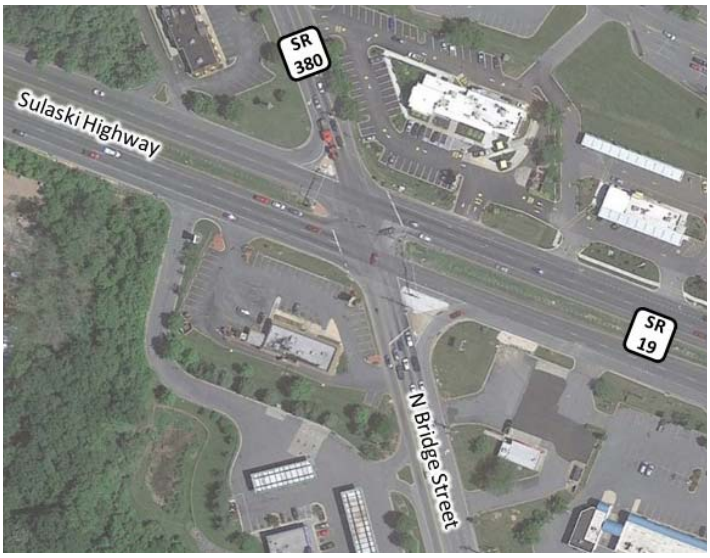
PENNDOT INTERSECTION CONTROL EVALUATION (ICE) POLICY CASE STUDY #5

PROJECT LOCATION



EXECUTIVE SUMMARY

Case Study #5 highlights the evaluation of a high-volume urban intersection experiencing safety and operational issues. The purpose of the case study is to illustrate the application of the ICE Policy where a preferred control strategy is an alternative intersection identified through multiple stages of analyses.

PROJECT DESCRIPTION

The intersection of SR 19 (Sulaski Highway) and SR 380 (N Bridge Street) near Pittsburgh is routinely identified as a high crash location. A substantial amount of crashes were reported at the intersection during the three-year period from January 1, 2011 to December 31, 2013 – a total of 17 property damage only (PDO) crashes and 22 injury crashes. The number and proportion of rear-end crashes (56 percent) at the intersection indicates that there are one or multiple factors causing this location to be high-risk for rear-end crashes. There were also 5 left-turn crashes despite protected left-turn signal phasing on all approaches. The fundamental safety issues at this intersection are related to the skew of the roadways and the poor operational performance resulting in long queues.

A recently conducted operational analysis determined the intersection currently operates at capacity with a level-of-service (LOS) "E" during the weekday p.m. peak period. Each through movement has volume that exceeds capacity. The long queues, in conjunction with the prevalence of "failure to give full attention" crash causes could indicate that unexpectedly slowed or stopped vehicles far in advance of this intersection are contributing to rear-end crashes. The purpose of this project is to enhance safety performance and reduce vehicular delays and queues.

CONDUCTING AN ICE

At the initial stage of the analyses, various control strategies were reviewed for their applicability. Adjacent development makes many of the control strategies unfeasible.

Considering right-of-way constraints and crash history at the intersection, the viable control strategies include:

- Median U-Turn
- Restricted Crossing U-Turn (RCUT)
- Traffic Signal (existing)
-

Currently, channelized right turn lanes are provided on northbound and southbound approaches; both of the turning lanes have a sufficiently large radius to allow relatively high speed, yield-controlled turning movements. This makes both median U-turn and signalized RCUT control feasible. Retaining a conventional signal with additional through lanes on SR 19 would help reduce delays incurred by vehicles from both mainline and side-street. As the preliminary analysis conducted in Stage 1 did not advocate a clear alternative, the three control strategies were recommended for additional analysis under ICE Stage 2

Stage 2 analysis was conducted by PennDOT's on-call consultants. The operational analysis showed both modified traffic signal and median U-turn would perform adequately under existing and projected design year (2033) traffic volumes. However, converting the existing signalized intersection to a RCUT would exacerbate the existing operational issues due to the high through and left-turn demand from the side street. The PennDOT HSM Analysis Tool and alternative intersection CMFs were applied to the three control strategies. Both median U-turn and modified traffic signal were projected to provide high B/C ratios. It was decided to conduct a detailed control strategy assessment under ICE Stage 3. Implementing a median U-turn strategy is still controversial since no median U-turns have been installed in Pennsylvania. Concerns from public and local government include possible driver confusion and disregard of left-turn prohibition at the intersection and increased delay and travel time for left-turning traffic.

