Pedestrian / Bicycle Crossing Enhancements Study: Alexandria, MN

3rd Avenue (TH 27/29) Focus

MEMO REPORT

March, 2010

BEFORE IMPROVEMENTS

AFTER IMPROVEMENTS

Prepared for:

DOUGLAS COUNTY active living Communities in Motion

DOUGLAS COUNTY SAFE COMMUNITIES

Prepared by WSB & Associates, Inc.

WSB & Associates, Inc.

To: **Douglas County Active Living Coalition**
Douglas County Safe Communities Coalition

From: Reuben Collins, EIT
Jack Forslund, PTP,

Date: **March, 2010**

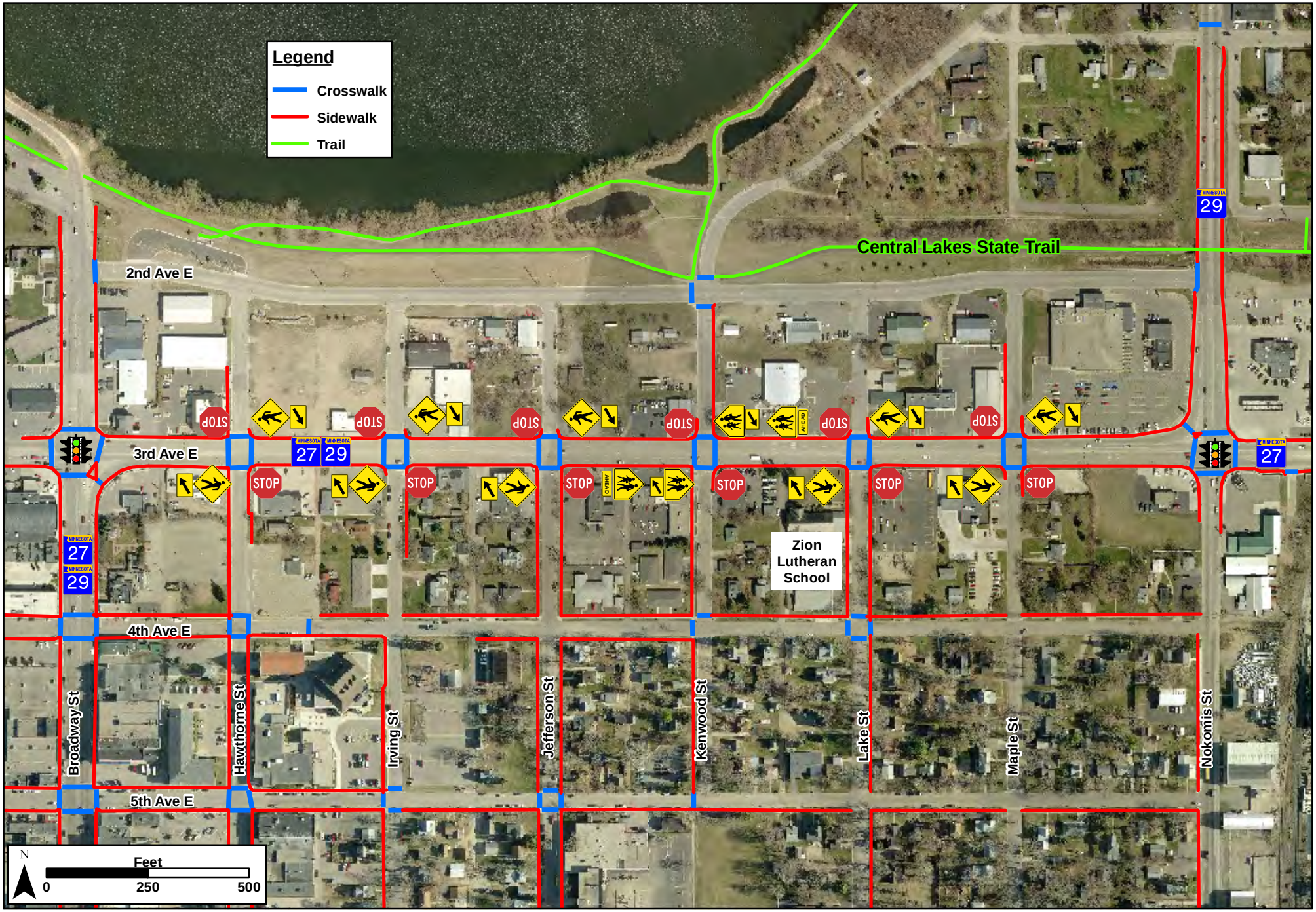
Subject: ***Bicycle – Pedestrian Crossing Enhancements Study***
3rd Avenue North (TH 27/29) Focus

The purpose of this report memorandum is to identify three alternatives to improve crossing opportunities for pedestrians and cyclists at the intersection of 3rd Avenue E (TH 27, TH 29) and Jefferson Street in Alexandria, MN. The **Appendix** to this document presents a Catalogue of Pedestrian and Bicycle Enhancements that could be used throughout Douglas County. This study is supported by Blue Cross and Blue Shield of Minnesota as part of Prevention Minnesota. Prevention Minnesota is Blue Cross' long-term health improvement initiative funded by tobacco settlement dollars to tackle the root causes of preventable diseases and cancer. This project is driven by a partnership between Douglas County Safe Communities and Active Living Douglas County.

Project Area

The current design of 3rd Avenue between Broadway Street and Nokomis Street presents a significant barrier to north-south pedestrian and bicycle movement in the City of Alexandria. The current roadway cross section includes five general-purpose traffic lanes, including a center two-way-left-turn-lane (TWLTL). The current right-of-way generally includes roughly 60’ of roadway space with 5-6’ sidewalks on both the north and south side of the roadway. This segment of 3rd Avenue carried 16,500 vehicles per day in 2008 (Mn/DOT). **Figure 1** displays the general study area within the City of Alexandria.

Each of the six intersections located between Broadway Street and Nokomis Street currently have crosswalks to assist pedestrians crossing 3rd Street, however, it is generally perceived that drivers often do not yield to pedestrians waiting to cross 3rd Avenue. In addition to heavy traffic volumes, the width of 3rd Avenue can be intimidating for many pedestrians. The intersections of 3rd Avenue with Broadway Street and Nokomis Avenue are fully signalized, allowing pedestrians to cross 3rd Avenue. However, these crossings are also complicated by the presence of high traffic volumes – particularly by the number of turning vehicles. Although Minnesota state statute 169.21 requires all vehicles on a roadway (including cyclists) to yield the right-of-way to pedestrians at unsignalized intersections with marked crosswalks, drivers often fail to properly yield.



WSB & Associates, Inc.

DOUGLAS COUNTY

DOUGLAS COUNTY active living Communities in Motion

DOUGLAS COUNTY SAFE COMMUNITIES

Figure 1: Existing Conditions

3rd Avenue & Kenwood Street Intersection Crossing Study
Alexandria, MN

At present time, there is no bicycle specific infrastructure in place to assist cyclists crossing 3rd Avenue. Cyclists are required to merge with motorized traffic and follow all laws and regulations that apply to motorized vehicles. While state and local laws generally permit cycling on sidewalks, Minnesota State Statute 169.222 prohibits the operation of bicycles on sidewalks within business districts (such as 3rd Avenue) unless local authorities enact ordinances specifying otherwise. Cyclists crossing 3rd Avenue who are uncomfortable merging with motorized traffic should dismount and walk their bicycles across 3rd Avenue at a crosswalk.

