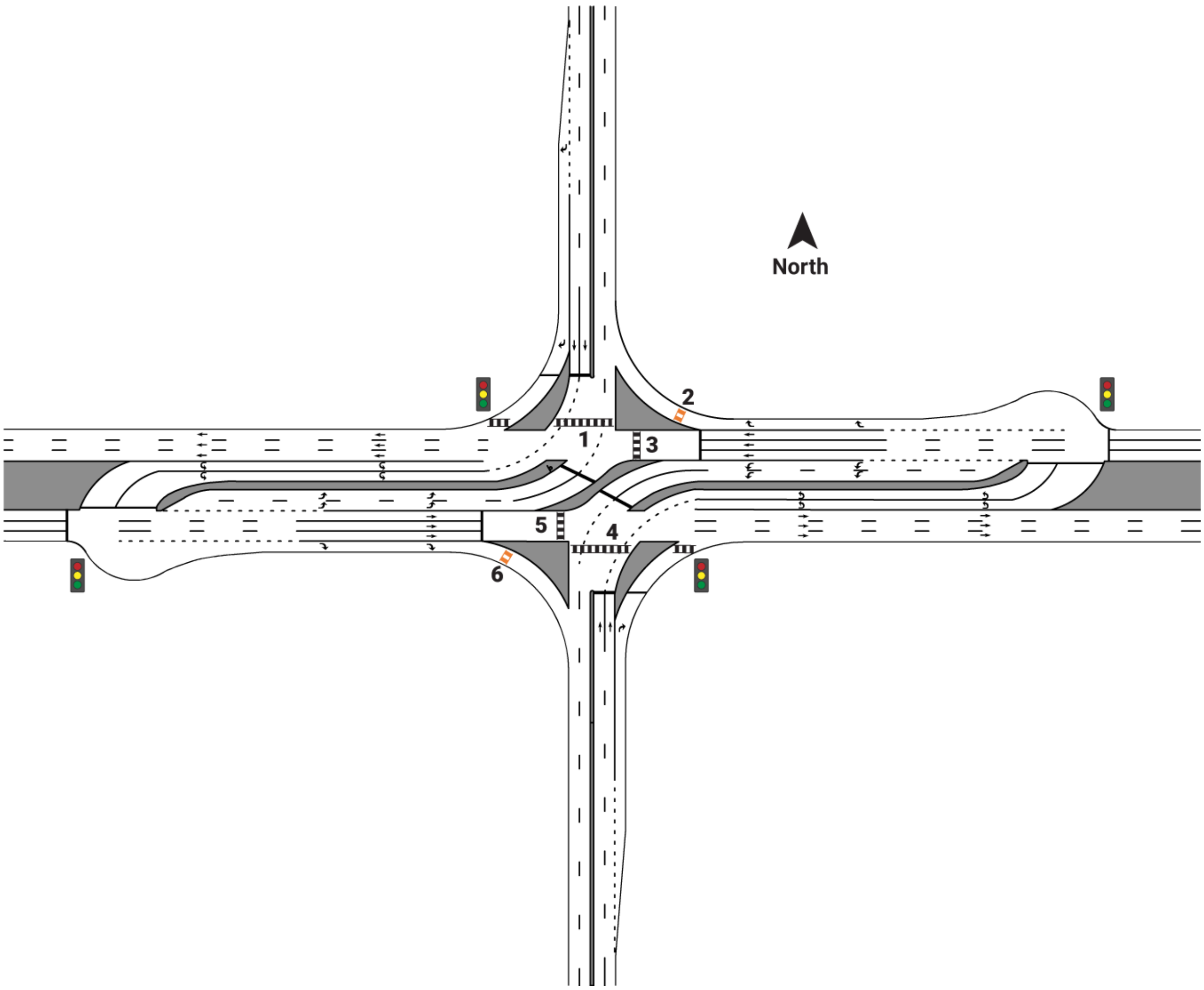


Figure C-33. Unsignalized Restricted Crossing U-Turn (N-S)

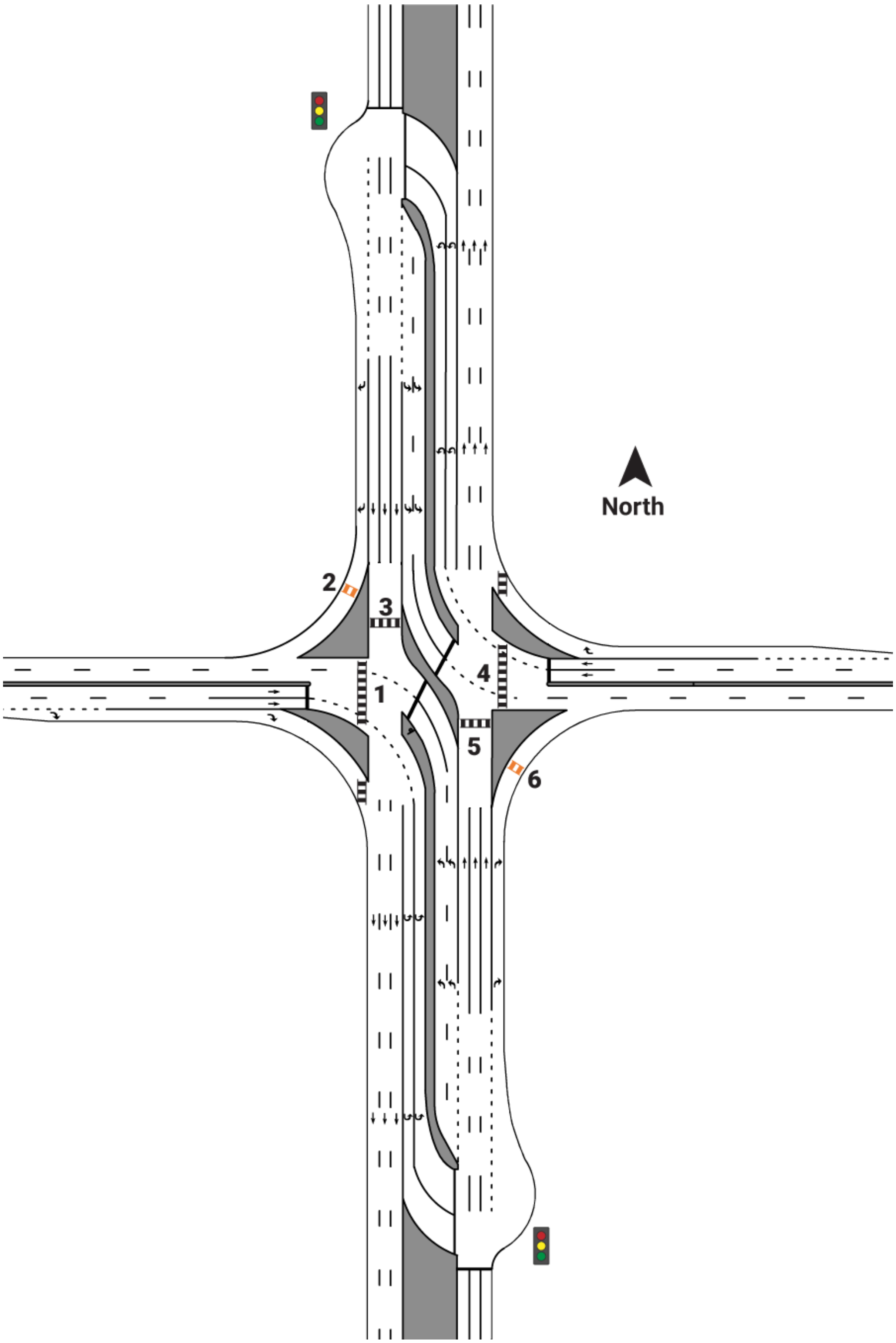


Figure C-34. Unsignalized Restricted Crossing U-Turn (E-W)

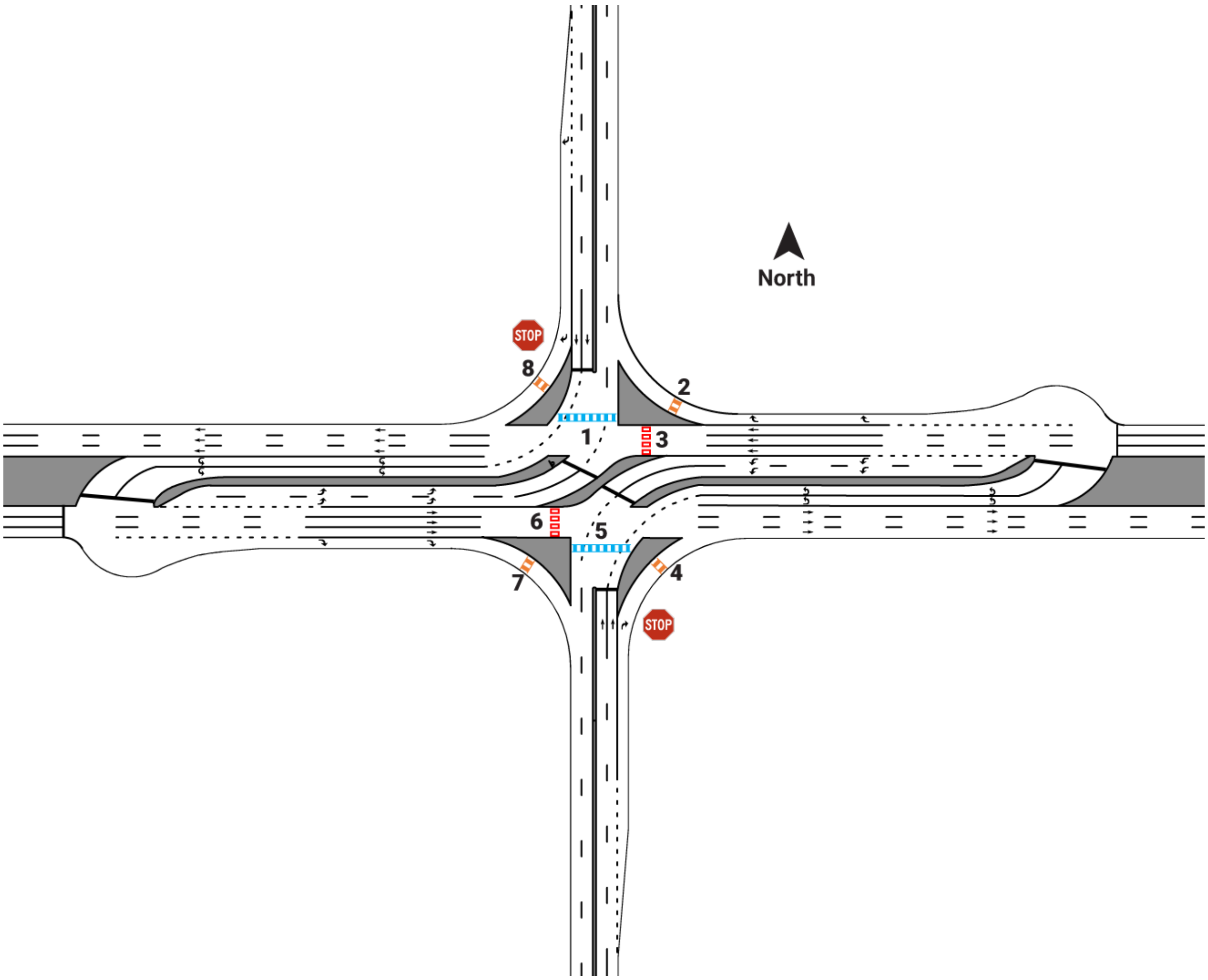


Figure C-35. Median U-Turn (N-S)

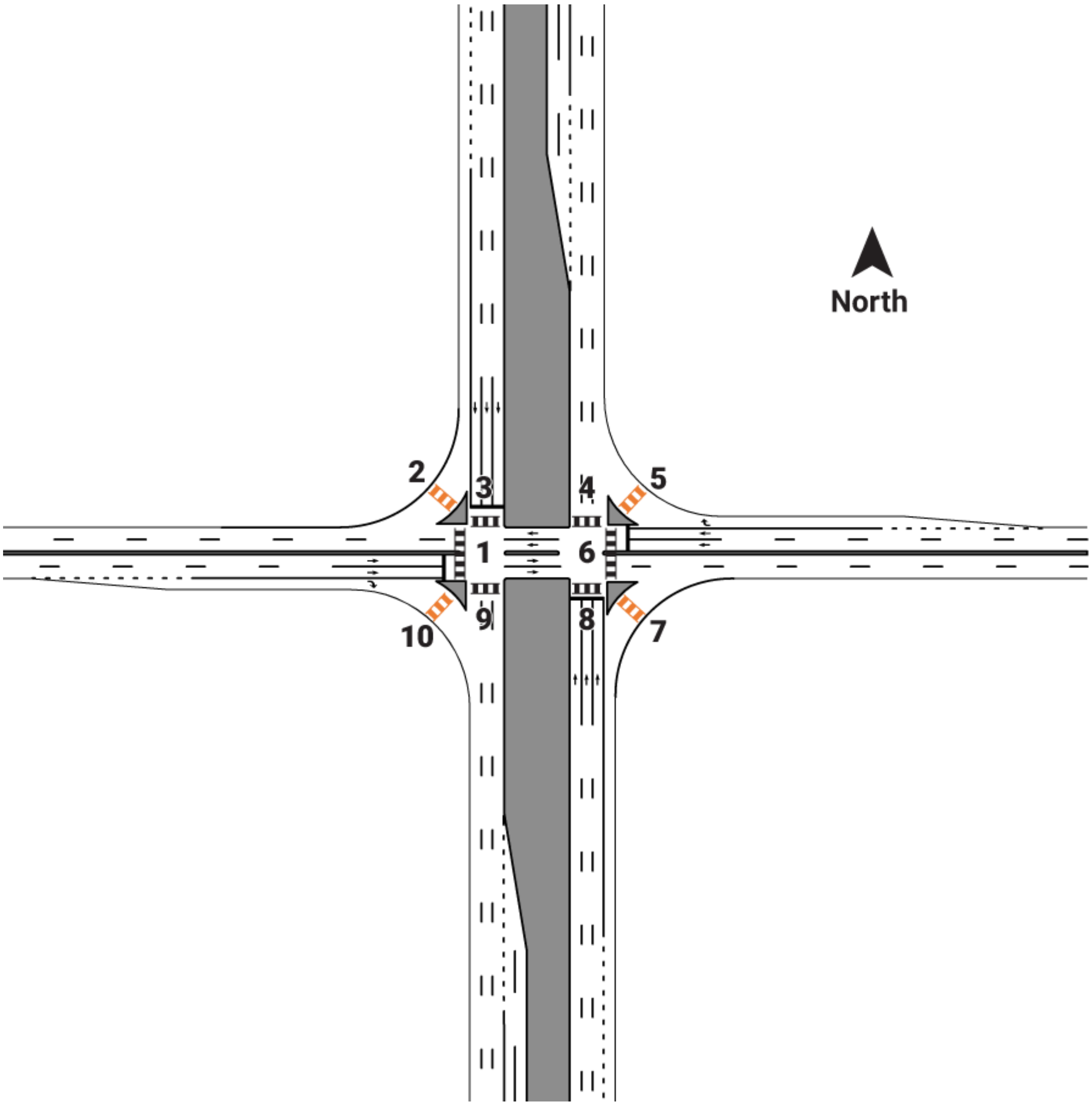


Figure C-36. Median U-Turn (E-W)