Stage 3 analysis further investigated property impacts. Widening the existing intersection would impact the surrounding commercial properties while not fundamentally addressing safety issues. The median U-turn strategy, on the other hand, will reduce signal phases and provide significant benefits in terms of increased roadway capacity and reductions in travel time and vehicular delay when compared to conventional intersections. The safety performance of a median U-turn is also better than a conventional intersection since they have fewer vehicle-vehicle conflict points. Therefore, it was determined that the most prudent way to improve safety and operations at the intersection was to implement the median U-turn. Existing driveways could remain in place and improvements could be constructed in the existing right-of-way. Initial concerns of local government and law enforcement officials were reduced after a stakeholder meeting. The recommendation for a median u-turn was approved by the District 11 DTE.

Project Location: Pittsburgh
County: Allegheny
PennDOT District: District 11
Project Type: Safety Improvement Project
Project Setting: Urban
Existing Intersection Control: Signalized
Outcome: Median U-Turn
Stages: 3

Pennsylvania Department of Transportation
Intersection Control Evaluation (ICE) Form
Stage I: Screening

pennsylvania DEPARTMENT OF TRANSPORTATION

To fulfill the requirements of Stage 1 (Screening) of PennDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms can be submitted to the District Traffic Engineer (DTE) for the project's location.

Project Information

Project Name	Case Study #5	Project Setting	Urban	Project ICE Reference Number	XXXX-XXXX
Submitted By	XXX	Agency/Company	PennDOT	Email	XXXX.XXXX@state.pa.us
Project Purpose and Goals (*What is the catalyst for this project and what are the intended outcomes?*)	The intersection of SR 19 and SR 380 is routinely identified as a candidate safety improvement location due to frequency and severity of reported crashes. The 95th percentile queue lengths of each through movement are hundreds of feet during peak periods. Each through movement has volume that exceeds capacity (yielding a theoretically infinite queue until traffic volume reduces) for at least one of the peak hours. The long queues could be creating conditions where drivers are confronted with slowed or stopped traffic far from an intersection, where this is not expected. The purpose of this project is to evaluate historical crash data and potential safety improvements, analyze existing intersection operations, and evaluate other changes to potentially improve safety.				
Project Setting Description (*Describe the area surrounding the intersection*)	SR 19 (Sulaski Highway) is designated as an Urban Principle Arterial in the study area and SR 380 is designated as an Urban Other Principal Arterial. Eastbound and westbound through movements on SR 19 are the dominant traffic volumes at the intersection, and SR 380 also carries approximately 40 percent of the intersection's entering volume. SR 380 serves as an important route to travel north/south to get around the nearby city. The nearby residences and commercial developments are significant trip generators.				
County	Allegheny	Project Locality (Township/Borough/City)	Pittsburgh		
PennDOT District	District 11	Project Type (select most appropriate)	Safety Improvement Project		
Multimodal Context (*Describe pedestrian, bicycle, and transit activity in the area and the potential for activity based on surrounding land uses and development pattern*)	There are no pedestrian or bicycle facilities at the intersection. The SR 19 corridor serves several regional bus routes; however, no bus stops are located near the study intersection.				

Basic Intersection Information

Major Street

Major Street Route Number(s)	19	Major Street Route Name(s)	Sulaski Highway			SR Segment #	60	SR Offset	0
Primary Functional Classification	Principal Arterial	Secondary Functional Class. (if app.)				Existing AADT	31,800	Existing Control	Signalized
Major Street Ownership	PennDOT			Sidewalks are present along:	Neither side of the roadway				
Crosswalks? ☐	On-Street Bike Facilities? ☐	Multi-Use Path? ☐		Scheduled Bus Service? ☑		Bus stop at intersection? ☐			