There are significant destinations for cyclists and pedestrians north and south of 3rd Avenue. The Central Lakes State Trail is a 55 mile asphalt trail linking three counties and ten communities. It is used by cyclists and pedestrians for both recreational and utilitarian purposes by local residents, as well as being a significant tourism amenity drawing users from across the State of Minnesota. In addition, Zion Lutheran School is an elementary school located at the intersection of 3rd Avenue and Lake Street. 3rd Avenue is also part of the City of Alexandria central business district and is home to many employers and retailers.

Project Focus (3rd Avenue / Jefferson Street)

The intersection of Jefferson Street and 3rd Avenue has been identified as a key intersection where additional pedestrian enhancements may be particularly helpful for pedestrians. This intersection is located roughly halfway between Broadway Street and Nokomis Street. Jefferson Street has been identified by the City of Alexandria as a bicycle route between 22nd Avenue and 3rd Avenue. Jefferson Street is particularly useful for cyclists and pedestrians because it extends as far south as Nokomis Street, further south than any nearby parallel route. There are also significant activity generators along Jefferson Street including Jefferson High School, Alexandria Technical College, and Douglas County Hospital. **Figure 2** displays how Jefferson Avenue is integrated within the surrounding pedestrian and bicycle network.

A complicating factor at the intersection of 3rd Avenue and Jefferson Street is that the existing network of sidewalks north of Jefferson Street is somewhat incomplete. Gaps within the existing sidewalk network may discourage pedestrian travel within the project vicinity or require pedestrians to travel additional distance to use sidewalks. For example, south of 3rd Avenue, Jefferson Street has a sidewalk on at least one side of the street in most places. North of 3rd Avenue, however, Jefferson Street does not have sidewalks. Pedestrians accessing the Central Lakes trail would need to travel one block east to Kenwood Street. In addition, the Central Lakes Trail is currently only accessible from the intersection of Kenwood Street and 2nd Avenue, one block east of Jefferson Street. The gaps in the sidewalks along Jefferson Street as well as the lack of a Central Lakes Trail connection from Jefferson Street may discourage pedestrian and bicycle activity along Jefferson. A central recommendation of all alternatives presented in this memorandum is the construction of sidewalks along both sides of Jefferson Street between 3rd Avenue and 2nd Avenue, as well as the construction of a new connection to the Central Lakes Trail north of Jefferson Street. A preliminary cost estimate of these improvements is about $41,000. These general recommendations are shown in **Figure 3**.

