Chapter 2 Presentation Script

Welcome to the Manual on Uniform Traffic Studies, also called MUTS computer based training! This training module will cover Chapter 2 - Traffic Signal Study Procedure.

The information in this chapter has been adopted from the Manual on Uniform Traffic Control Devices or MUTCD and the Intersection Control Evaluation, or ICE, Manual.

To get started, we will share more detail on the purpose of the Traffic Signal Study Procedure and the elements to consider in order to complete the study.

MUTS Chapter 2 provides an overview of the logical and systematic data collection procedure for investigating traffic signal requirements.
The data and procedure outlined in this chapter are designed to minimize the data collection effort and reduce the number of field reviews.

This chapter also provides guidance for determining the installation of a new traffic signal or the need for operational improvements of an existing traffic signal. When conducting these studies, make sure to download the latest excel available through the website.

Figure 2-1, found in the MUTS, provides an overview of the study procedure steps included in this chapter. Let's take a closer look into the different steps **through** this flow chart.

The procedure begins with an alleged problem that has been brought to the engineer.
The engineer should then conduct a field review to observe the problem followed by a traffic Signal Warrant Analysis.
The next half of the flow chart will describe the report process once the Signal Warrant Analysis is completed.

If a signal is warranted, the engineer will conduct an Intersection Control Evaluation or ICE analysis which will include the conceptual design of the proposed solution. The proposed solution will then go through the traffic regulation approval process and the plans preparation process, simultaneously.

If approved, the solution will move into implementation followed by the education/information dissemination process.
If a signal is not warranted, the procedure will move directly into the education/information dissemination process.

Let’s take a closer look at the first step in the procedure: learning about the problem.

The first step is learning of an alleged problem.
When notified of a problem, the engineer is required to respond to the notice regardless of its source.

Once notified, the engineer should conduct a field review of the site to determine if a full-scale investigation is required.
Once an observation is conducted, the engineer should notify the reporting party of the action to be taken.

The next step in the process involves observation of problem symptoms.
Let’s take a closer look at the intersection elements.

During the field review the engineer should observe and record the operational and geometric characteristics of the location as well as any unusual or significant circumstances.
A condition diagram should be created or updated to record site characteristics.

Operation conditions should be observed and documented during the time that operational issues were reported to have occurred.
Photographs and video should be used to document observations.
Following the completion of the field review the engineer should determine if a real problem exists or if no further investigation is needed.
The engineer should notify relevant parties of the action to be taken.

The purpose of a Condition Diagram is to record relevant site information for analysis.
The Condition Diagram should include the location of existing traffic signal control devices, intersection geometry, and other physical features.
Further details on preparing a Condition Diagram are provided in MUTS Section 5.4.2.

Figure 2-2, found in the MUTS, provides greater detail into the study procedure.
We will break the chart down into three sections and discuss its content in detail in the following three slides.

Once a problem has been determined, the basic areas of concern should be established to understand the issues. These can include vehicle operations, pedestrians, and / or crashes.
Once the issues are understood, relevant data should be collected for evaluation.
This data can include but is not limited to turning movement counts, pedestrian demand, historical crash data, vehicular delay, and available gaps.
This step is followed by the Traffic Signal Study Report which contains the Traffic Signal Warrant Analysis.

If a traffic signal is warranted, the ICE analysis procedure should be applied.
The first step for the ICE analysis is to go through the ICE applicability criteria
at the study intersection.

Under ICE Stage 1, the engineer will determine viable intersection improvement alternatives
to advance to ICE Stage 2.
Signalized intersection improvement alternatives can include options
such as the Restricted Crossing U-turn or R-CUT or the Median U-turn or MUT.

During ICE Stage 2 **the** engineer conducts a more detailed evaluation
of the viable intersection alternatives which includes initial concept development.
Typically, the preferred alternative is selected during the ICE Stage 2 analysis.
At the conclusion of the ICE analysis, a preferred alternative conceptual design
and report should be developed and submitted for review.

If the conceptual design and report are approved,
the recommended solution should be moved into implementation.
As a final step, the engineer should evaluate the need to educate stakeholders,
road users, and community members regarding the improvement being implemented.

We will now discuss and dive deeper into understanding how to establish
the basic areas of concern for the study intersection.

When conducting a traffic signal study, there are three basic areas of concern:
vehicle operations, pedestrians and bicyclists, and crashes.
It is important to recognize that the observed issue may be a result of more than one basic area
of concern.