Approach #1	Number of Lanes (Count Shared Lanes as Through):	Left-Turn	1	Through	2	Right-Turn	1	
	AM Peak Hour Traffic Volumes:	Left-Turn	136	Through	745	Right-Turn	342	
	PM Peak Hour Traffic Volumes:	Left-Turn	147	Through	698	Right-Turn	390	
Approach #2	Number of Lanes (Count Shared Lanes as Through):	Left-Turn	1	Through	2	Right-Turn	1	
	AM Peak Hour Traffic Volumes:	Left-Turn	89	Through	998	Right-Turn	180	
	PM Peak Hour Traffic Volumes:	Left-Turn	114	Through	1060	Right-Turn	199	

Minor Street

Existing ☑ New ☐

Minor Street Route Number(s)	380	Minor Street Route Name(s)	Bridge Street			SR Segment #	110	SR Offset	0
Primary Functional Classification	Principal Arterial	Secondary Functional Class. (if app.)				Existing AADT (if available)		18,100	
Minor Street Ownership	PennDOT			Sidewalks are present along:	Neither side of the roadway				
Crosswalks? ☐	On-Street Bike Facilities? ☐	Multi-Use Path? ☐		Scheduled Bus Service? ☐		Bus stop at intersection? ☐			

Approach #1	Number of Lanes (Count Shared Lanes as Through):	Left-Turn	2	Through	1	Right-Turn	1	
	AM Peak Hour Traffic Volumes:	Left-Turn	405	Through	525	Right-Turn	78	
	PM Peak Hour Traffic Volumes:	Left-Turn	338	Through	418	Right-Turn	48	
Approach #2	Number of Lanes (Count Shared Lanes as Through):	Left-Turn	1	Through	1	Right-Turn	1	
	AM Peak Hour Traffic Volumes:	Left-Turn	243	Through	402	Right-Turn	105	
	PM Peak Hour Traffic Volumes:	Left-Turn	206	Through	382	Right-Turn	130	
Approach #3	Number of Lanes (Count Shared Lanes as Through):	Left-Turn		Through		Right-Turn		
	AM Peak Hour Traffic Volumes:	Left-Turn		Through		Right-Turn		
	PM Peak Hour Traffic Volumes:	Left-Turn		Through		Right-Turn		

Crash History (Existing Intersections Only)

Append the most recent five-years of crash data for the intersection from the CDART. If the crash data evidences any issues relating to safety performance, discuss briefly here:

A review of the most recent five-years of crash data show there were 52 crashes at the intersection between 2013 and 2017. Crash data for the intersection also showed that 27 of the 52 crashes over the five-year period involved personal injury, with a total of 40 persons injured. No fatalities were recorded during the period of available data. Slightly over half of the reported crashes (56 percent) are classified as rear-end collisions.

Screening 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.

Note: FHWA's CAP-X tool is helpful for assessing the viability of alternative intersection forms.

Control Strategy	Strategy Viable?	Justification	Strategy to be Advanced?
Two-way Stop-Controlled	No	The existing signalized intersection currently operates at LOS "D" during the a.m. peak hour and LOS "E" during the p.m. peak hour. Converting the minor street approaches to stop-controlled would cause unnecessary increases to delay to northbound and southbound vehicles, and queuing would likely spill back to the upstream intersections.	No
All-way Stop-Controlled	No	The existing signalized intersection currently operates at LOS "D" during the a.m. peak hour and LOS "E" during the p.m. peak hour. Converting the intersection to all-way stop-controlled would likely increase the delays experienced by all vehicles at the intersection.	No
Signalized Control	Yes	The existing intersection is under signalized control. The volume to capacity ratio (V/C) is 0.78 in the a.m. peak hour and 1.0 during the p.m. peak hour. Signal re-timing and widening the minor approach would alleviate the operational conditions at the intersection.	Yes
Roundabout	No	While a roundabout would potentially help reduce delays incurred on the mainline approaches, the footprint required to accommodate this control strategy would have substantial impacts to the surrounding commercial properties.	No
Median U-Turn	Yes	Considering right-of-way constraints and driveways near the intersection, the median U-turn seems to be a promising alternative intersection form. The median U-turn will improve overall operation and enhance safety performance of the intersection.	Yes
Restricted Crossing U-Turn (RCUT) Signalized	Yes	Considering right-of-way constraints and driveways near the intersection, a signalized RCUT seems to be a promising alternative intersection form.	Yes
Restricted Crossing U-Turn (RCUT) Unsignalized	No	Given the nature of the intersection, unsignalized RCUT will not accommodate existing and future travel demand.	No