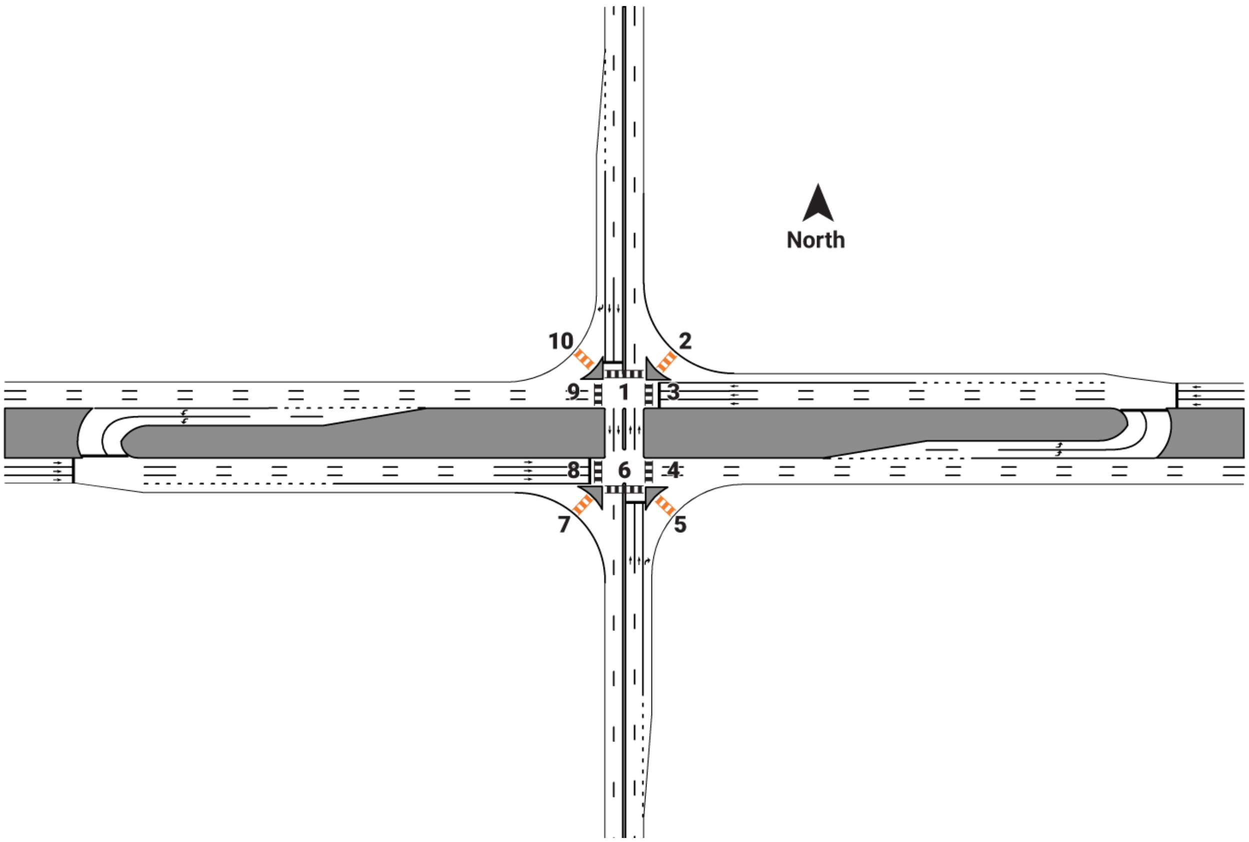


Figure C-37. Partial Median U-Turn (N-S)

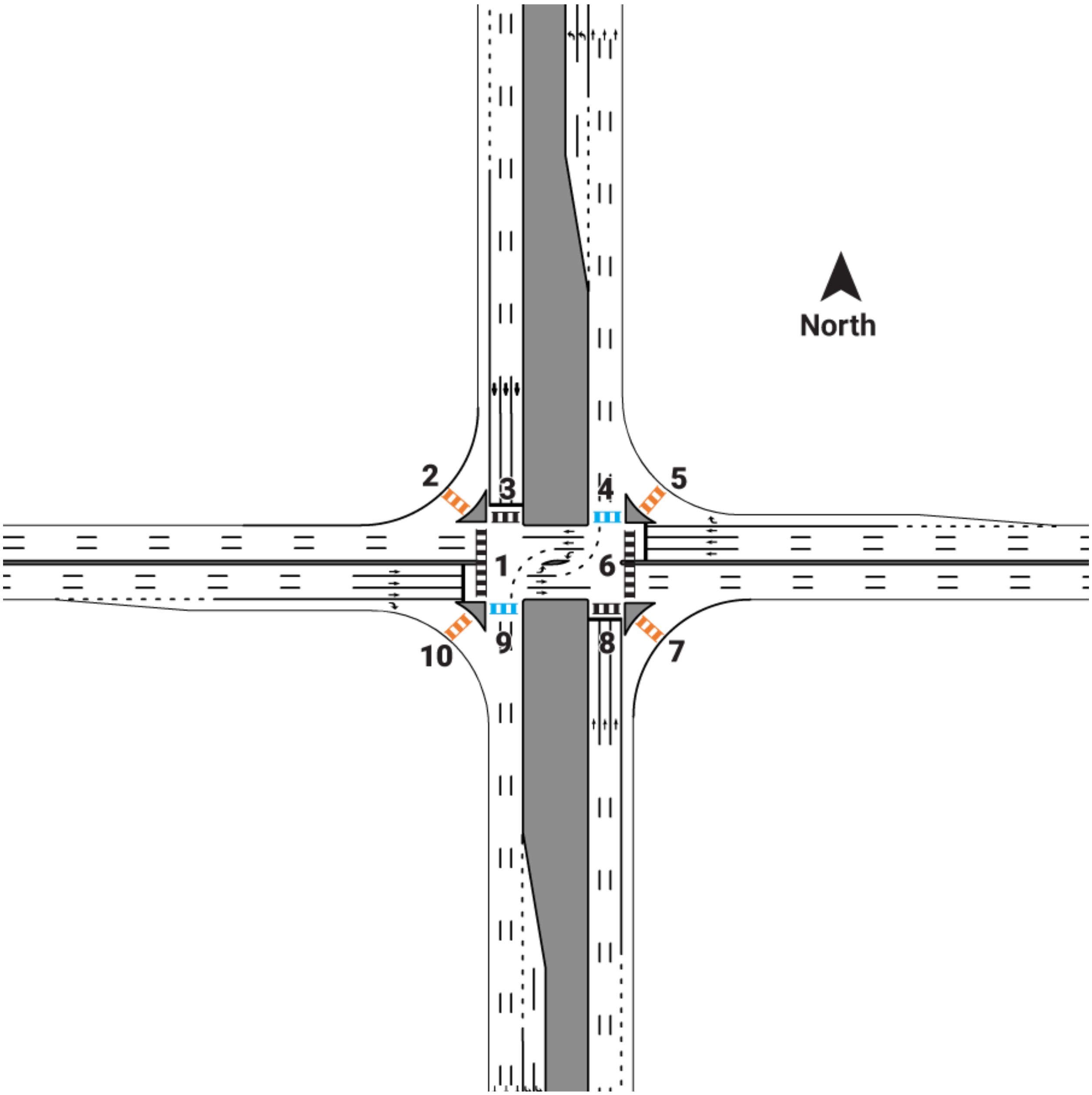


Figure C-38. Partial Median U-Turn (E-W)

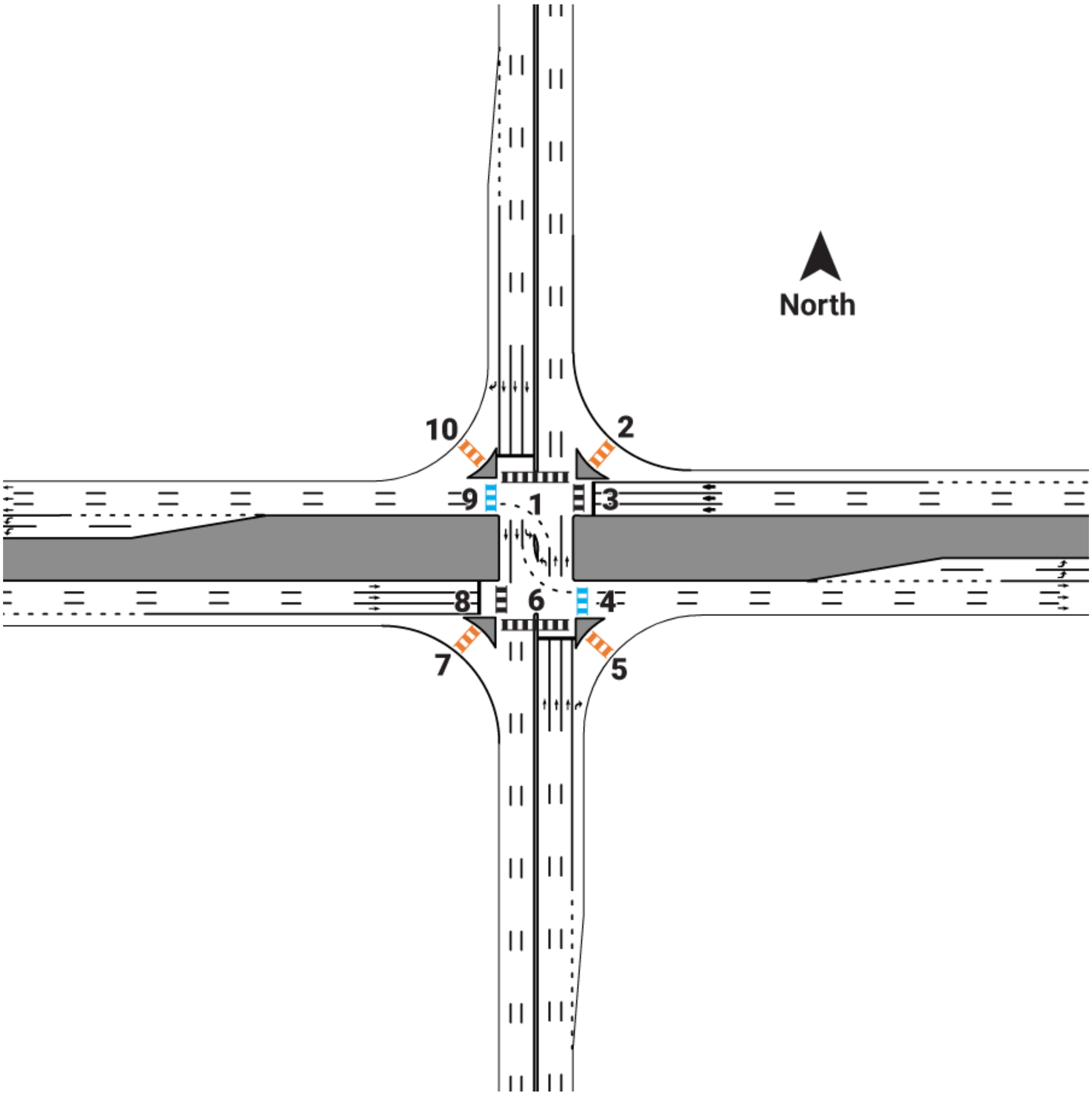


Figure C-39. Bowtie (N-S)

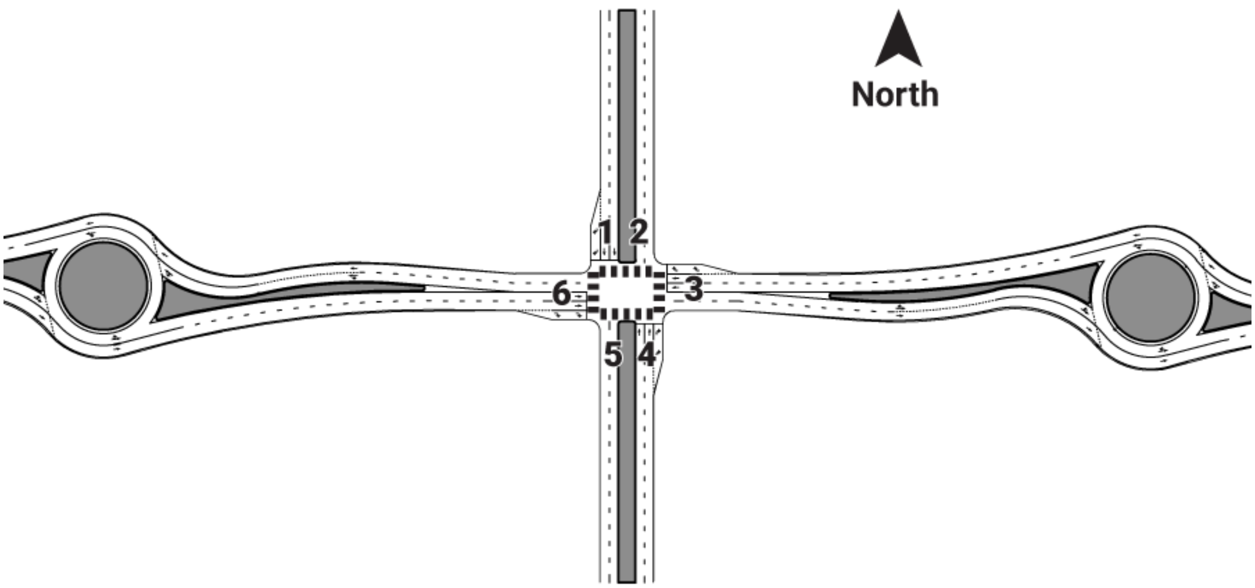


Figure C-40. Bowtie (E-W)