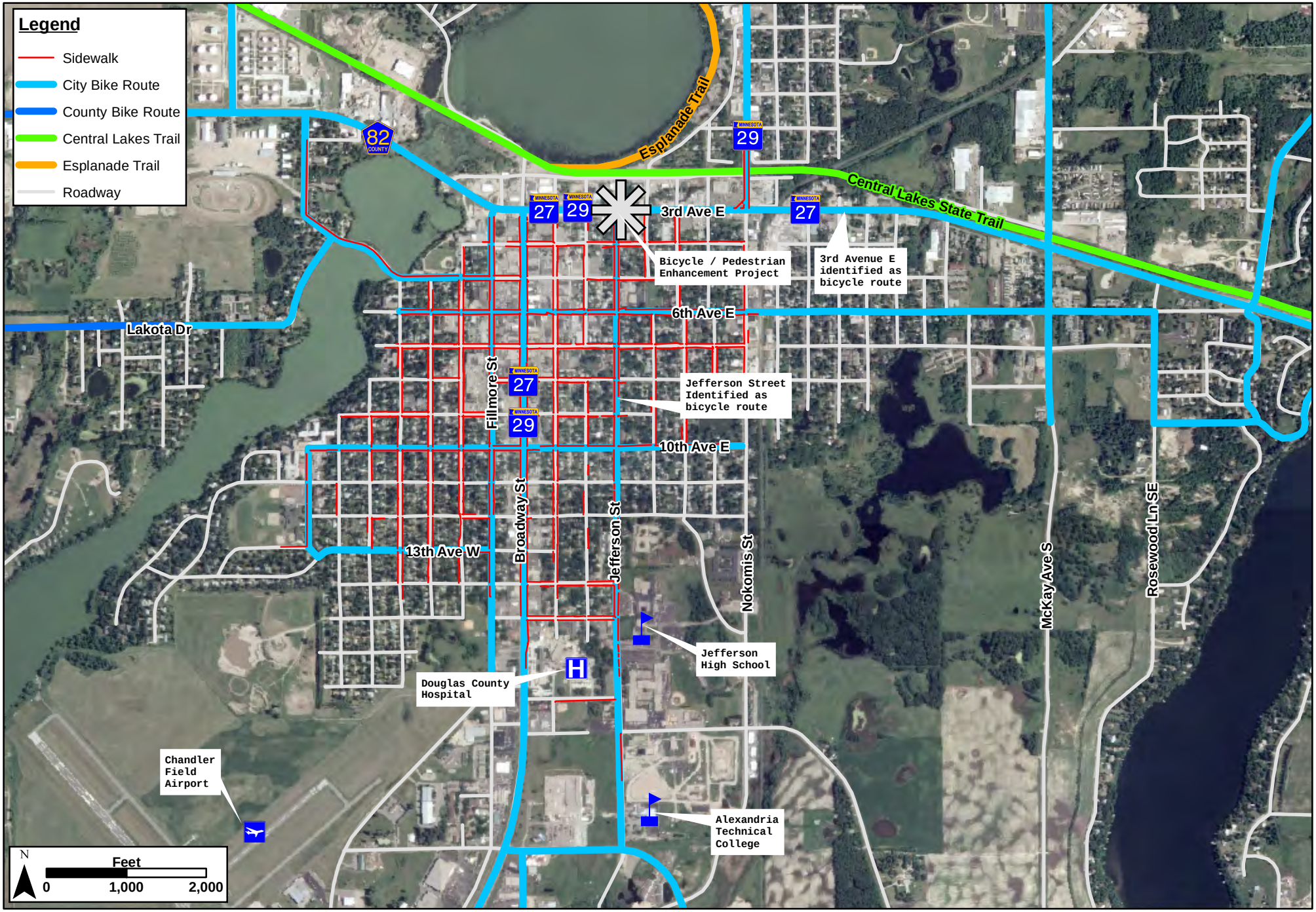


Figure 2: Bicycle and Pedestrian Network

3rd Avenue & Jefferson Street Intersection Crossing Study
Alexandria, MN

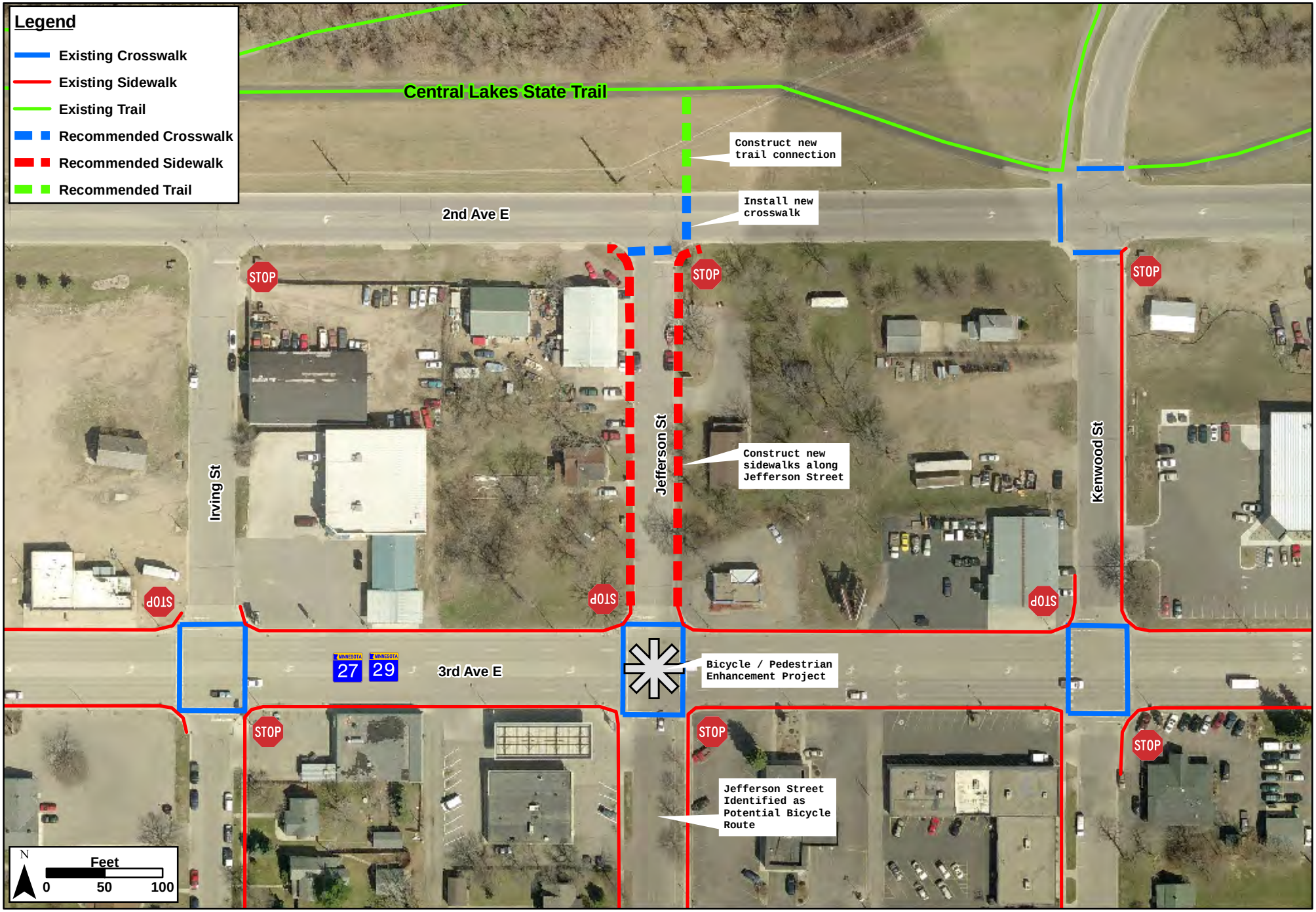
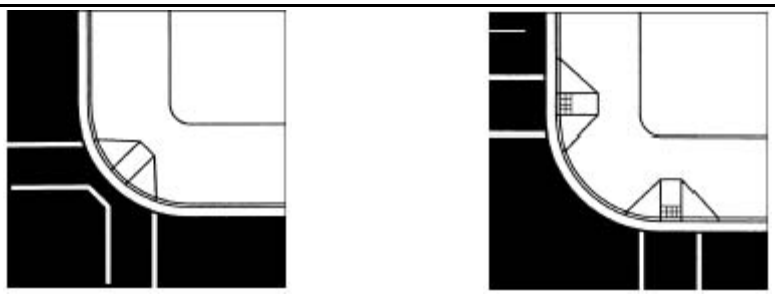


Figure 3: Recommended Network Enhancements

3rd Avenue & Jefferson Street Intersection Crossing Study
Alexandria, MN

The existing intersection of 3rd Avenue and Jefferson Street includes one pedestrian ramp (also referred to as a curb-cut) on each corner. Each ramp points diagonally towards the center of the intersection. Current best practice is to install two ramps per corner. This allows for the crosswalks to be moved several feet further from the intersection where it will be less influenced by the corner turning radius, providing a shorter crossing distance for pedestrians. **Figure 4** illustrates one and two-ramp corner designs.



The illustration on the left depicts a single pedestrian ramp pointed diagonally towards the center of the intersection. The illustration on the right depicts two pedestrian ramps pointed in perpendicular directions – one for each crosswalk.(SOURCE: FHWA)

Figure 4: Pedestrian Ramp Designs

The purpose of this memorandum is to document three alternatives that could be applied to the intersection of Jefferson Street and 3rd Avenue that would facilitate and encourage pedestrians and bicycles to safely cross 3rd Avenue. While the objective of enhancements to this intersection is not to discourage pedestrians from crossing 3rd Avenue elsewhere along the corridor, it is believed that some pedestrians or cyclists may choose to modify their route if a safer alternative is available – perhaps those most intimidated by the current crossing options. With this understanding of the potential for the Jefferson Street and 3rd Avenue intersection, it is clear that the alternatives presented should appeal to the most vulnerable pedestrians and cyclists.

Pedestrian Actuated Signal

One of the common elements among the three alternatives presented later in this memorandum is a pedestrian actuated signal or beacon designed to draw motorist attention the presence of pedestrians. This section of this memorandum describes two types of pedestrian warning signals in detail. The two most feasible options that could be effective in this location are the High-intensity Activated crossWalK (HAWK) signal or Rectangular Rapid Flash Beacons (RRFB).

HAWK signals (shown in **Figure 5**) are a relatively new strategy, and are currently used in only one location in Minnesota, on CSAH 23 at 12th Avenue South in St. Cloud. The HAWK beacon consists of two red signal indications above a single yellow indication forming a beacon signal that remains dark until activated by a pedestrian. The HAWK signal is most commonly activated using a common push-button, but motion-sensors may also be used. Once activated, the signal initiates a flashing yellow indication to warn approaching drivers followed by a solid yellow to warn of an impending requirement to stop. The solid yellow is followed by a solid red, which is followed by a flashing red signal requiring drivers to stop before proceeding.[1]

[1] In some locations, the two red indications alternate flashing in a "wig-wag" format. However, to avoid confusion with railroad crossing indications, it is recommended that both red indications flash simultaneously.

Figure 5: HAWK Signal in St. Cloud, MN

RRFBs (shown in **Figure 6** and **Figure 7**) are user-actuated, amber colored LEDs that supplement warning signs at unsignalized intersections or mid-block crosswalks. The can be activated by pedestrians manually by a push-button or passively by a pedestrian detection system. RRFB's use an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs may be installed on multi-lane roadways by placing sets of beacons both at the roadway edge and in the median. They may be operated by drawing power from a solar panel, or they may use a traditional, permanent power source. RRFBs were approved for use within certain guidelines (i.e. signage requirements, beacon flashing rates, crosswalk availability, etc.) as documented in the MUTCD (IA-11, July 2008).

Figure 6: Rectangular Rapid Flash Beacons

Figure 7: Rectangular Rapid Flash Beacons

There are several key differences between the HAWK signal and RRFB indicators. The main advantages of a HAWK signal is that it utilizes standard traffic signal heads that are familiar to drivers. A corresponding pedestrian signal directs pedestrians to walk only after the beacon has entered the solid red phase. HAWK signals may also be coordinated with adjacent traffic signals to minimize delay for motorists. However, one of the key disadvantages of HAWK signals is that the phasing sequence may be confusing to drivers. HAWK signals use a relatively complex sequence of lights that may not be understood by many roadway users. In addition, there is concern that the pedestrian signals used by HAWK signals may give pedestrians a false sense of security by directing pedestrians to walk when vehicles may not have stopped. Another key disadvantage of the HAWK signal is the cost, estimated between $75,000 and $100,000, depending on the width of the street and the length of the mast-arm poles.