Jughandle	No	The study segment is a two-lane arterial in an urban environment. Constructing a jughandle ramp would have substantial impacts to the surrounding commercial properties.	No
Displaced Left-Turn	No	The study segment is a two-lane arterial in an urban environment. The infrastructure required to develop a displaced left-turn would have substantial impacts to the surrounding commercial properties.	No
Continuous Green Tee	No	This control strategy is not applicable given the study intersection has four approach legs.	No
Quadrant Roadway	No	The construction of a quadrant roadway would have a substantial impact on the adjacent businesses.	No
Other			

Resolution				
To be filled out by PennDOT District Traffic Engineer or designee only.				
Project Determination	Multiple Viable Alternatives Identified: Continue to Stage 2			
Comments				
DTE or Designee Name *(Type)*		Signature		Date

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

To fulfill the requirements of Stage 2 (Intersection Control Strategy) of PennDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms can be submitted to the District Traffic Engineer (DTE) for the project's location.

Project Information

Project Name	Case Study #5	Project ICE Reference Number	XXXX-XXXX
Submitted By: XXX	Agency/Company: PennDOT	Email	XXXX.XXXX@state.pa.us

List all viable intersection control strategies identified in Phase 1 (Screening):

Signalized Control	Median U-Turn	Restricted Crossing U-Turn (RCUT) Signalized

Operational Analysis

Summarize the results of the peak hour analysis performed for each control strategy. Select analysis year based on guidance in the ICE procedures document.

Overall Intersection Performance

Opening Year

Control Strategy	Analysis Year: 2017 — Peak Hour Analyzed: Weekday AM Peak — LOS	V/C	Delay (sec.)	All queues accommodated?	Peak Hour Analyzed: Weekday AM Peak — LOS	V/C	Delay (sec.)	All queues accommodated?
Signalized Control	C	0.85	27.2	Yes	C	0.73	31.5	Yes
Median U-Turn	C	0.91	44.5	Yes	D	0.81	42.7	Yes
Restricted Crossing U-Turn (RCUT) Signalized	F	1.24	178.4	No	E	1.32	65.6	No

Design Year

Control Strategy	Analysis Year: 2037 — Peak Hour Analyzed: Weekday PM Peak — LOS	V/C	Delay (sec.)	All queues accommodated?	Peak Hour Analyzed: Weekday PM Peak — LOS	V/C	Delay (sec.)	All queues accommodated?
Signalized Control	E	1.11	63.7	Yes	D	0.90	42.1	Yes
Median U-Turn	E	1.13	79.1	Yes	E	0.98	79.6	Yes
Restricted Crossing U-Turn (RCUT) Signalized	F	2.54	396.7	No	F	2.45	120.0	No

Provide any additional discussion necessary regarding the results of the operational analysis:

Both the modified traffic signal and median u-turn operate acceptably under year 2017 traffic volumes and can accommodate future design year growth. To achieve these levels of operation under signalized control, additional northbound and southbound through lanes should be provided and signal timing plan should be adjusted and optimized.

Costs

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 account for preliminary engineering, required right-of-way acquisitions, construction, and a contingency.

Control Strategy	Cost ($)	Estimate Includes:	Control Strategy	Cost ($)	Estimate Includes:
Signalized Control	$500,000	PE, ROW, & Construction			
Median U-Turn	$2,000,000	PE, ROW, & Construction			
Restricted Crossing U-Turn (RCUT) Signalized	$10,000,000	PE, ROW, & Construction			

Safety Performance

Apply the PennDOT HSM Analysis Tool and provide the "Safety B/C" ratio provided by the tool's output. You may wish to append the complete output to this form. For intersection types not accommodated in the tool, manually apply crash modification factors detailed in the ICE policy document or qualitatively describe safety impacts.