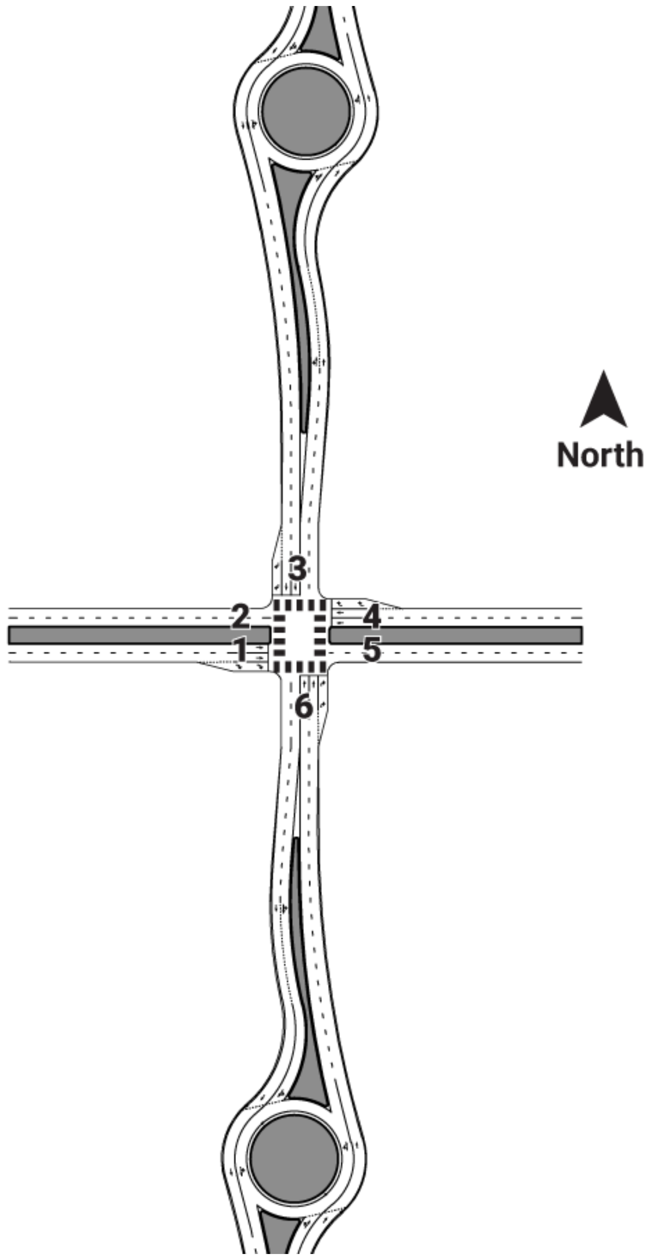


Figure C-41. Signalized Thru-Cut (N-S)

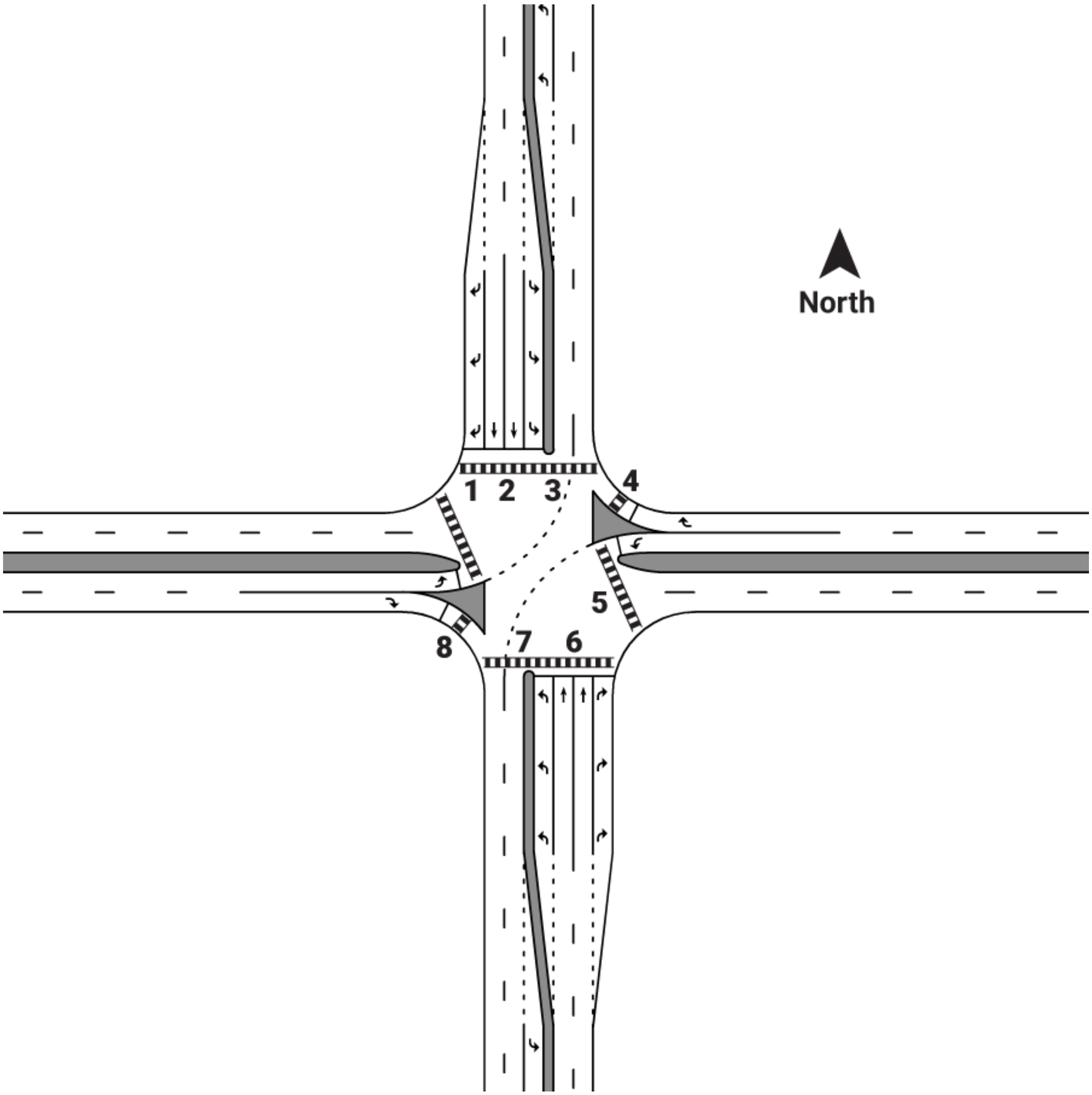


Figure C-42. Signalized Thru-Cut (E-W)

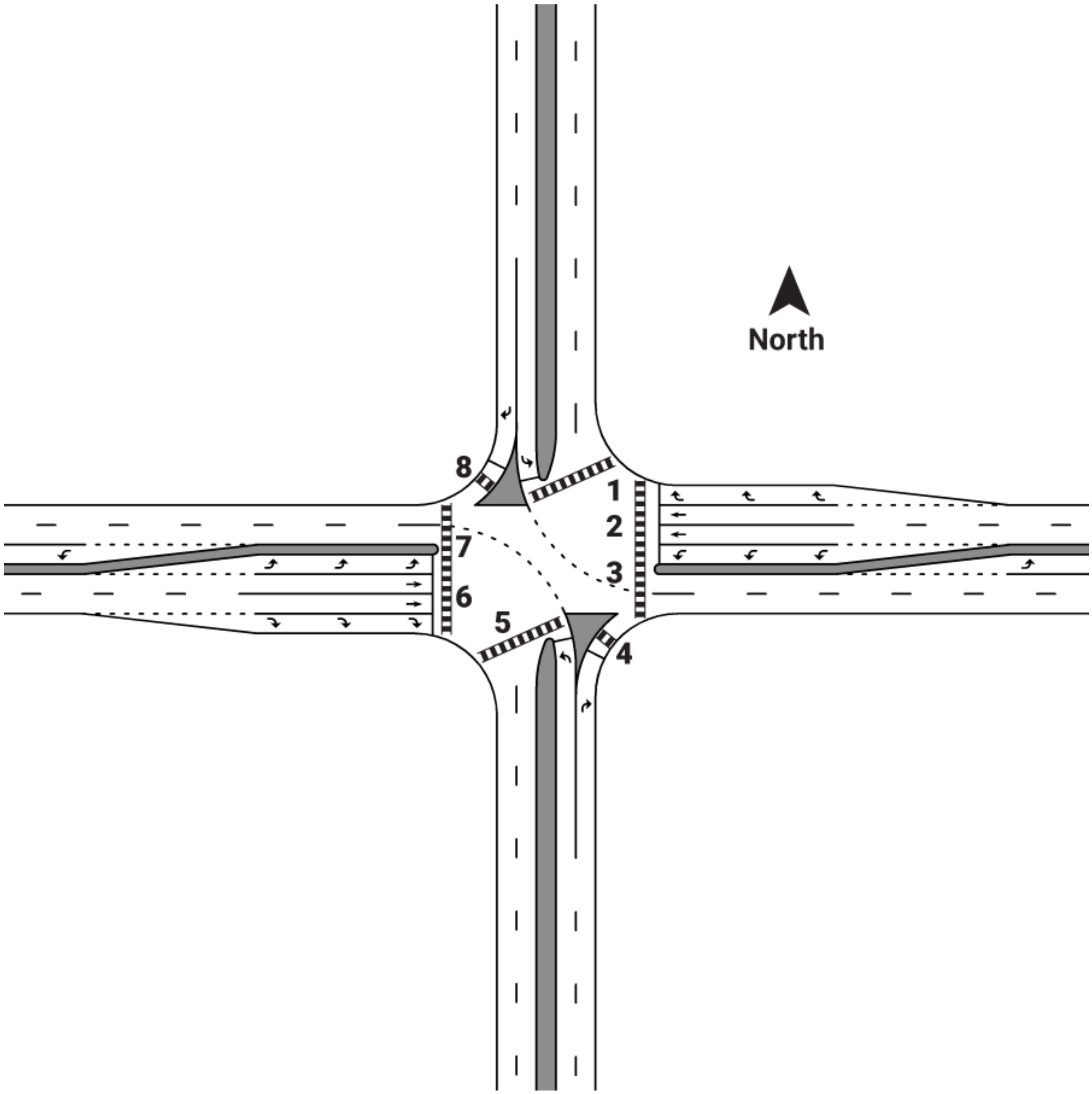


Figure C-43. Unsignalized Thru-Cut (N-S)

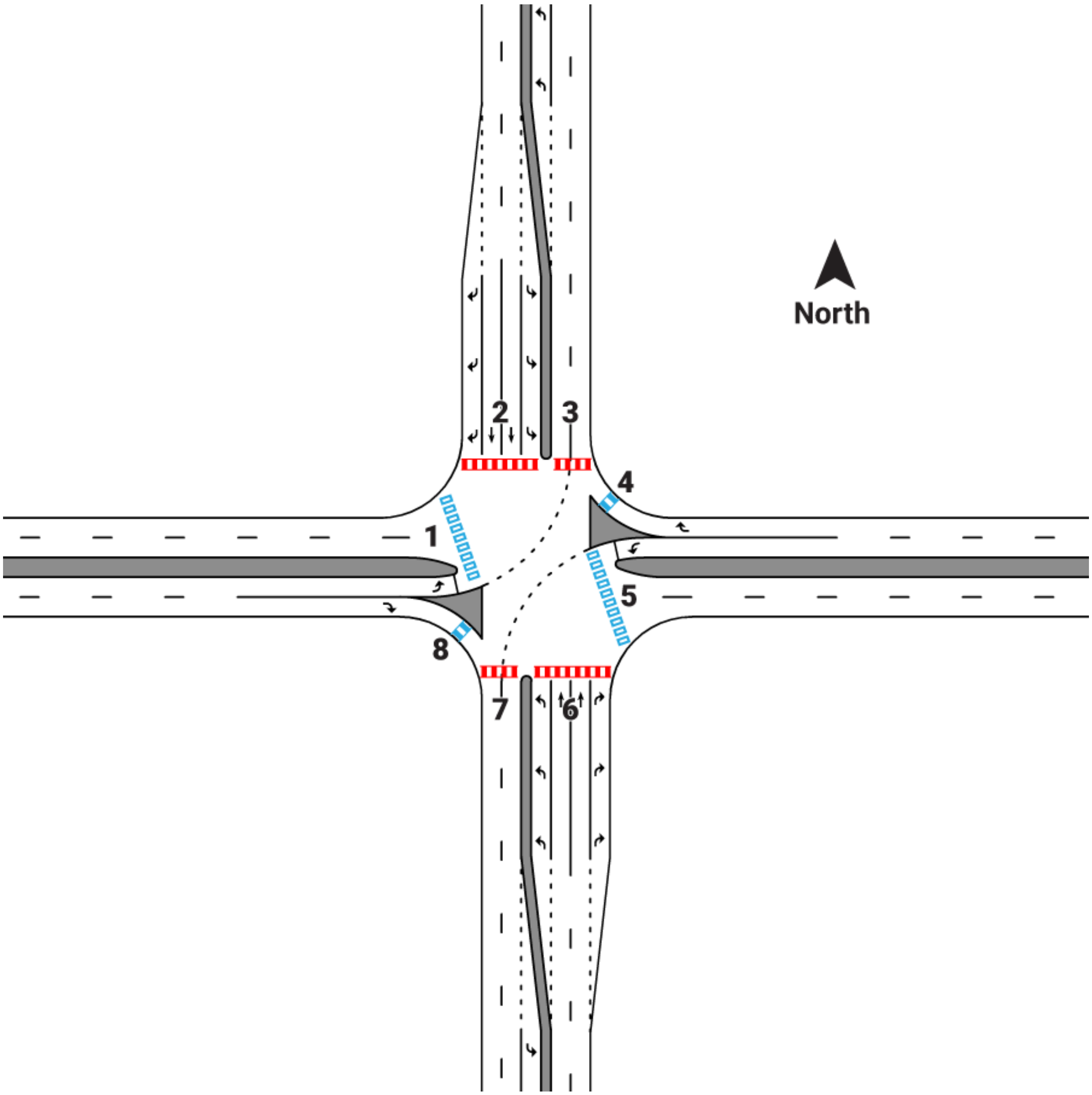


Figure C-44. Unsignalized Thru-Cut (E-W)