Conversely, one of the main advantages of RRFBs is the relatively low cost. RRFBs may be solar powered, reducing the need for traditional power sources. Two RRFBs may cost as little as $14,000. In addition, since RRFBs don't use a pedestrian signal to direct pedestrians when to cross, RRFBs may avoid giving pedestrians a false sense of security.

There is a key difference between the purpose of HAWK signals and RRFBs. When activated, HAWK signals deliver a solid red light requiring motorists to stop (after separate flashing yellow and solid yellow phases). When the indicators return to flashing red, motorists may accelerate if the pedestrian has already passed their lane. In contrast, RRFBs deliver only flashing lights designed to draw additional attention to the presence of a pedestrian. After motorists are aware of the pedestrian, existing laws requiring motorists to yield to pedestrians in a crosswalk govern.

Several studies have been conducted to determine the effectiveness of both HAWK signals and RRFBs. A Federal Highway Administration study conducted in St. Petersburg, FL, observed that both systems produced motorist compliance between 80% and 90% up to two years after the treatment was initially installed.

Alternatives

Three alternatives presented in this memorandum have been developed to present a range of options surrounding a central theme, which generally consists of a median or pedestrian island, an enhanced crosswalk, and one of the two types of pedestrian actuated signals described earlier. It was determined that the most significant barrier facing pedestrians and cyclists in the area is the overall width of 3rd Avenue and the lack of gaps in the traffic stream appropriate to cross the entire street at once. Alternative 1 represents the least amount of modification from the existing conditions, Alternative 2 represents slightly more modification, and Alternative 3 represents the largest modification from the existing conditions. The improvement options have been structured so that each succeeding alternative builds upon the previous alternative.

Alternative 1 - Pedestrian Refuge Island

Alternative 1 (**Figure 8** and **Figure 8a**) includes the construction of a pedestrian refuge island on the western approach of the 3rd Avenue and Jefferson Street intersection within the center turn-lane. Alternative 1 also prohibits vehicles from making an eastbound left-turn movement to avoid queues from forming in the eastbound through lanes and to improve intersection safety. A more visible crosswalk would be painted, and a pedestrian actuated signal would be installed (either a HAWK signal or RRFBs). The pedestrian island would extend east of the existing crosswalk as far as feasible possible without becoming an obstacle to the safe operation of the intersection. The pedestrian island may be extended as far as 80' west of the existing crosswalk without restricting access to the gas station located on the southwest corner of the intersection.

Alternative 1 is an improvement for pedestrians crossing 3rd Avenue as the crossing distance is reduced from over 70' to two 30' sections. In addition, pedestrians are only navigating traffic in a single direction at a time, and the pedestrian actuated signal alerts motorists to the presence of pedestrians. However, Alternative 1 does not improve conditions for cyclists crossing 3rd Avenue, unless cyclists dismount and cross as pedestrians.

The cost of Alternative 1 will vary based on the size of the pedestrian island and the type of pedestrian actuated signal included at the crosswalk (HAWK signal or RRFBs). Preliminary estimates range from approximately $23,000 to $99,000.

Alternative 2 - Partial Median

Alternative 2 (**Figure 9**) includes the construction of a pedestrian refuge island on the western approach of the 3rd Avenue and Jefferson Street intersection within the center turn-lane that extends into the intersection. The footprint of the pedestrian island prohibits vehicles from making the eastbound left-turn, northbound through and left-turn, and southbound through and left-turn movements. Northbound and southbound vehicles on Jefferson Street would only be permitted to turn right. Restricted vehicle movement in the intersection improves pedestrian safety. The pedestrian island may be extended as far as 80' west of the existing crosswalk without restricting access to the gas station located on the southwest corner of the intersection. In addition, a more visible crosswalk would be painted, and a pedestrian actuated signal (either a HAWK signal or RRFBs) would be installed.

Alternative 2 is an improvement for pedestrians crossing 3rd Avenue as the crossing distance is reduced from over 70' to two 30' sections. In addition, pedestrians are only navigating traffic in a single direction at a time, and the pedestrian actuated signal draws addition to pedestrians. The restricted vehicle turning movements at the intersection further simplifies vehicle patterns, improving pedestrian safety. Alternative 2 does not permit cyclists (or other vehicles) to cross 3rd Avenue. Cyclists crossing 3rd Avenue would be required to dismount and cross as pedestrians.

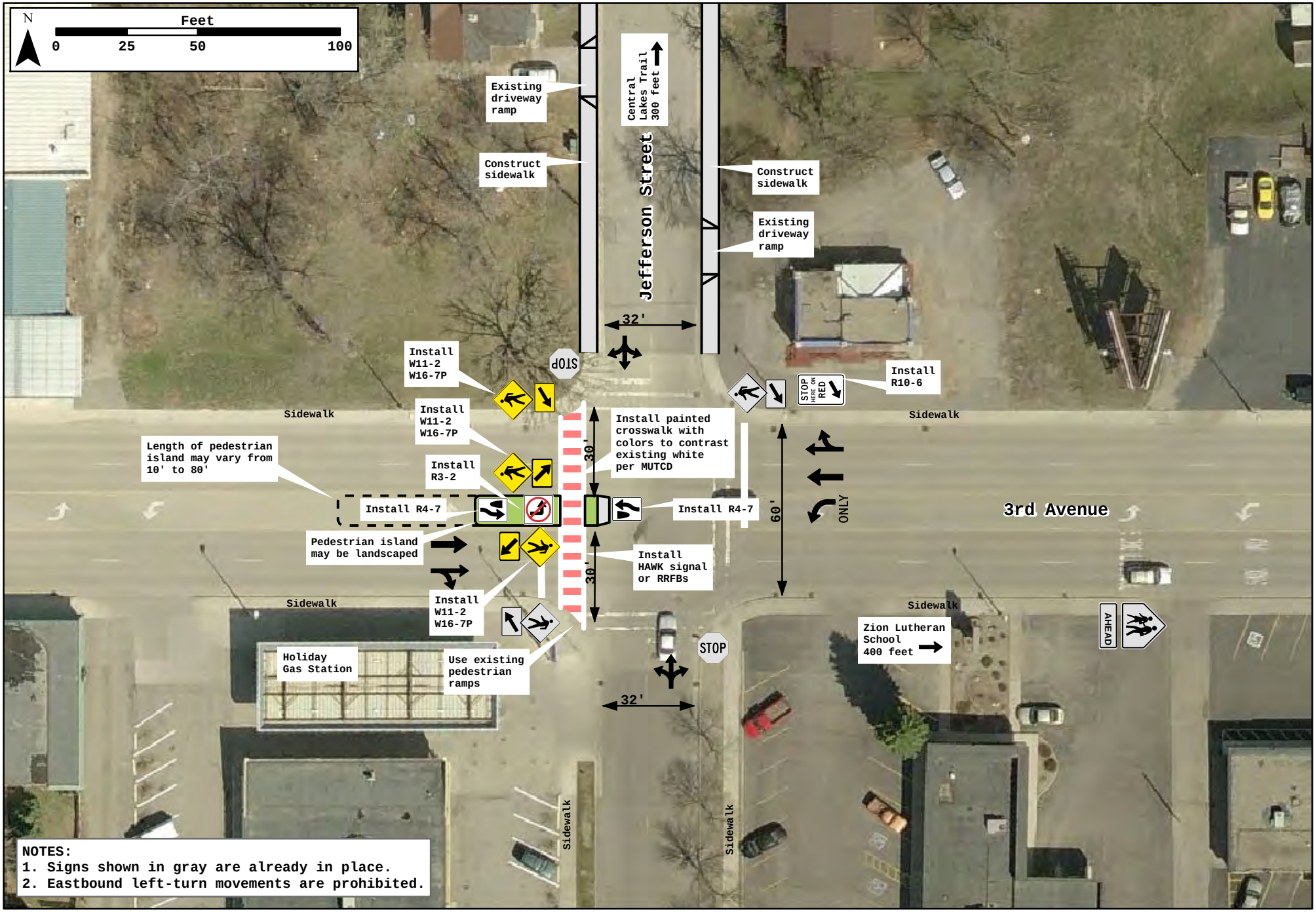
The cost of Alternative 2 will vary based on the size of the pedestrian island and the type of pedestrian actuated signal included at the crosswalk (HAWK signals or RRFBs). Preliminary estimates range from approximately $25,000 to $101,000.