Control Strategy	Anticipated Impact on Safety Performance	Predicted Total Crashes	Predicted Fatal & Injury Crashes	Safety B/C
Signalized Control	Improving the existing signal timing plan would reduce the number of severe collisions by producing smoother traffic flow and fewer stops. As a result, the number of rear-end crashes would be anticipated to be reduced.	7.99	6.98	0.20
Median U-Turn	A median U-turn design is anticipated to have better safety performance, as it has fewer vehicle-vehicle conflict points. Installing a median U-turn would reduce the probability of head-on and angle crashes that typically have high percentage of injury severity.	7.15	3.05	4.16
Restricted Crossing U-Turn (RCUT) Signalized	Installing an RCUT would reduce the number of conflict points at the intersection and consequently result in a reduction in crashes, especially right angle crashes.	7.15	3.39	2.90

Multimodal Accommodations

Note the existing/anticipated level of pedestrian/bicyclist activity at the study intersection during the peak hours of the typical day.

	AM Peak Hour		PM Peak Hour	
	Major Street	**Minor Street**	**Major Street**	**Minor Street**
# of ped. crossings (both approaches, if app.):	0	0	0	0
# of bicyclists (both approaches, if app.):	0	0	0	0

Summarize the ability of each viable control strategy to accommodate the existing/anticipated level of:

Control Strategy	Pedestrians and Bicycles	Transit Services	Freight Needs
Signalized Control	No existing or anticipated ped and bike activities in site vicinity.	The modified signal control would continue to adequately accommodate bus service operating along SR 19.	Modifications would accommodate WB-67 design vehicle
Median U-Turn	No existing or anticipated ped and bike activities in site vicinity.	The design of the median U-turn intersection would not impact existing bus service along SR 19.	Accomodates WB-67 design vehicle
Restricted Crossing U-Turn (RCUT) Signalized	No existing or anticipated ped and bike activities in site vicinity.	The design of the restricted crossing U-turn intersection would not impact existing bus service along SR 19.	Accomodates WB-67 design vehicle

Environmental, Utility, and Right-of-Way Impacts	
Summarize any issues related to environmental, utility, or right-of-way (to include relocations) impacts specific to each control strategy.	
Signalized Control	Improvements to signalized control include re-timing and widening of the minor approach. The widening would likely require relocating the signal controller cabinet, as well as several utility access points. It would also require right-of-way acquistions along SR 380, which would impact the adjacent businesses.
Median U-Turn	Some right-of-way acquisitions are anticipated at the U-turn crossovers to accommodate through and left-turn traffic from side streets. As the 2035 long-range plan for the area calls for the widening of SR 19, some right-of-way has already been dedicated by the adjacent properties to accomodate a widening. As such, right-of-way acquistions required to accomodate a MUT are relatively limited.
Restricted Crossing U-Turn (RCUT) Signalized	Some right-of-way acquisitions are anticipated at the U-turn crossovers to accommodate through and left-turn traffic from side streets. As the 2035 long-range plan for the area calls for the widening of SR 19, some right-of-way has already been dedicated by the adjacent properties to accomodate a widening. As such, right-of-way acquistions required to accomodate an RCUT are relatively limited.

Public Input/Feedback	
Summarize public input received or any stakeholder considerations regarding the control strategies:	The analyses results of the SR 19/SR 380 Safety Improvement study were presented to the county and members of the public in attendance, highlighting the need for improvements to the study intersection based on both safety performance and operational analyses. Planning-level concepts for the three control strategies were outlined. Attendees from both public and political sides shared their experiences and concerns about each strategy. It was suggested to exclude the RCUT strategy given the evident operational deficiency. Further detailed control

Benefit-Cost Analysis

Apply the PennDOT ICE Tool and provide the "Net Present Value" and "Benefit-Cost Ratio" from the "Output" tab for each control strategy. The "Benefit-Cost Ratio" is only applicable for improvements to an existing intersection.

Control Strategy	Net Present Value	Benefit-Cost Ratio
Signalized Control	$681,086	<1.0 (no output from ICE Tool)
Median U-Turn	$604,614	4.43
Restricted Crossing U-Turn (RCUT) Signalized	$533,762	2.95

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 control strategy to be advanced.