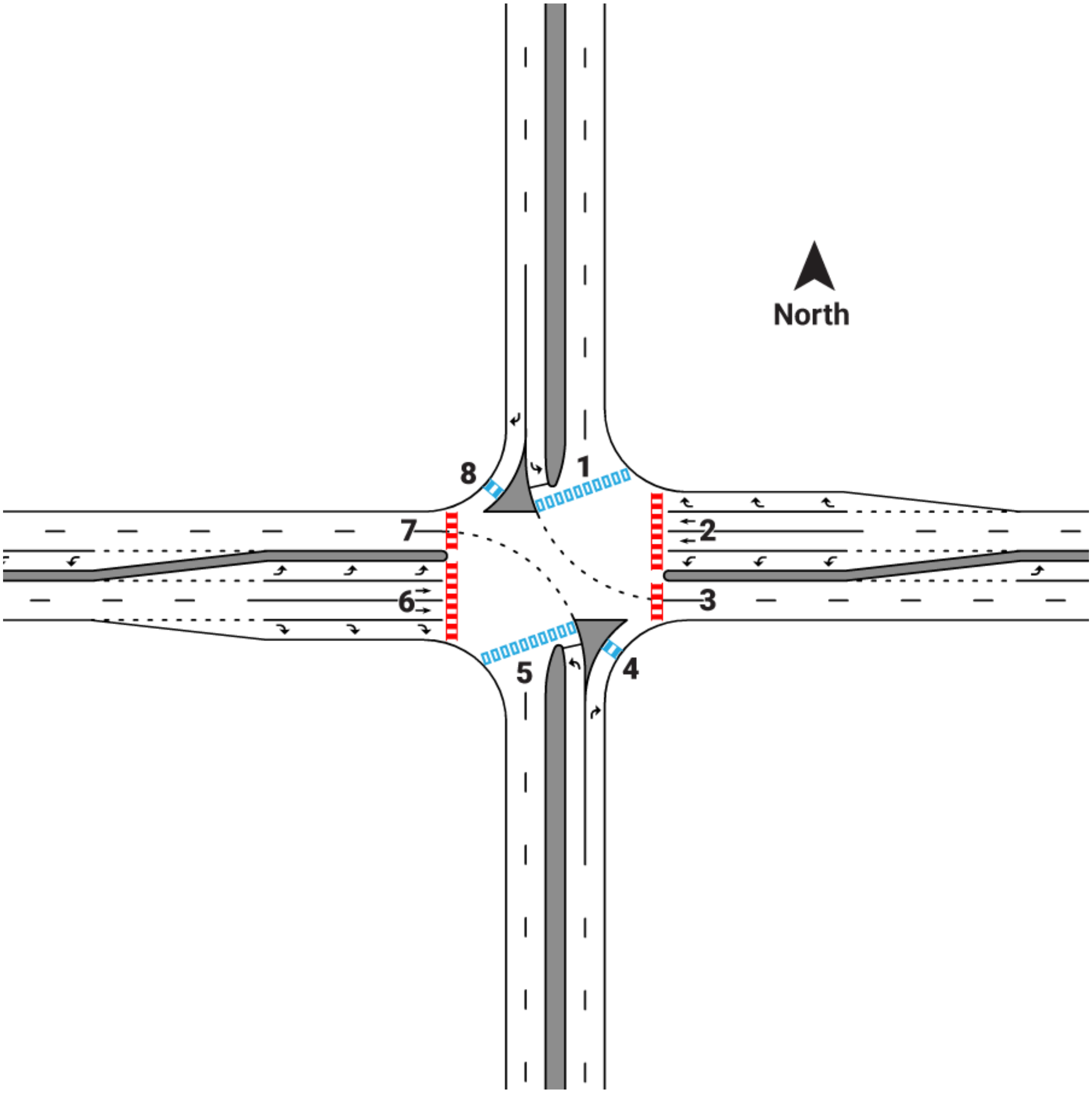


Figure C-45. Mini and Single-Lane Roundabout

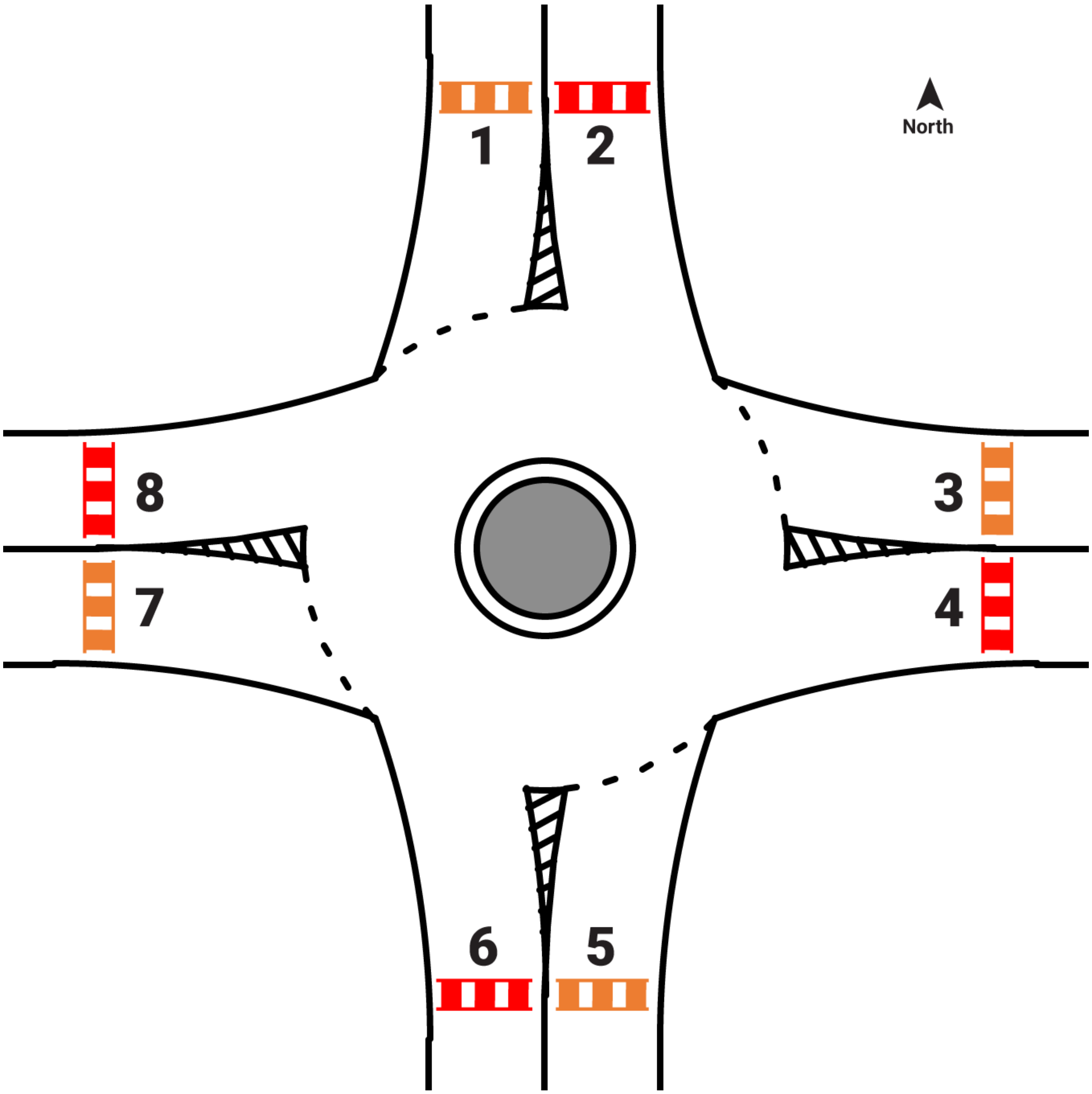


Figure C-46. 1NS X 2 EW Roundabout

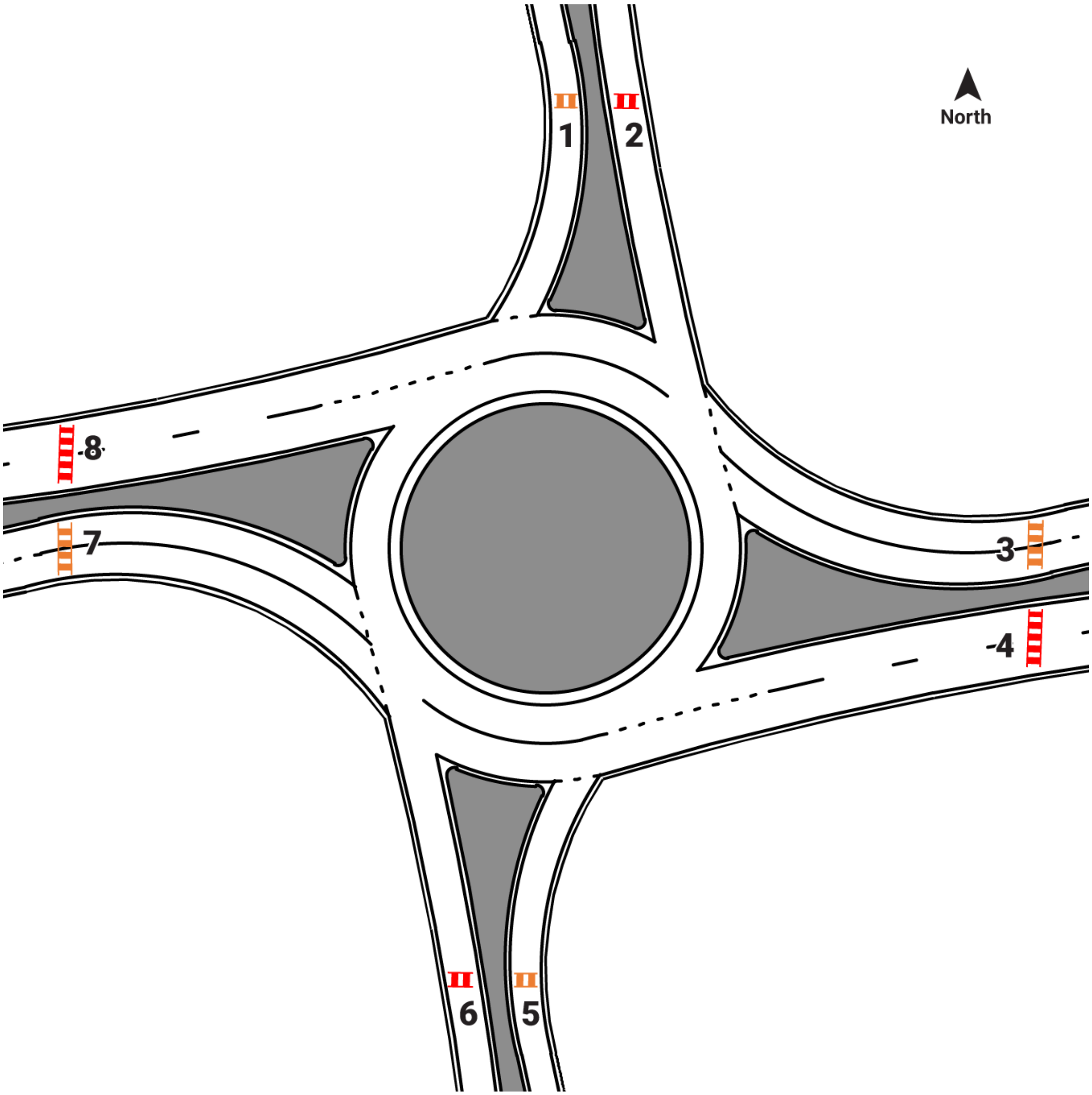


Figure C-47. 2NS X 1EW Roundabout

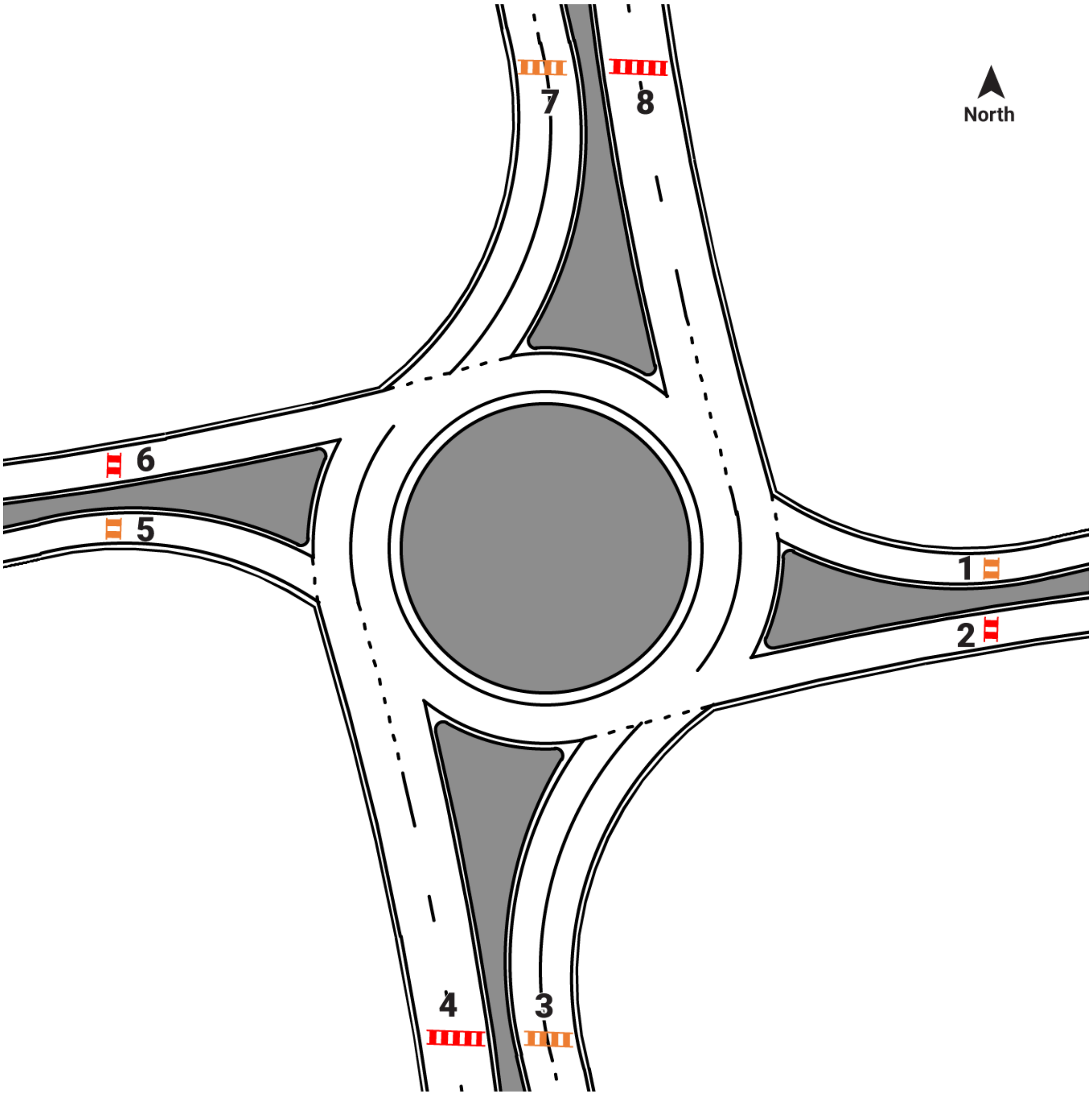


Figure C-48. 2X2 Roundabout