Alternative 3 - Full Median

Alternative 3 (**Figure 10**) includes the construction of a full median across the intersection of 3rd Avenue and Jefferson Street. The median may stretch as far as 80' west of the existing western crosswalk and 20' east of the existing eastern crosswalk. Alternative 3 includes moving the crosswalks approximately 5'-8' further from the intersection, which will require the construction of eight new pedestrian ramps (two on each corner). In addition, Alternative 3 includes a slightly reduced corner radius to slow turning vehicles. Alternative 3 includes improvements to the crosswalks on both the eastern and western sides of the intersection. The median prohibits northbound through and left-turn, southbound through and left-turn, eastbound left-turn and westbound left-turn movements. The median includes two bicycle pass-through gaps to allow northbound and southbound cyclists to pass through the median. A pedestrian actuated signal (either a HAWK signal or RRFBs) will be installed only on the west crosswalk.

Alternative 3 is an improvement for pedestrians crossing 3rd Avenue as the crossing distance is reduced from over 70' to two 26' sections. In addition, pedestrians are only navigating traffic in a single direction at a time, and the pedestrian actuated signal draws additional attention to pedestrians. The restricted vehicle turning movements at the intersection further simplifies vehicle patterns, improving pedestrian safety. Alternative 3 is a significant improvement for cyclists crossing 3rd Avenue. The median acts as a refuge island for cyclists and allows cyclists to cross only one direction of traffic at a time.

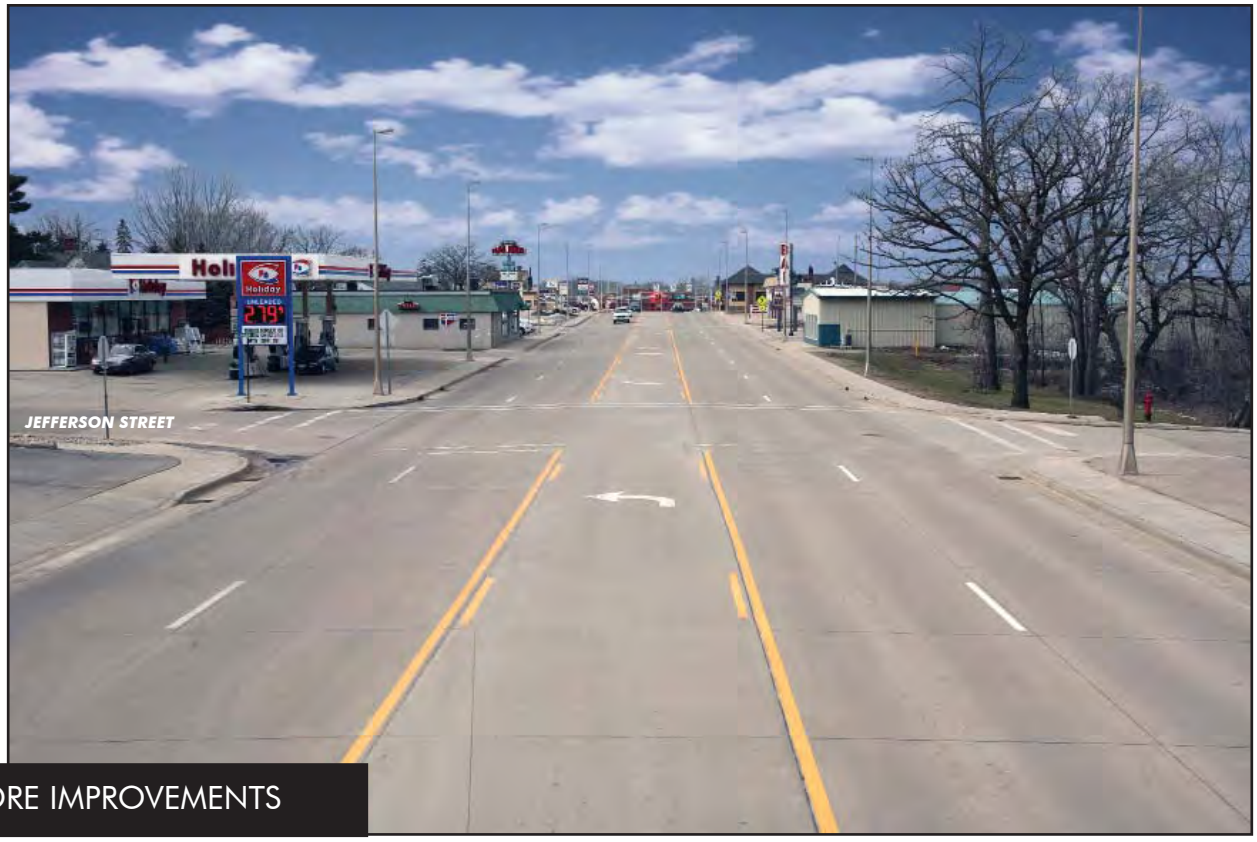
The cost of Alternative 3 will vary based on the size of the median and the type of pedestrian actuated signal included at the crosswalk (HAWK signals or RRFBs). Preliminary estimates range from approximately $52,000 to $129,000.