MUTS Chapter 3 provides additional detail on each of the traffic signal warrants.
Warrants relevant to vehicle volumes and operations are discussed MUTS Section 3.5, 3.6,
and 3.7 regarding M-U-T-C-D signal warrants 1, 2 and 3.
MUTS Sections 3.8 and 3.11 discuss M-U-T-C-D signal warrants 4 and 7
relevant to pedestrian volumes and activity.
MUTS Section 3.11 discusses M-U-T-C-D signal warrant 7 relevant to crashes.

Let’s take a closer look into vehicle operations as an area of concern.
Vehicle operations issues such as excessive queue lengths, slow queue dissipation rates, and substantial traffic volumes can usually be identified during a field investigation and data collection.

Typical data collected to determine the extent of a vehicle operations concern includes hourly approach volumes, distance to the nearest signal, intersection delay, and travel time and delay.

The second area of concern is pedestrian and bicycle issues.
Although pedestrian and bicycle issues can be identified during a field review, it is difficult to ascertain the severity of the issue without additional data collection.
Typical data collected to determine the extent of pedestrian and / or bicycle issue includes non-motorized volume studies, gap studies, distance to the nearest crosswalk or signalized intersection, pedestrian characteristics, and walking speed studies.

Walking speed studies, including procedures to evaluate and determine appropriate walking speeds, are further discussed in MUTS Section 9.6 as well as Section 3.11 as part of Traffic Signal Warrant 7: Crash Experience.

The third area of concern is crashes.
It is often difficult to determine an intersection's crash potential during a field review.
Nonetheless, engineers have to leverage the available data.
A review of historical crash records should be conducted to gain insight on potential crash frequency at the study intersection.

The number of years that are needed for review will be determined based on the existence of any recent projects at the site.
A minimum of five years of historical crash data should be reviewed, but engineering judgement should be used to determine the required number of years if a major change to the site has occurred.

There are many types of data that can help an engineer further define a crash problem.
The following are some types: historical records of recent projects or treatments,
as well as existing or proposed projects, hourly approach volumes,
crash records and / or crash rates, a collision diagram, pedestrian volume counts,
a vehicle spot speed study, intersection geometry including sight distances,
pavement conditions, roadside hazards,
existing guidance through signing and pavement marking, existing roadway lighting,
and a traffic conflict investigation.

It is important to understand the crash types that may be experienced at the study intersection.
Note that the typical crashes susceptible to correction by a signal include angle, left turn,
and sideswipe in some cases.

Some examples of remedial measures include advance warning signs
of unsignalized intersections and realigning available lanes.
Refer to MUTS Section 2.4.3 for additional guidance on resources for each of these elements.

Once the data is collected, the next step is data analysis and interpretation.

Following data collection, a traffic signal warrant analysis should be conducted to understand
if a traffic signal is warranted.
This analysis can be completed using Form Number 750-020-01,
Traffic Signal Warrant Summary.

The two captures shown are the input tab from this form;
MUTS Chapter 3 and its corresponding computer-based training
will cover in detail the application of this form and its features.
Once the warrant analysis has been completed, ideally using Form Number 750-020-01
or a similar tool, and a traffic signal is warranted,
engineering judgement should be used to determine if a traffic signal should be installed.

Consideration should be given to understand if a traffic signal would create greater problems than it would solve.
Considerations should include development of excessive queues, queue dissipation rates, spacing between adjacent signals, intersection geometry, public transportation, distance between pedestrian crossings, and signal timing.

Consider the situation at the intersection of Main Street and a commercial business driveway.
A relatively minor volume exits and enters the driveway,
but the volumes do meet the 70% threshold for Warrant 2 - Four-Hour Vehicular Volume.
A traffic signal is warranted due to meeting Warrant 2,
but the traffic signals adjacent to the driveway provide good platooning of vehicles on Main Street.

Due to the platooning, there are sufficient gaps in traffic and the delays for vehicles coming from the commercial business driveway are low.
In this case, engineering judgement should be applied to determine if the benefits for the relatively minor volume at the commercial business driveway outweigh the cost of delay increase for the major movement.

In another example, consider a new development that is being built along Main Street.
The phased development is approximately 30% built out.
The existing volumes do not meet warrants, but the projected future volumes at build out meet Warrant 1 and Warrant 2 for the 100% volume threshold.

The developer requested that a signal be installed based upon the projected future volumes.
In this case, engineering judgement should be applied to determine if a traffic signal should be installed when the existing volumes do not meet warrants and the development may never reach full build-out.