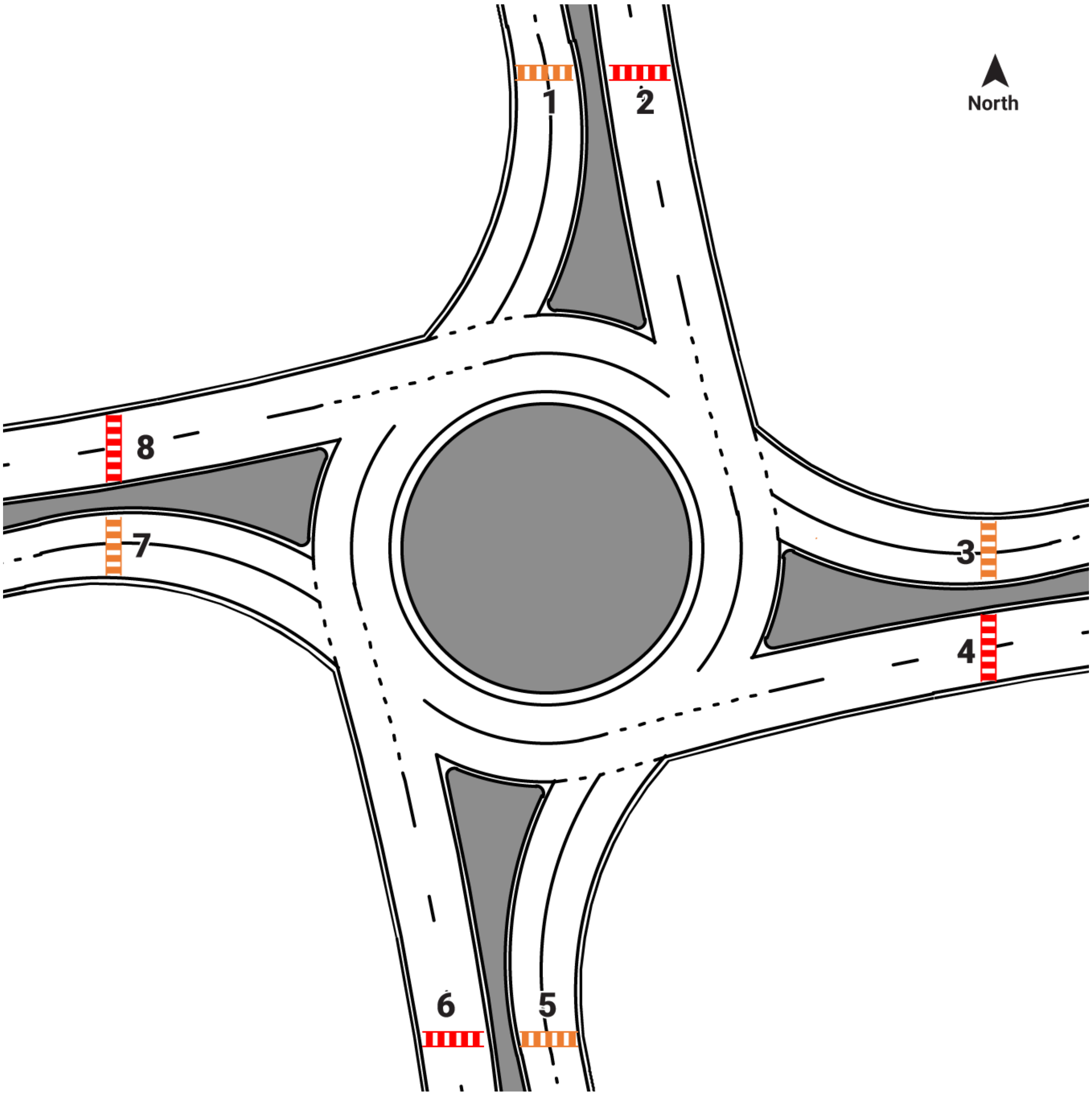


Figure C-49. Diamond (N-S)

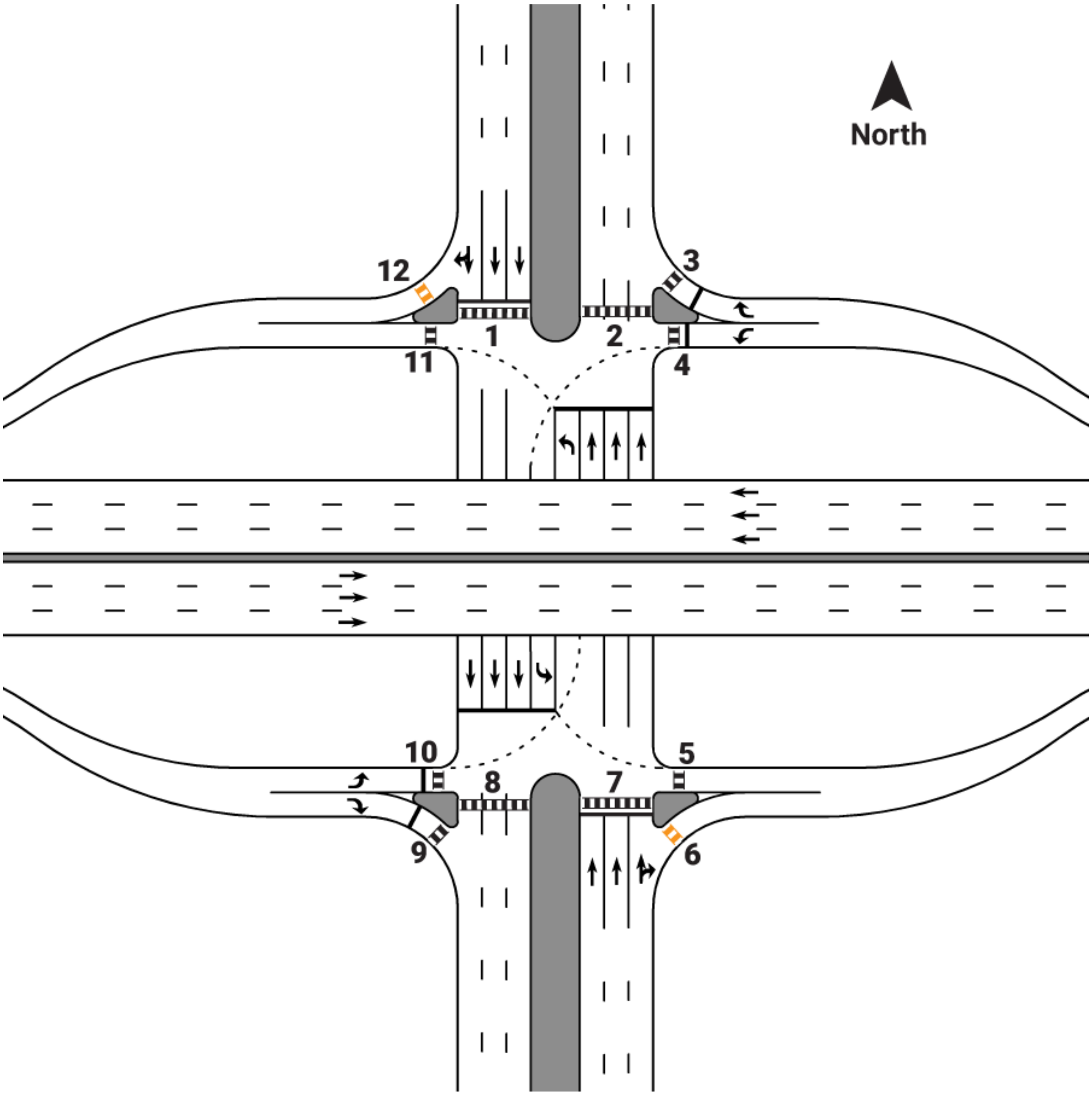


Figure C-50. Diamond (E-W)

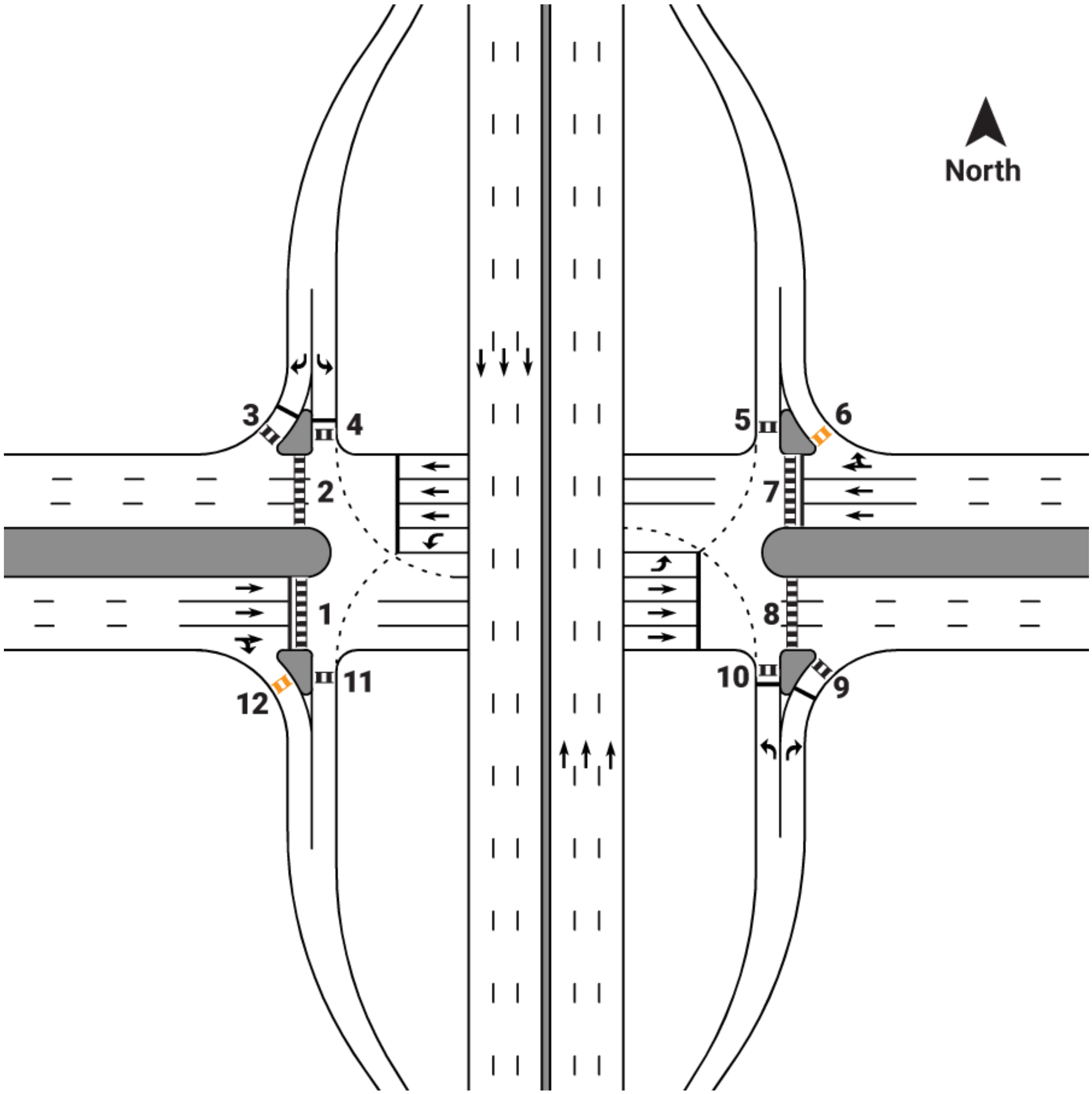


Figure C-51. Partial Cloverleaf B (N-S)

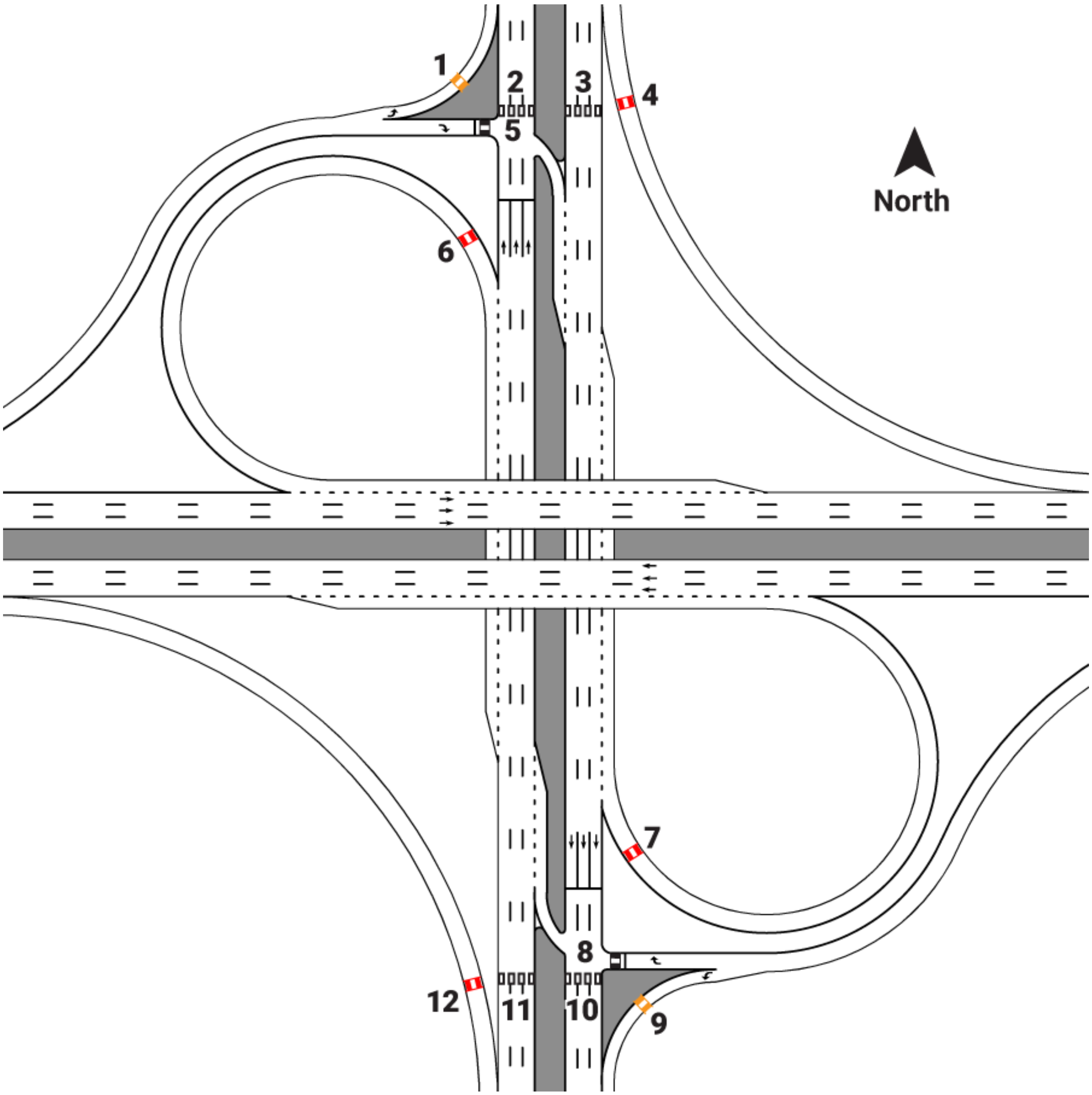


Figure C-52. Partial Cloverleaf B (E-W)