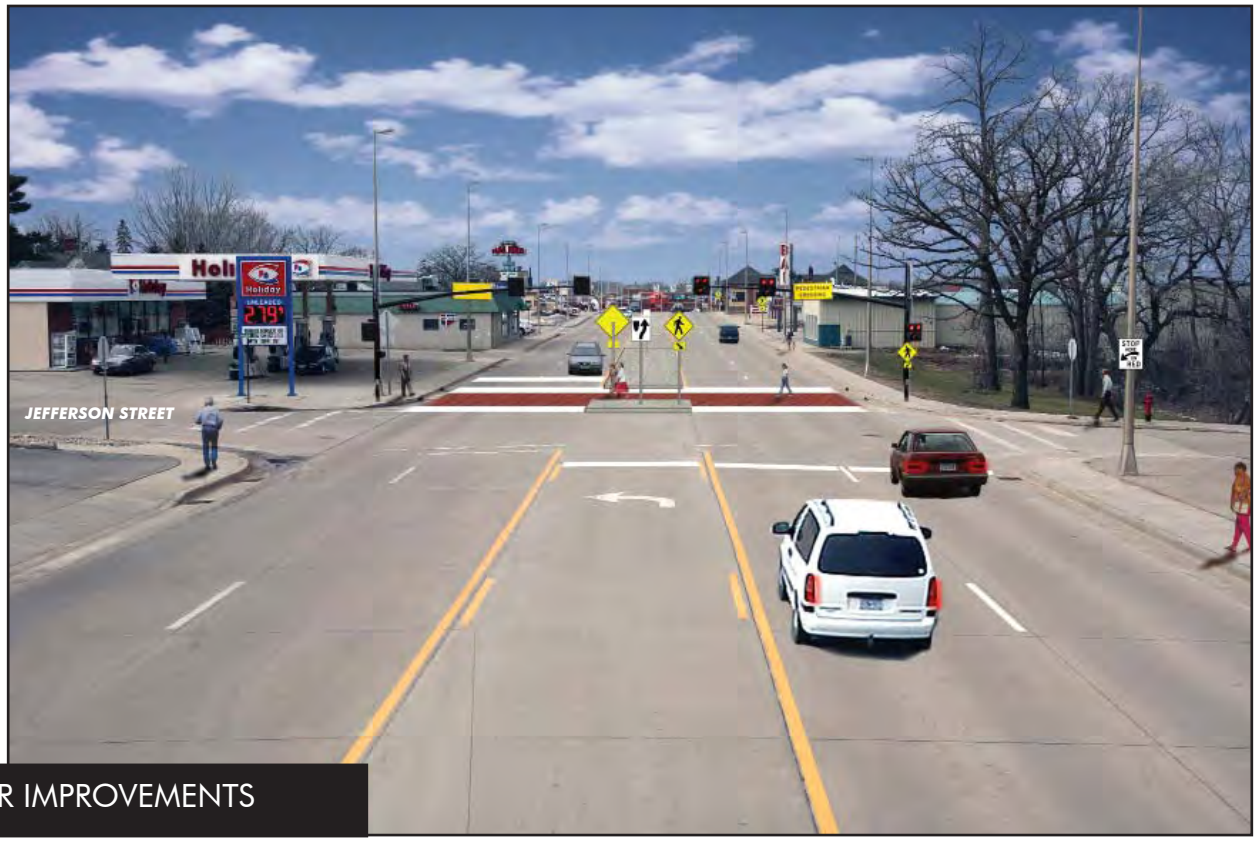
NOTES:
1. Signs shown in gray are already in place.
2. Eastbound left-turn movements are prohibited.

Figure 8: Alternative 1 - Pedestrian Refuge Island

3rd Avenue & Jefferson Street Intersection Crossing Study
Alexandria, MN



BEFORE IMPROVEMENTS



AFTER IMPROVEMENTS

NORTH

WSB & Associates, Inc.