As a result, it is suggested to design the intersection to accommodate a signal in the future.
The construction of the signal would only happen if the future development occurs.

FDOT's Intersection Control Evaluation or ICE is a methodology developed
to evaluate control alternatives at intersections.
If signal warrants are met on a state roadway,
ICE is required to determine which kind of control is best for the intersection’s context.

The following list provides situations when ICE is required:
when new signalization is proposed, when an existing signalized intersection
undergoes major reconstruction such as adding exclusive left turns or adding intersection legs,
when converting from a directional or bi-directional median opening to a full median opening,
as part of driveway and connection permit applications for Category E, F, and G,
and when the District Design Engineer and District Traffic Operations Engineer
consider ICE to be a good fit for the project.

In contrast, ICE is not required for the following situations:
when work does not include substantive changes such as milling and resurfacing,
when an existing signalized intersection undergoes minor reconstruction
such as adding a right turn lane or signal phasing improvements,
or when work is being done on a local roadway.
ICE is not required but is recommended at ramp terminal intersections.

The purpose of ICE is to consistently consider multiple context-sensitive control strategies when planning a new or modified intersection.
The goal is to better inform FDOT's decision-making process to identify and select a control strategy meeting the project's purpose and need, fitting the intersection location's context classification, providing safe travel facilities for all road users, and reflecting the overall best value.
ICE is broken into three stages.

Stage 1 is a Screening process completed during a project's initial stage.
This stage reviews existing conditions and evaluates viable alternative intersection forms at a planning level.

There are two tools provided for this analysis.
For the operations analysis, Capacity Analysis for Planning Junctions or CAP-X is used.
For the safety analysis, Safety Performance for Intersection Control Evaluation or SPICE is used.

Stage 2 is a Preliminary Control Strategy Assessment completed following a project's initial stage when more detailed information is available.
This stage involves detailed operations and safety analysis to conduct a benefit-cost comparison of the viable alternative intersections.

The Analysis Guidance shown on this slide is the concept development of the Stage 2 control strategies to be included in preliminary construction and right-of-way cost estimates.

More detailed operations analysis is done using FDOT Synchro templates developed for the different control strategies.
SPICE is analyzed at a greater detail and uses existing crash history in the analysis.
The FDOT ICE Tool uses the operations and safety results for the benefits analysis and the construction, right-of-way, and operations & maintenance costs to conduct the benefit-cost and net present value analysis.
Typically, the ICE analysis will identify a preferred control strategy with the completion of Stage 2.
If not, Stage 3 is conducted.

Stage 3 is a detailed control strategy assessment completed to answer the reason why Stage 2 was not approved.

This stage is an extension of Stage 2, digging further into any necessary details and analysis to find the most viable solution.
There are no additional tools in Stage 3.

ICE trainings have been conducted for each FDOT district around the state.
Materials were developed for the trainings and have been made available on FDOT's website to aid engineers in learning the basics of the process.
Additionally, the corresponding ICE resources and tools can be obtained from the FDOT’s Traffic Engineering and Operations Office website shown on the slide.

Preparation and Approval of Traffic Signal Study Report.
Many of the ICE control strategies may result in the installation of a traffic signal.
This report is required whether the ICE procedure's preferred alternative is a traffic signal, Restricted Crossing U-turn, Median U-turn, or another control strategy requiring a traffic signal.

Proper documentation of all activities taking place from the initial allegation of a problem through the warrant analysis is required.
A traffic signal study report including the following elements should be prepared:
a cover and title page that is signed and sealed,
a description and aerial image of the study intersection,
and an Existing Conditions Diagram.

Additional report elements may include Crash Analysis and Collision Diagram,
discussion of the Signal Warrant Analysis, and discussion of the ICE analysis
including approved Stage 1 and Stage 2 ICE Forms
showing the traffic signal installation is the preferred alternative and the type of control strategy being a standard signalized intersection, Restricted Crossing U-turn, Median U-turn,
or another control strategy requiring a traffic signal.

Discussion of the Traffic Operations Analysis conducted, recommendations,
and all other relevant supplemental information are part of the preparation
and approval of the study.

There are four potential outcomes of a traffic signal study.
Case one is that no problem exists and therefore no traffic signal is warranted.
Case two is that a problem exists, but the solution is not a traffic signal.
Case three is that a problem exists, and a traffic signal will correct or reduce the problem.
Case four is that a problem exists and a traffic signal in conjunction with other improvements will correct or reduce the problem.