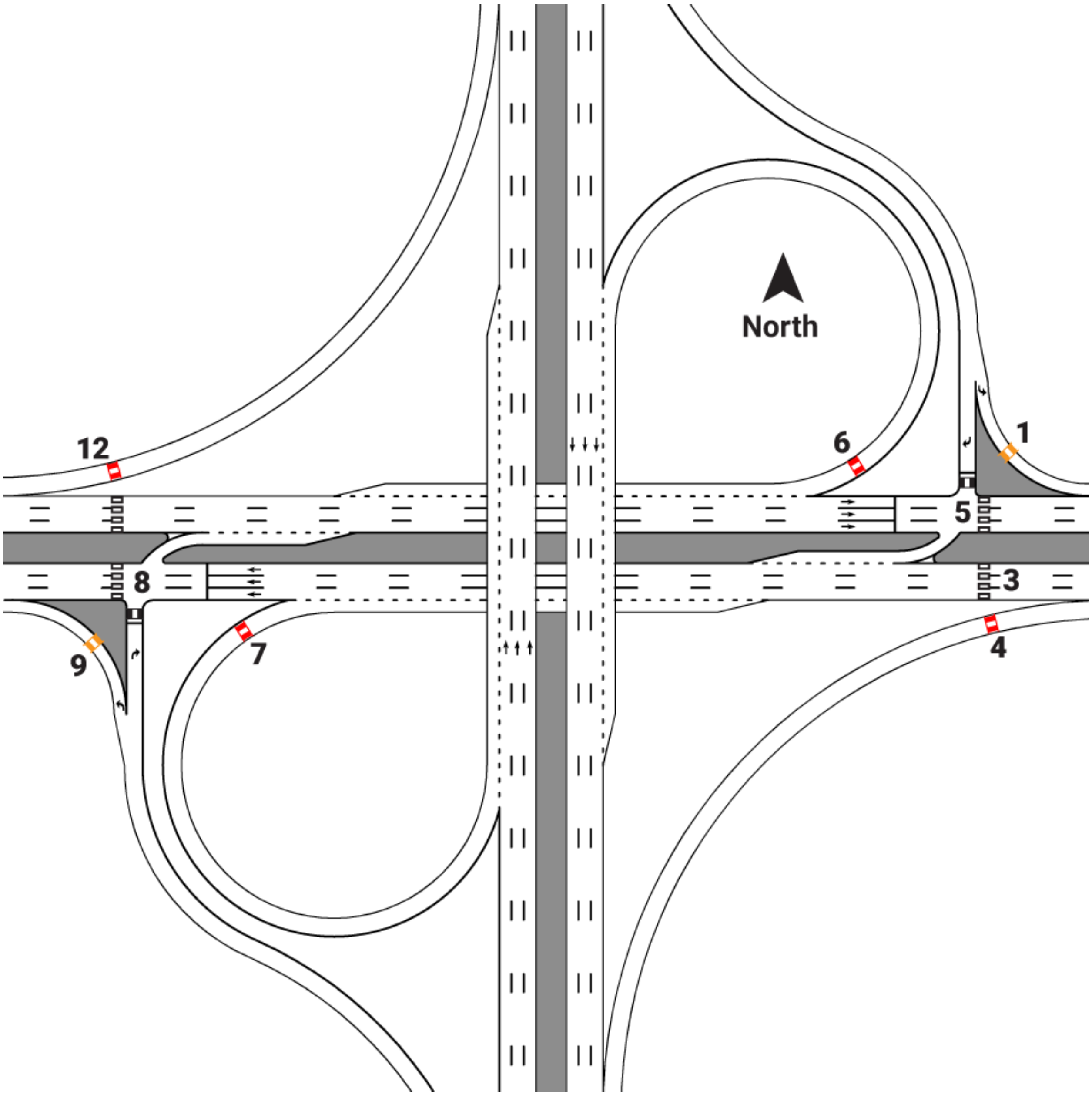


Figure C-53. Displaced Left Turn Interchange (N-S)

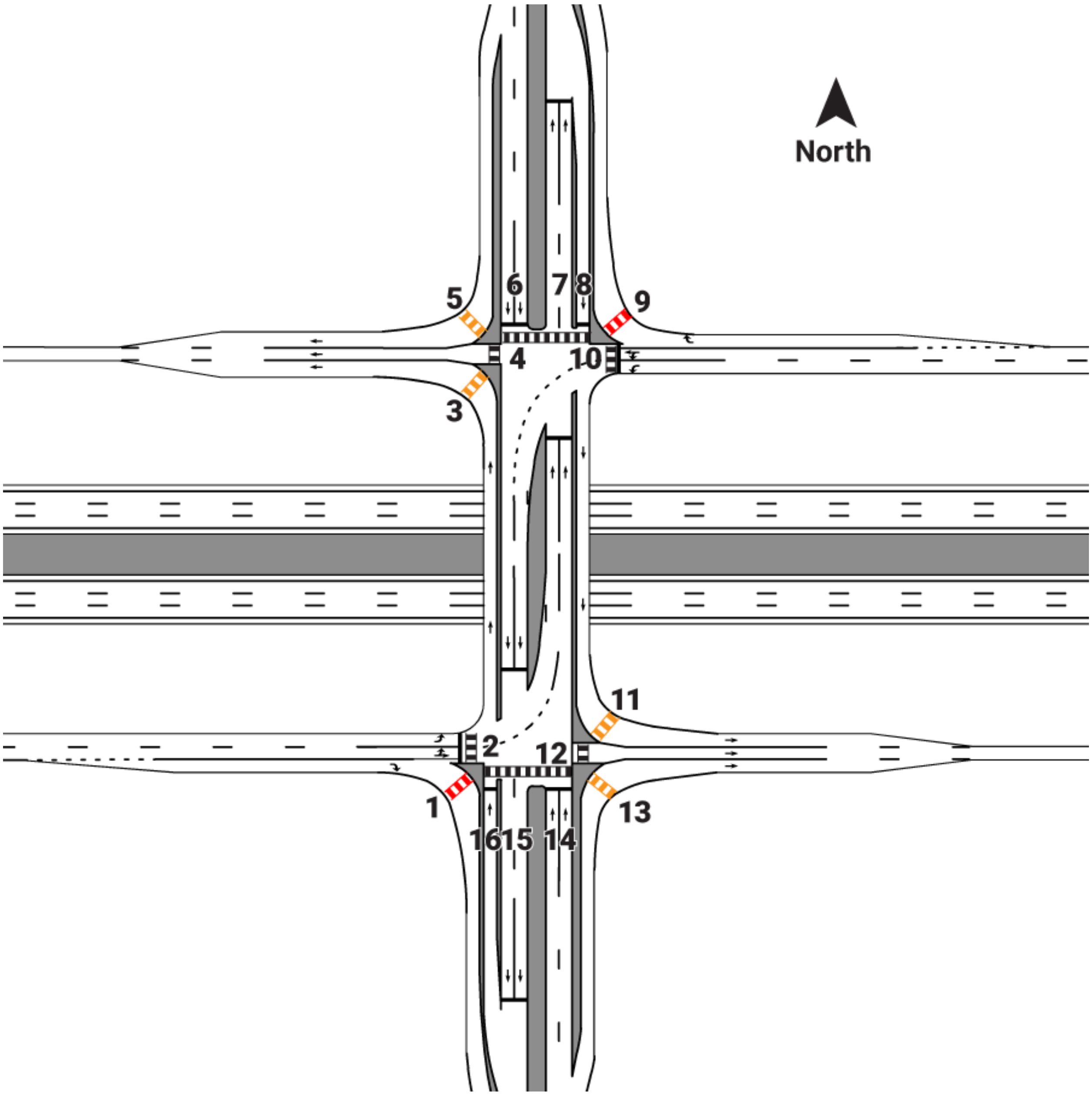


Figure C-54. Displaced Left Turn Interchange (E-W)

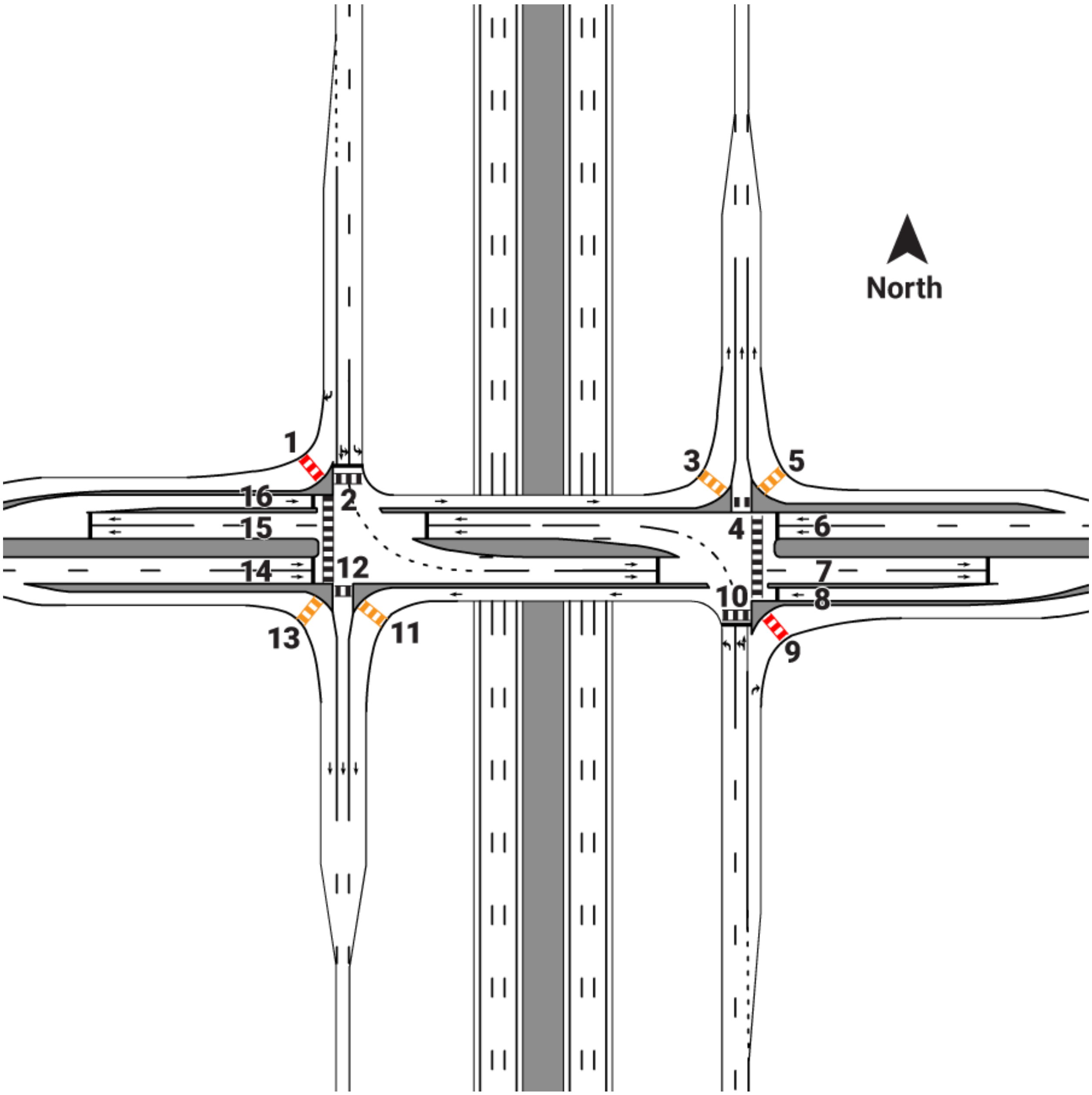


Figure C-55. Diverging Diamond (N-S)