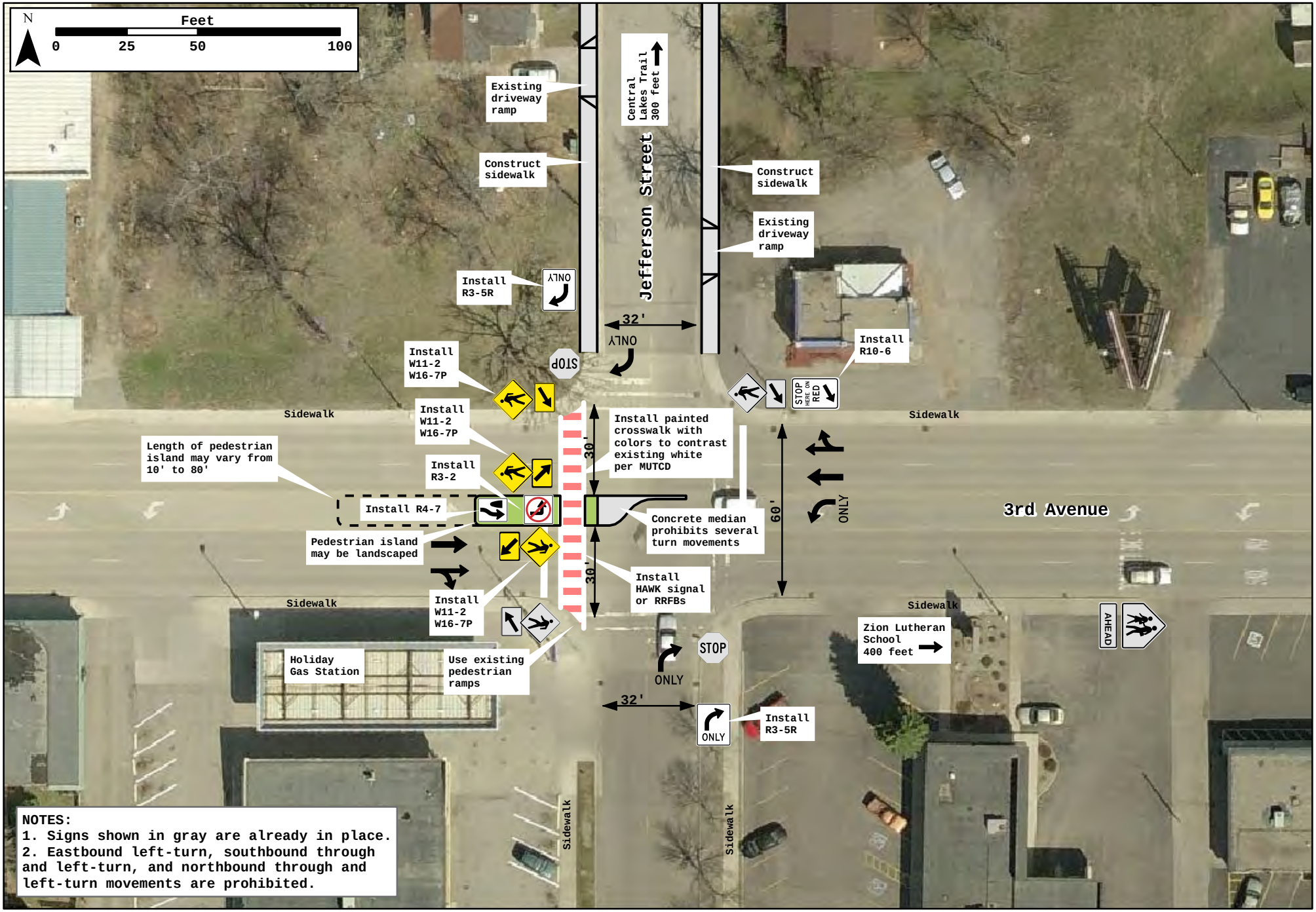
DOUGLAS COUNTY

active living Communities in Motion

DOUGLAS COUNTY SAFE COMMUNITIES

FIGURE 8A: ALTERNATIVE 1 - PEDESTRIAN REFUGE ISLAND

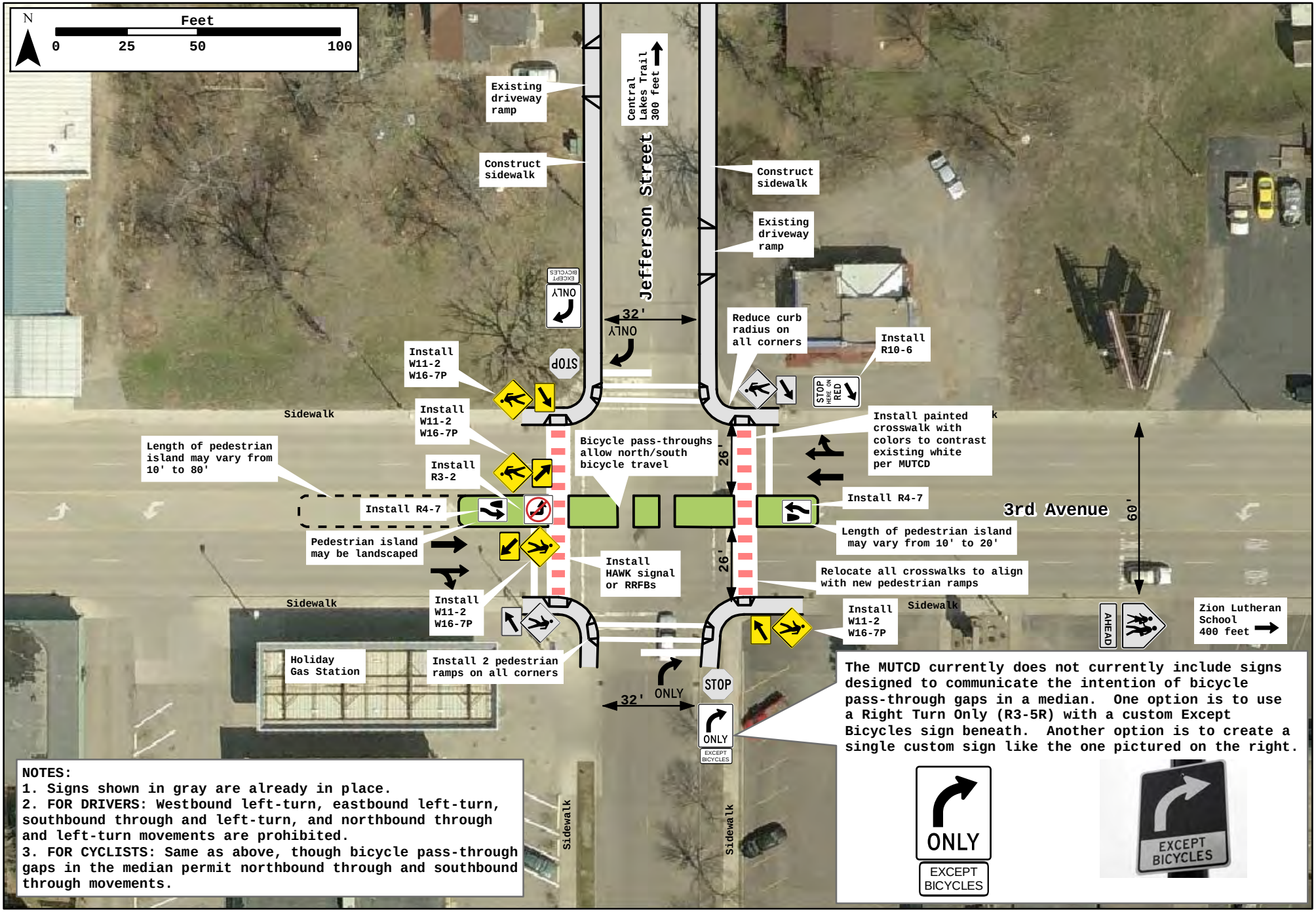
3rd Ave. & Jefferson Street Intersection Crossing Study
Alexandria, MN



NOTES:
1. Signs shown in gray are already in place.
2. Eastbound left-turn, southbound through and left-turn, and northbound through and left-turn movements are prohibited.

Figure 9: Alternative 2 - Partial Median

3rd Avenue & Jefferson Street Intersection Crossing Study
Alexandria, MN



NOTES:
1. Signs shown in gray are already in place.
2. FOR DRIVERS: Westbound left-turn, eastbound left-turn, southbound through and left-turn, and northbound through and left-turn movements are prohibited.
3. FOR CYCLISTS: Same as above, though bicycle pass-through gaps in the median permit northbound through and southbound through movements.

The MUTCD currently does not currently include signs designed to communicate the intention of bicycle pass-through gaps in a median. One option is to use a Right Turn Only (R3-5R) with a custom Except Bicycles sign beneath. Another option is to create a single custom sign like the one pictured on the right.

WSB & Associates, Inc. | Douglas County | Douglas County Active Living Communities in Motion | Douglas County Safe Communities

Figure 10: Alternative 3 - Full Median

3rd Avenue & Jefferson Street Intersection Crossing Study
Alexandria, MN

Improvement Phasing

Not all desired improvements need to be implemented at the same time. For each Alternative, an appropriate phasing schedule can be developed. Alternative 1 and Alternative 2 do not include the reconstruction of the pedestrian ramps or curbs, so the crosswalks can remain in their existing location. In this case, the crosswalks can immediately be improved by adding a contrasting color paint within the existing crosswalks. This is a relatively affordable step that can be implemented immediately.

Construction of the pedestrian islands in Alternative 1 and Alternative 2 will require a slightly longer timeframe for completion. The construction of the pedestrian island involves prohibiting one or more turning movements, which may involve a public involvement process or meetings with local stakeholders.

The final element of Alternative 1 and Alternative 2 is the implementation of a pedestrian actuated signal. Implementation of a HAWK signal should include a public education element before and after deployment. RRFBs are fairly intuitive, since their sole purpose is to catch the attention of motorists, although a public education element may still be helpful.

If the intersection corners are to be modified with new pedestrian ramps as suggested in Alternative 3, phasing the project becomes more difficult. Installation of the new corner geometry and pedestrian ramps should be completed first. The new ramps will need to be in place before the crosswalks can be modified and the median can be constructed. In addition, as Alternative 3 represents the largest change from the existing conditions, it may require more stakeholder involvement and public input and education before construction.

If Alternative 3 is the ultimate desired vision for the intersection, it may be beneficial to complete the entire project at once. However, depending on the project timeline, improving the existing crosswalk may be an appropriate temporary step.

Summary

This memo described the existing conditions for pedestrians and cyclists at the intersection of 3rd Avenue and Jefferson Street. Three Alternatives were presented to enhance pedestrian safety. This memo also described two types of pedestrian actuated signals that could be implemented at this location to draw motorist attention to pedestrians. Preliminary cost estimates for each of the three alternatives ranged from $23,000 to $124,000, depending on the size of the pedestrian island or median and the type of pedestrian actuated signal installed (HAWK signal or RRFBs). A summary of assumed project costs is presented in the **Appendix**.

As Alternative 1, achieves the goal of providing a safe bicycle/pedestrian crossing while maintaining reasonable construction cost estimates, it is recommended that this improvement is considered for implementation.

Provided above is a view looking west on 3rd Avenue North. At the western approach at the 3rd Avenue North and Jefferson Street intersection, a pedestrian refuge island would be constructed along with the installation of a High-intensity Activated crossWalK (HAWK) signal (mounted above the roadway on mast arms). Appropriate signage and striping would also accompany the crossing.

Figure 11: Rendering of Recommended Crosswalk Improvement Measure

The Appendix of this memorandum is a catalogue of bicycle and pedestrian enhancements created for Douglas County. The purpose of this catalogue is to provide an overview of the strategies that could be used to enhance pedestrian and bicycle movement throughout the City of Alexandria, MN. For each strategy, the document provides a list of the benefits and drawbacks for each option.

Many of the strategies presented here fall into an over-arching category of options commonly referred to as *traffic calming*. While it is generally true that any measure intended to reduce vehicle speeds provides some benefit to cyclists and pedestrians, the purpose of this document is not to provide an exhaustive catalogue of all traffic calming options. The focus of this catalogue is on enhancements that directly aid pedestrians and cyclists traveling along or across a roadway corridor.