If the outcome of the study is case one, no problem exists,
the study should end and the party initiating the request should be notified.
If the outcome is case two, a problem exists, but a signal is not the solution,
the study should end and another study should be initiated to resolve the problem.

If the outcome of the study is case three or case four,
a problem exists and a signal is the solution or a problem exists and a signal in conjunction with other improvements is the solution, the ICE process should be initiated to resolve the problem.
A new signal installation may change the intersection's control strategy
to a different intersection form such as a Restricted Crossing U-turn or Median U-turn.

An example of case four could be an intersection that meets signal warrants
and has high pedestrian crossing volumes along the segments adjacent to the study intersection.
An alternative to a signalized intersection could be a Restricted Crossing U-Turn called a R-CUT.
This alternative would provide the traffic signal at the main intersection
as well as two signalized U-turn locations located on the segments adjacent to the main intersection.

The signalized U-turns can provide **signalized** pedestrian crossings
to help meet the pedestrian crossing demand.
Further, when the Restricted Crossing U-turn is the ICE preferred alternative,
the traffic signal warrant analysis for the main intersection justifies signalization of the U-turn signals. No further signal warrant analysis is required.

The step to follow includes the development of conceptual design
for the proposed improvements and signalization.

Once a new traffic signal or modifications of an existing signal have been justified,
conceptual design should be completed.
The following elements should be included in a traffic signal design conceptual report:
data collection, alternatives development, alternatives evaluation,
selection of the best alternative, and identification of the design improvement.

Each element is part of the ICE procedure.
Stage 1 includes data collection and alternative development while the alternatives evaluation,
selection of the best alternative, and identification of the design improvement
are typically part of Stage 2.

The final step once data collection, analysis, and reporting are completed
is the preparation and approval of a traffic signal conceptual design report.

Upon completion of the conceptual design process,
a traffic signal conceptual design report should be prepared.
At a minimum, the report should include: the elements of a traffic signal study report,
additional data collected, **a** description of alternatives, **a** description of analyses conducted,
and the engineer's recommendations.

Additionally, the report should include work to be performed, the maintaining agency,
the enforcement agency, copies of resolutions and agreements,
and approval of the recommended concept.

If ICE was conducted as part of the analysis the approved Stage 1 and Stage 2 ICE Forms
with the applicable supporting documentation should be included.
The report should be provided to the engineers responsible for the preparation
of the traffic signal plans and for conducting the necessary steps
of the traffic regulation approval process.

Consider the example intersection of US 1 and Reba Avenue.
This location met signal warrants 1, 2, 3, and 7; therefore, ICE was applied
to determine which intersection control type was most applicable for the existing characteristics.

Following the completion of ICE Stage 1 and Stage 2, the partial Median U-Turn
was selected as the preferred alternative based on safety and operations results.
Implementation of the partial median U-turn at US 1 and Reba Avenue
would provide an additional signalized pedestrian crossing at the signalized U-turn
located south of Reba Avenue.

It is important to note that the partial and full Median U-Turn
as well as the Restricted Crossing U-Turn do not require signal warrants
to signalize the U-turn intersections.

Implementation is the remaining step to complete the task and carry it through completion.

Implementation of the improvement should take place
as soon as possible after the project development and design report are completed.
Following implementation, the engineer should visit the site to determine if the traffic signal is operating as designed.
This evaluation may require additional data collection.

This concludes the Manual on Uniform Traffic Studies computer based training,
Chapter 2 - Traffic Signal Study Procedure.

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You will now be directed to a 10-question quiz to test your knowledge and understanding
on the material presented in this computer-based training.
A passing grade of 70% is required to obtain the Certificate of Completion for the training.
If a grade below 70% is obtained, the trainees are required to re-take the full training
until a passing grade of 70% or higher is obtained.

If you do not pass the quiz, please return to the Index page by selecting the Index button below and re-take this training.
Once you've received your certificate, please continue to the next chapter
by selecting the "NEXT" button below this CBT.
On the next slide, please enter your first and last name before continuing to the quiz.
Thank you for your time and attention.

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You will now take a 10-question quiz to test your knowledge and understanding on the material presented in this computer-based training.
A passing grade of 70% is required to obtain the Certificate of Completion for the training.

If a grade below 70% is obtained, the trainees are required to re-take the full training until a passing grade of 70% or higher is obtained.
If you do not pass the quiz, please return to the Course Content tab, and re-take this training.
Once you've passed the quiz and received your certificate please continue to the next chapter by returning to the MUTS course content tab and selecting the next chapter in the training.
Please, continue to the quiz and thank you for your time and attention.