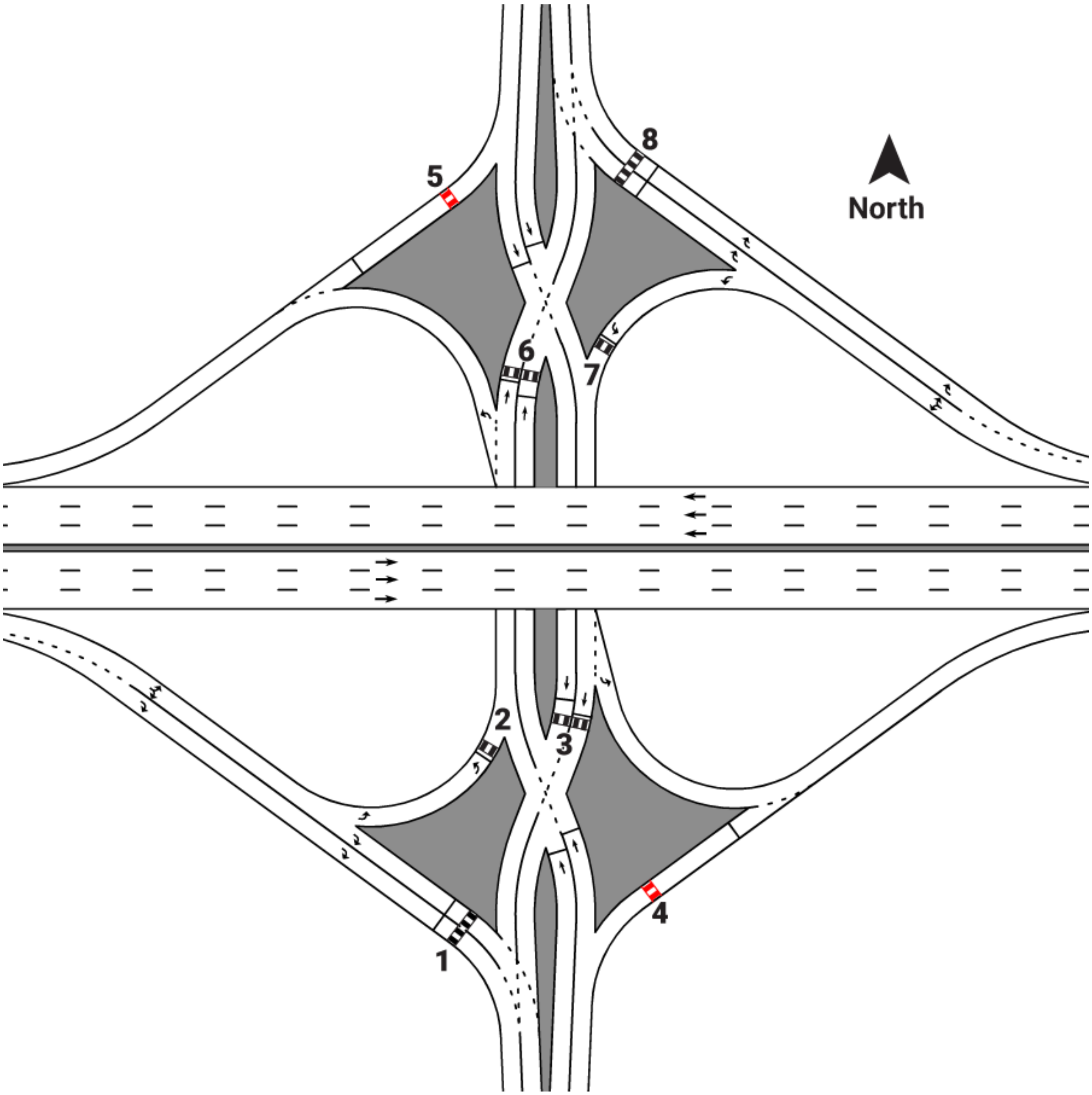


Figure C-56. Diverging Diamond (E-W)

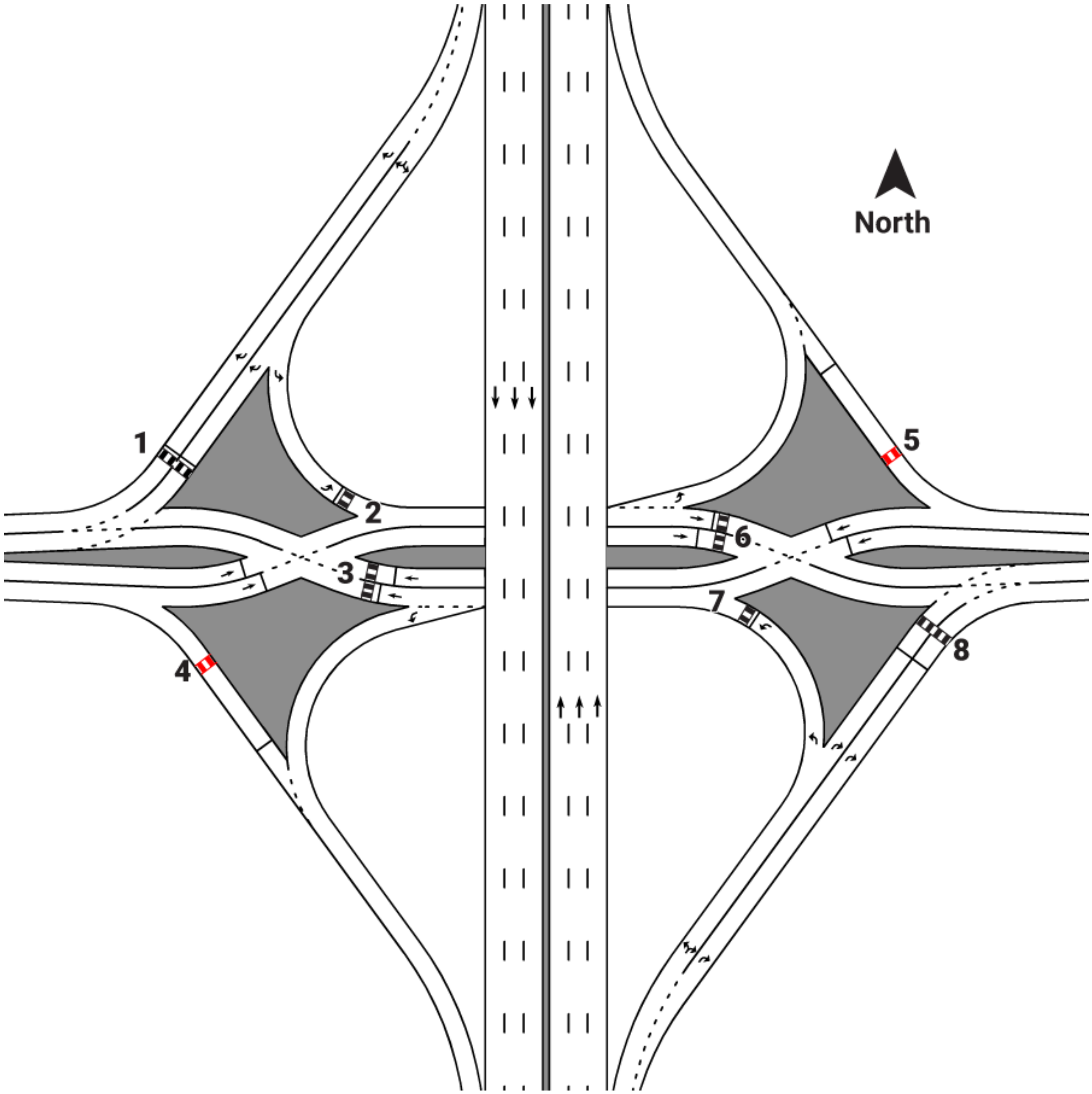


Figure C-57. Single Point Diamond (N-S)

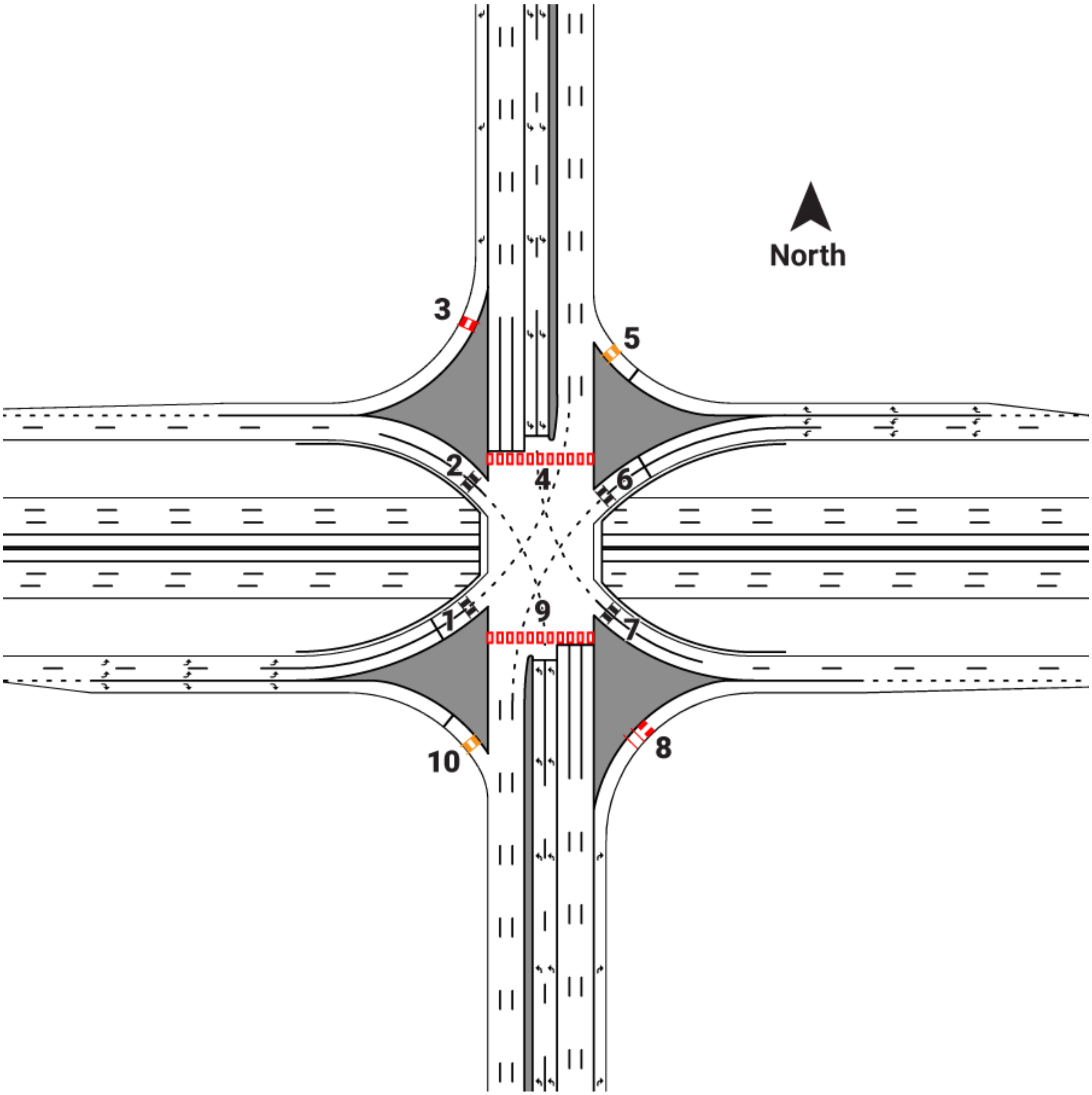
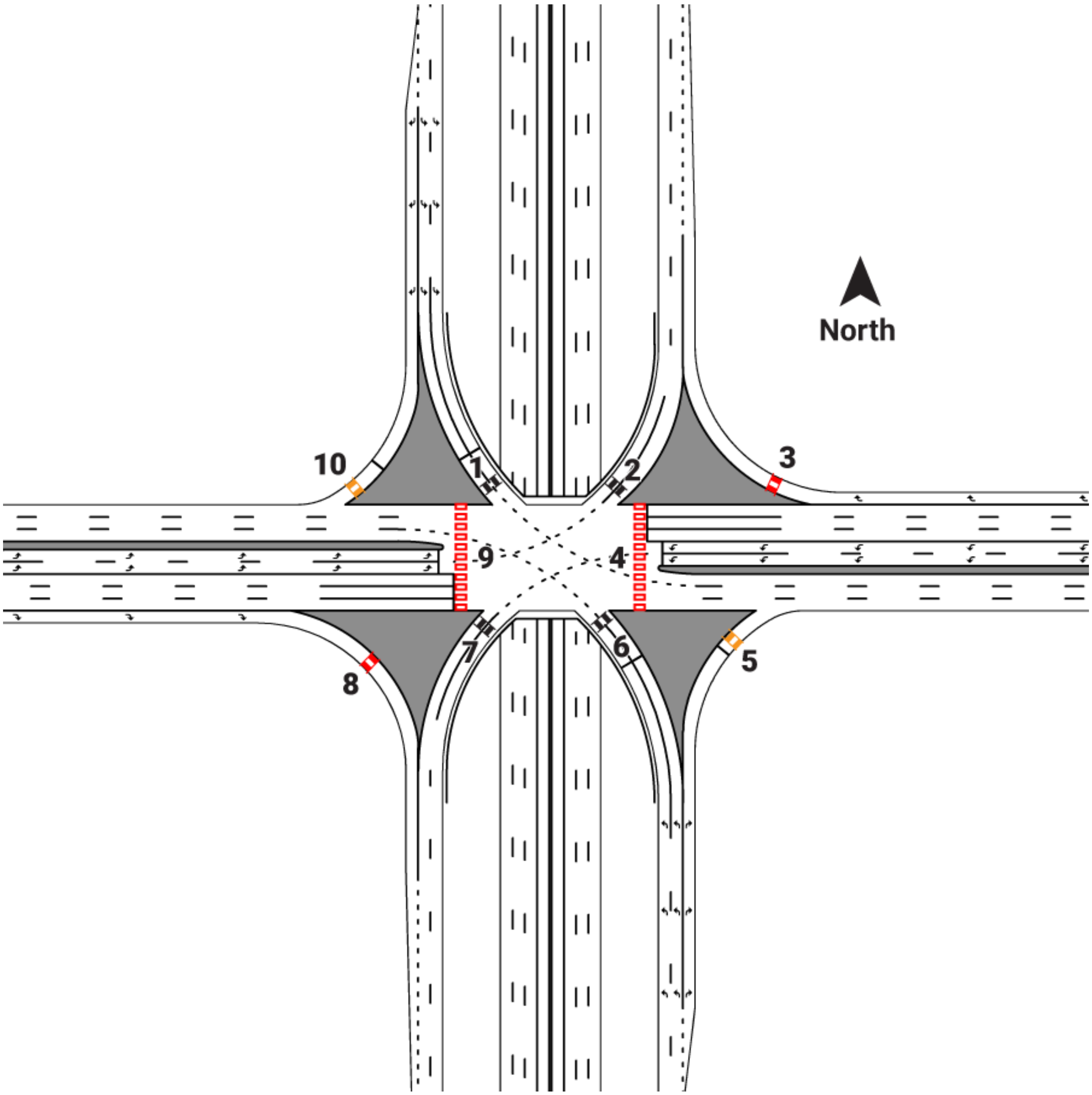


Figure C-58. Single Point Diamond (E-W)



APPENDIX D
ASSUMPTIONS FOR THE SSI METHOD

Table D-1 and **Table D-2** present the assumptions made in the SSI method calculations for at-grade and ramp terminal intersection control strategies, respectively. These are the default assumptions made in the FDOT SPICE tool for each intersection strategy. There are several overarching assumptions that apply across multiple control strategies:

- The calculations assume that intersection approaches have medians, channelizing islands, and/or nonmotorized refuge points only when those features are inherent to the design of the intersection alternative.
- The calculations do not consider U-turn movements unless they are an inherent part of the intersection design (such as in an RCUT or MUT intersection).
- The calculations do not consider exit ramp-to-entrance ramp through movements at ramp terminal intersections.
- Where left turn or exclusive pedestrian phasing is modifiable, as noted in **Table D-1** and **Table D-2**, the default assumption is protected left turn phasing without exclusive pedestrian phasing.