Control Strategy	Strategy Viable?	Justification	Strategy to be Advanced?
Signalized Control	Yes	The modified traffic signal is anticaipted to improve both operations and safety performance substantially compared to the existing traffic signal.	Yes
Median U-Turn	Yes	The median U-turn control strategy can adequately accommodate existing condition and projected future and improve the operation and safety conditions.	Yes
Restricted Crossing U-Turn (RCUT) Signalized	No	RCUT would exacerbate the existing operational issues due to the high through and left-turn demand from the side street. If a RCUT were to be implemented, high through and left-turning traffic may create potential for spillback out of crossover storage lane.	No

Resolution

To be filled out by PennDOT District Traffic Engineer or designee only

Project Determination	Multiple Viable Alternatives Identified: Continue to Stage 3		
Comments			
DTE or Designee Name		Signature	Date

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

To fulfill the requirements of Stage 3 (Detailed Control Strategy Assessment) of PennDOT'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 can be submitted to the District Traffic Engineer (DTE) for the project's location.

Project Information

Project Name	Case Study #5			Project ICE Reference Number	XXXX-XXXX
Submitted By	XXX	Agency/Company	PennDOT	Email	XXXX.XXXX@state.pa.us

List all viable intersection control strategies identified at the end of Phase 2 (Initial Control Strategy Assessment):

Signalized Control	Median U-Turn	

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
Operations	Both the modified signal control and MUT strategies are anticipated to improve design year operations relative to the existing signalized intersection. Additional operational analyses would be useful to help highlight the operational benefits/drawbacks of each strategy.
Right-of-Way	Both the modified signal control and MUT strategies would require right-of-way acquisitions near the intersection. Under the signalized control, impacts to adacent businesses as well as utilities along SR 380 (including the signal controller cabinet) are anticaipted. The RCUT control strategy would require minor right-of-way acquistions to accomodate the through and left-turn traffic from side streets; however, some right-of-way was previously dedicated along SR 19 to accomodate future widening.

Describe specific evaluation activities undertaken in Stage 3 analysis to identify a preferred control strategy and discuss the findings:

Category	Description of Additional (Stage 3) Analysis
Operations	To help differentiate the anticaipted operational performance of modified signal and MUT, traffic counts were conducted during the weekday midday peak hour (11AM-2PM) and Saturday midday peak hour (11AM-2PM). Using the same models developed in Stage 2, these additional two analysis periods were evaluated during the design year. Under year 2037 weekday midday and Saturday midday peak hours, the modified signal is anticipated to operate at LOS D and LOS E, respectively. The MUT is anticipated to operate at LOS C and LOS D during the same analysis periods. With a lower number of mainline left turns on SR 19 during these time periods, the MUT can more adequate handle anticipated levels of traffic. The additional traffic counts and model outputs are appended to this form.
Right-of-Way	To better understand the potential impacts of the proposed control strategies, the designs of each were refined beyond the sketches developed for previous stages. The more detailed plans (appended to this form) provided greater resolution when determining the impacts to right-of-way and utilities. To accomodate the additional lanes on SR 380 under the modified signal control strategy, the signal controller cabinet (previously noted) and two traffic signal poles (previously unknown impact) would need to be relocated. It would also require the acquisition of approximately 10 feet of right-of-way from the adjacent businesses. Right-of-way acquistions related to the MUT range from 3-5 feet along SR 19 due previously dedicated right-of-way for widening on SR 19.

Public Input/Feedback

If not discussed as a part of the preceding section, summarize public input received or stakeholder considerations regarding the control strategies:	Initial outreach efforts to the public exposed some concern over potential driver confusion and/or the potential for drivers to knowingly disregard the left-turn prohibitions associated with the MUT control strategy. Additional outreach to the public (via public meetings) provided the opportunity to better highlight the benefits of each control strategy. In particular, the improved operations and safety performance anticipated with the MUT garnered positive feedback relative the to modified signal design and widening.

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
Signalized Control	No	The required widening of SR 380, as outlined with this control strategy, would have substanial impacts to adjacent commercial properties. As the widening would be limited to the immediate vicinity of the intersection, it would result in a bottleneck downstream on SR 280. And although widening and re-timing are anticipated to reduce the rear-end crashes, other safety concerns are not addressed under this strategy.
Median U-Turn	Yes	The MUT strategy will reduce the number of required signal phases and increase roadway capacity, thereby reducing travel times and vehicular delay when compared to the traffic signal. The MUT is also anticipated to improve safety performance relative to a conventional intersection, as MUTs they have fewer vehicle-vehicle conflict points.

Resolution

To be filled out by PennDOT District Traffic Engineer or designee only

Project Determination	Identified Alternative Approved	
Comments		
DTE or Designee Name	Signature	Date