Table D-1. SSI Assumptions for At-Grade Intersection Control Strategies

At-Grade Intersection Control Strategy	SSI Considerations
Two-way stop-control	• Presence of median opening adequate to store vehicles for two-stage crossing is modifiable on SSI Input sheet. • Presence of major- or minor-street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
All-way stop-control	• Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
Signalized Control	• Presence of street median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major- or minor-street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Left turn phasing operation is modifiable on SSI Input sheet.
Roundabout	• Three roundabout entry geometries considered: 1x1 Roundabout (1 lane in each direction on all approaches), 2x1 Roundabout (2 lanes in each direction on major road, which yield to one circulating lane; 1 lane in each direction on minor road, which yield to two circulating lanes), and 2x2 Roundabout (2 lanes in each direction on all approaches, yielding to two circulating lanes). • All approaches have splitter islands/pedestrian refuge islands. • All approaches operate under yield control. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized movements due to footprint and placement of crosswalks.
Median U-Turn (MUT)	• All approaches have medians/pedestrian refuge islands. • All direct left turns are removed from intersection. • U-turn movements operate under traffic signal control.
Bowtie	• Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
Signalized Restricted Crossing U-Turn (RCUT) or Superstreet	• All approaches have medians/pedestrian refuge islands. • Z-type pedestrian crossing pattern is utilized. • Indirect Paths (out of direction travel) adjustment is applied to nonmotorized road users crossing major street. • U-turn movements operate under traffic signal control.

At-Grade Intersection Control Strategy	SSI Considerations
Unsignalized RCUT or J-Turn	• All approaches have medians/pedestrian refuge islands. • Z-type pedestrian crossing pattern is utilized. • Indirect Paths (out of direction travel) adjustment applied to nonmotorized road users crossing major street. • U-turn movements operate under stop control.
Jughandle	• Though other configurations are possible, the most common type–the forward jughandle–is assumed. • For left turns at the main intersection which are not redirected, phasing operation is modifiable on SSI input sheet. • Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
Displaced Left-Turn	• Two DLT alternatives considered: partial DLT (PDLT), displaced left turns on major street approaches only) and full DLT (displaced left turns on all four approaches). • All approaches have medians/pedestrian refuge islands and right turns are all channelized. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized conflict points (due to channelized right turns); Non-Intuitive Motor Vehicle Movements adjustment is applied to nonmotorized conflict points along nonmotorized movements that cross approaches with displaced left turns (i.e., all nonmotorized conflict points for full DLT). • For PDLT, minor street left turn phasing operation is modifiable on SSI input sheet.
Continuous Green T	• Nonmotorized movements crossing the continuous through movement on the major road are protected through user actuated signal control. • Major road approach without continuous movement has median that provides refuge to nonmotorized users. • Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.

At-Grade Intersection Control Strategy	SSI Considerations
Quadrant Roadway (QR)	• Though it is possible for other configurations, such as having QR in two quadrants or having roundabouts serve as the secondary intersections, a single QR with signalized T-intersections is assumed. • Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major- or minor-street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Phasing operation for left turns onto auxiliary road is modifiable on SSI input sheet. • Analysis for exclusive pedestrian phasing at auxiliary intersections is available on SSI input page in SPICE and QR tab in CAP-X.
Signalized Thru-Cut	• All approaches have medians/pedestrian refuge islands. • U-turn movements operate under traffic signal control. • Left turns from the major road operate under protected phasing. • Analysis for exclusive pedestrian phasing is available on SSI input page in SPICE and QR tab in CAP-X.
Unsignalized Thru-Cut	• All approaches have medians/pedestrian refuge islands. • Stop control is present on minor road approaches. • U-turn movements operate under stop control.

Table D-2. SSI Assumptions for Ramp Terminal Intersection Control Strategies

Ramp Terminal Intersection Control Strategy	SSI Considerations
Signalized Diamond	• Presence of cross-street median serving as pedestrian refuge island is modifiable on the SSI Input sheet. • Nonmotorized user paths across the cross-street are located outside the ramp legs. • Left-turn phasing operation from the arterial is modifiable on SSI input sheet.
Diverging Diamond	• Nonmotorized users travel using the centerline median island. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized conflict points. • Non-Intuitive Motor Vehicle Movements adjustment is applied to all nonmotorized conflict points. • All signal-controlled movements are protected.
Single Point Diamond	• Nonmotorized user paths across the cross-street are located just outside the single point intersection. • Analysis for exclusive pedestrian phasing is available on SSI input sheet in SPICE and Single Point tab in CAP-X. • The on- and off-ramp pedestrian crossings feature refuge islands. • Presence of cross-street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Indirect Paths (out of direction travel) adjustment is applied to nonmotorized movements crossing the cross-street.
Unsignalized Diamond	• No median present, or if present, the median is inadequate to store vehicle for two-stage crossing. • No approaches have pedestrian refuge islands. • Nonmotorized user paths across the cross-street are located outside the ramp legs.
Roundabout	• Three roundabout entry geometries considered: 1x1 Roundabout (1 lane in each direction on all approaches), 2x1 Roundabout (2 lanes in each direction on major road, yielding to one circulating lane; 1 lane in each direction on minor road, yielding to two circulating lanes), and 2x2 Roundabout (2 lanes in each direction on all approaches, yielding to two circulating lanes). • Cross-street approaches have splitter islands/pedestrian refuge islands. • All approaches operate under yield control. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized movements due to footprint and placement of crosswalks.
Signalized Tight Diamond	• Presence of cross-street median and channelized turning island serving as pedestrian refuge island is modifiable on SSI Input sheet. • Left turns onto ramps operate under protected signal phasing.

APPENDIX E
GENERAL CONSIDERATIONS FOR CONTROL STRATEGY EVALUATION

The following sections highlight areas of consideration when evaluating control strategies:

Context Classification

ICE evaluations consider the FDOT context classification of the project intersection. The Context Classification of the roadway is determined by FDOT. The selected control type should serve the transportation needs of all the transportation system users of all ages and abilities, including pedestrians, bicyclists, transit riders, motorists, and freight handlers. Refer to Section 200.4 in the FDM for more information on context classifications.

Design User

Design users are those anticipated users of a roadway (including drivers, pedestrians, bicyclists, transit, and freight handlers) forming the basis of each roadway's design. Roadway users' varying skills and characteristics introduce a variety of human factors that can influence users' driving, walking, and bicycling capabilities. Design users and the design vehicle should be taken into consideration when determining design details such as sidewalk widths, type of bicycle facility, design speed, signal timing and spacing, location of pedestrian crossings, location of transit stops, number of vehicular travel lanes, intersection width, required turning radii based on design vehicle, and lighting. Refer to FDOT's 2022 FDM for more information on design users.

Target Speed

FDM Section 202.2.1 – Target Speed says target speed is the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multi-modal activity generated by adjacent land uses, to provide mobility and safety for all users. It is the speed at which vehicles should operate. Target speed is influenced by elements of roadway design that are governed by design speed, as well as the form and function of the adjacent uses beyond the right of way. The concept of target speed utilizes design strategies and elements to reinforce operating speeds consistent with the posted or proposed speed limit.

For lower-speed roadways, those with design speed of 45 mph or less, it is desirable for the posted speed limit, the operating speed, and the design speed to be identical.

Refer to the FDOT *Speed Zoning Manual*, 2022 FDM, and the upcoming revisions to the FDOT *Traffic Engineering Manual* for more information on target speed, design speed, and other design controls based on context classification.

Agency Coordination and Public Input

Evaluations should assess driver expectations, agency coordination, and public input for each viable control strategy. When determining the acceptability of a control strategy, evaluators should typically consult the local jurisdictions, other important stakeholders, and potentially the public. The evaluation should eliminate control strategies from further consideration if stakeholder engagement is negative, especially if their cost participation is required. The project manager in consultation with local stakeholders and FDOT functional units should determine the degree of public involvement required/necessary in the control strategies' discussion. The evaluators should make stakeholders aware of the technical merits and potential issues of each control strategy.

Unconventional Intersection Geometry Evaluation

Conventional traffic control strategies are often less efficient at intersections with a difficult skew angle, significant offset, odd number of approaches, or close spacing to other intersections. Roundabouts may better suit such intersections because they do not require complicated signing or signal phasing. Roundabouts' ability to accommodate high turning volumes makes them especially effective at "Y" or "T" junctions. The use of roundabouts may also eliminate a pair of closely spaced intersections by combining them to form a multi-legged roundabout. Intersection sight distance for roundabouts is significantly less demanding than for other conventional intersection treatments.

Adjacent Intersections and Coordinated Signal Systems

The spacing of intersections along a highway corridor should be consistent with the spacing of primary full-movement intersections as shown in the FDOT Access Management Policy (Rule 14-97). The DTOE may allow intersection spacing exceptions for roundabouts based on justifiable merits on a case-by-case basis. Positioning a roundabout within a coordinated signal system or very near to an adjacent signal is not preferred; however, under some circumstances it may be an acceptable option. A comprehensive traffic analysis is needed to determine if it is appropriate to locate a roundabout within a coordinated signal network.

System Consistency

On Strategic Intermodal System facilities or other highways where a corridor study was previously prepared, any ICE should address the impact on the SIS performance or compare control strategies to those recommended in the corridor study.

Pedestrian and/or Bicycle Issues

Accommodating non-motorized users is a priority. Depending on the volume of non-motorized users and the context of the location, one control strategy may be preferred to another entirely for pedestrian and bicycle reasons.

Additional Resources

Table E-1 provides links to potentially useful tools and resources when conducting an ICE.

Table E-1. Useful Tools and Resources for ICE

Category	Title	Description	Web Link
Operational and Safety Performance Evaluation Tools	Capacity Analysis for Planning of Junctions (CAP-X) Tool	Excel spreadsheet-based critical lane method operational analysis tool	https://www.fdot.gov/traffic/trafficservices/intersection-operations.shtm
	Safety Performance for Intersection Control Evaluation (SPICE) Tool	Excel spreadsheet-based safety performance screening tool for conventional and alternative intersection types	https://www.fdot.gov/traffic/trafficservices/intersection-operations.shtm
	Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis	Definitive reference for traffic analysis of intersections and underlying basis of many intersection operations software packages	http://www.trb.org/main/blurbs/175169.aspx
	FDOT-extended NCHRP 17-38 and 17-58 Spreadsheets	FDOT Present Worth Analysis - FDOT Procedural Forms 750-020-21(A-D)	https://www.fdot.gov/traffic/trafficservices/studies/muts/muts.shtm
	A Safe System-Based Framework and Analytical Methodology for Assessing Intersections	Quantitative framework for assessing the extent to which intersection alternatives in a given context align with Safe System principles	https://safety.fhwa.dot.gov/intersection/ssi/fhwasa21008.pdf
Life-Cycle Cost Analysis Tools	NCHRP Intersection Lifecycle Cost Analysis Tool	Excel spreadsheet-based economic evaluation tool	http://www.trb.org/Main/Blurbs/173928.aspx

Category	Title	Description	Web Link
Intersection Pedestrian and Bicycle Facility Videos	ICE Example Videos	Videos showing operations for various pedestrian and bicycle facility designs at MUT, RCUT, and DLT intersections	https://www.fdot.gov/traffic/trafficservices/intersection-control-example-videos
Intersection Control Type Reference Guides	Unsignalized Intersections Improvement Guide	A web-based guide documenting safety, mobility, and accessibility improvements to unsignalized intersections	https://toolkits.ite.org/uiig/default.aspx
	FHWA-SA-13-027 – Signalized Intersections Informational Guide, Second Edition	PDF report providing guidance on enhancing the safety of signalized intersections	http://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/fhwasa13027.pdf
	FHWA-SA-14-069 – Median U-Turn Intersection Informational Guide	PDF report providing guidance on median U-turn (MUT) intersections	https://rosap.ntl.bts.gov/view/dot/29476
	FHWA-HRT-09-055 – Displaced Left-Turn Intersection	Technical brief about displaced left-turn (DLT) intersections	http://www.fhwa.dot.gov/publications/research/safety/09055/09055.pdf
	FHWA-SA-14-070 – Restricted Crossing U-Turn Intersection Informational Guide	PDF report providing guidance on restricted crossing U-turn (RCUT) intersections	https://rosap.ntl.bts.gov/view/dot/29477
	FHWA-HRT-07-032 – Traffic Performance of Three Typical Designs of New Jersey Jughandle Intersections	Technical brief about performance of New Jersey Jughandle intersections	http://www.fhwa.dot.gov/publications/research/safety/07032/07032.pdf
	FHWA-SA-14-068 – Displaced Left-Turn Intersection Informational Guide	PDF report providing guidance on displaced left-turn (DLT) intersections	http://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14068_dlt_infoguide.pdf
	FHWA-SA-19-032 – Safety Evaluation of Continuous Green T Intersections	Technical brief about safety impacts of continuous green T (CGT) intersections	http://safety.fhwa.dot.gov/intersection/innovative/others/casestudies/fhwasa09016/fhwasa09016.pdf

Category	Title	Description	Web Link
	FHWA-HRT-09-058: Quadrant Roadway Intersection	Technical brief about quadrant roadway (QR) intersections	http://www.fhwa.dot.gov/publications/research/safety/09058/09058.pdf
	FHWA-HRT-09-060: Alternative Intersections/Interchanges: Informational Report	PDF report providing guidance on various alternative intersection control types. Information on DLT, MUT, QR, and RCUT intersections superseded by the individual guidebooks above.	http://www.fhwa.dot.gov/publications/research/safety/09060/09060.pdf
	NCHRP 345 – Single Point Urban Interchange Design and Operations Analysis	Research report providing guidance on design and operations of single point urban interchanges	http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_345.pdf
	NCHRP 672 - Roundabouts: An Informational Guide, Second Edition	Research report discussing roundabout design and evaluation	http://www.trb.org/Publications/Blurbs/164470.aspx
	NCHRP Report 888 – Development of Roundabout Crash Prediction Models and Methods	Research report providing SPFs and CMFs to estimate number and severity of crashes at roundabouts	http://www.trb.org/Publications/Blurbs/178663.aspx
	NCHRP 948 – Guide for Pedestrian and Bicyclist Safety at Alterative and Other Intersections and Interchanges	Research report providing guidance for comparative qualitative evaluation of pedestrian and bicyclist safety at any intersection or interchange type. Information on MUT, RCUT, DLT, and Diverging Diamond Interchange (DDI) pedestrian and bicyclist facility designs are also provided.	http://www.trb.org/Main/Blurbs/181781.aspx
	NCHRP 959 – Diverging Diamond Interchange Informational Guide, Second Edition	Research report providing guidance on safety, operations, design, and multimodal considerations of DDIs	http://www.trb.org/Publications/Blurbs/181562.aspx