APPENDIX

Cost Estimates
Catalogue of Pedestrian and Bicycle Enhancements

Cost Estimates *(2010 dollars)*

Signs

Item	Unit	Estimated Cost	Alternative 1 Quantity	Alternative 1 Total	Alternative 2 Quantity	Alternative 2 Total	Alternative 3 Quantity	Alternative 3 Total
W11-2 (Pedestrian Warning)	each	$ 250	3	$ 750	3	$ 750	4	$ 1,000
W16-7P (Arrow)	each	$ 250	3	$ 750	3	$ 750	4	$ 1,000
R3-2 (No Left Turn)	each	$ 250	1	$ 250	1	$ 250	1	$ 250
R4-7 (Keep Right)	each	$ 250	2	$ 500	1	$ 250	2	$ 500
R3-5R (Right Turn Only)	each	$ 250	0	$ -	2	$ 500	2	$ 500
R10-6 (Stop Here On Red)	each	$ 250	1	$ 250	1	$ 250	1	$ 250
Custom (Except Bikes)	each	$ 250	0	$ -	0	$ -	2	$ 500
SubTotal:				***$ 2,500***		***$ 2,750***		***$ 4,000***

Crosswalk / Stop Line

Item	Unit	Estimated Cost	Alternative 1 Quantity	Alternative 1 Total	Alternative 2 Quantity	Alternative 2 Total	Alternative 3 Quantity	Alternative 3 Total
Paint / Epoxy	each	$ 2,000	1	$ 2,000	1	$ 2,000	4	$ 8,000
RRFBs	each	$ 15,000	1	$ 15,000	1	$ 15,000	1	$ 15,000
HAWK	each	$ 80,000	1	$ 80,000	1	$ 80,000	1	$ 80,000
SubTotal (with RRFB):				***$ 17,000***		***$ 17,000***		***$ 23,000***
SubTotal (with HAWK):				***$ 82,000***		***$ 82,000***		***$ 88,000***

Median / Pedestrian Island

Item	Unit	Estimated Cost	Alternative 1 Quantity	Alternative 1 Total	Alternative 2 Quantity	Alternative 2 Total	Alternative 3 Quantity	Alternative 3 Total
Remove Existing Roadway Min	sq.yd.	$ 11	15	$ 167	31	$ 338	81	$ 890
Remove Existing Roadway Max	sq.yd.	$ 11	99	$ 1,091	115	$ 1,262	174	$ 1,916
Curb Min	lin. ft.	$ 13	68	$ 884	146	$ 1,898	242	$ 3,146
Curb Max	lin. ft.	$ 13	212	$ 2,756	290	$ 3,770	402	$ 5,226
Concrete Clear Zone Min	sq.ft.	$ 4	60	$ 240	138	$ 552	222	$ 888
Concrete Clear Zone Max	sq.ft.	$ 4	204	$ 816	282	$ 1,128	382	$ 1,528
Landscape Area Min	sq.yd.	$ 8	9	$ 68	15	$ 123	56	$ 450
Landscape Area Max	sq.yd.	$ 8	77	$ 612	83	$ 667	132	$ 1,054
Min SubTotal:				***$ 1,359***		***$ 2,911***		***$ 5,374***
Max SubTotal:				***$ 5,275***		***$ 6,827***		***$ 9,725***

Pedestrian Ramps

Item	Unit	Estimated Cost	Alternative 1 Quantity	Alternative 1 Total	Alternative 2 Quantity	Alternative 2 Total	Alternative 3 Quantity	Alternative 3 Total
Remove Existing Curbs	sq.yd.	$ 11	0	$ -	0	$ -	150	$ 1,650
Curb	lin. ft.	$ 13	0	$ -	0	$ -	200	$ 2,600
Replace Corner Sidewalk	sq.ft.	$ 4	0	$ -	0	$ -	538	$ 2,152
Ped Ramp	each	$ 1,100	0	$ -	0	$ -	8	$ 8,800
SubTotal:				***$ -***		***$ -***		***$ 15,202***

Lower Range Cost Estimate *(including Engineering)*

Cost Component	Alternative 1	Alternative 2	Alternative 3
Work Item Total:	**$ 20,900**	**$ 22,700**	**$ 47,600**
Engineering /Design (10%)	**$ 2,100**	**$ 2,300**	**$ 4,800**
Project Cost (lower range)	**$ 23,000**	**$ 25,000**	**$ 52,400**

Upper Range Cost Estimate *(including Engineering)*

Cost Component	Alternative 1	Alternative 2	Alternative 3
Work Item Total:	**$ 89,800**	**$ 91,600**	**$ 116,900**
Engineering /Design (10%)	**$ 9,000**	**$ 9,200**	**$ 11,700**
Project Cost (upper range)	**$ 98,800**	**$ 100,800**	**$ 128,600**

Jefferson Street (2nd Ave - 3rd Ave) Sidewalk & Trail Connection

Item	Unit	Estimated Cost	All Alternatives Quantity	All Alternatives Total
Clear Sidewalk Area	sq.yd.	$ 5	389	$ 1,945
Sidewalk Base	sq. yd.	$ 4	3500	$ 12,600
Sidewalk	sq.ft.	$ 4	3500	$ 14,000
Curb	lin. ft.	$ 13	30	$ 390
Ped Ramp	each	$ 1,100	3	$ 3,300
Clear Asphalt Trail Area	sq. yd.	$ 5	54	$ 270
Asphalt Trail Base	sq. yd.	$ 4	480	$ 1,920
Asphalt Trail	sq.yd.	$ 6	480	$ 2,880
SubTotal:				***$ 37,305***
Enginering / Design (10%)				**$ 3,731**
Sidewalk / Trail Project Cost				**$ 41,000**

Source: WSB & Associates, Inc.

Lane Reconfiguration ("Road Diet")

Before

Photo by Dan Burden

After

Photo by Dan Burden

Photo by FHWA

Photo by FHWA

Benefits:

- Reduces the number of lanes for pedestrians to cross
- Allows for reclaimed space to be used for other purposes such as parking, bicycle lanes, landscaped medians, pedestrian refuge islands, sidewalks, etc.
- Reduces "multiple lane threat" to pedestrians
- Introduction of turn lanes may improve traffic flow and efficiency
- Slower vehicle speeds (slower vehicles act as "pace cars")

Drawbacks:

- Average gap between vehicles may decrease, resulting in fewer gaps long enough for pedestrians to safely cross
- Decreased roadway capacity

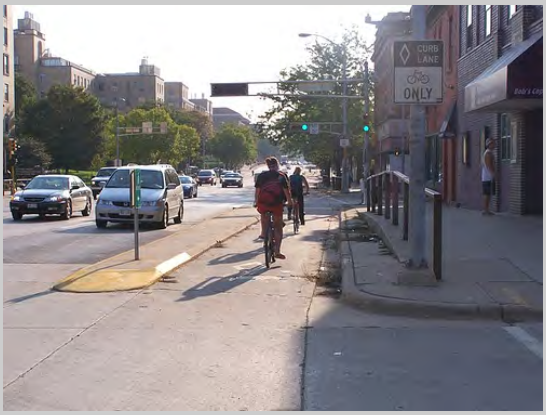
Other Info:

- The most common form of "road diet" is a four-lane to three-lane conversion, most commonly implemented on roadways with up to 20,000 vehicles per day, although case studies include roadways with as much as 30,000 vehicles per day.
- May be combined with "lane diet" (reducing the width of travel lanes)
- Minnesota State-Aid standards require at least four lanes on new roadways with more than 15,000 vehicles per day.
- COST: Depends on roadway length, traffic signals, etc.., $5,000-$20,000 per mile not including planning and engineering

Segregated Bicycle Facilities

Bike Lane

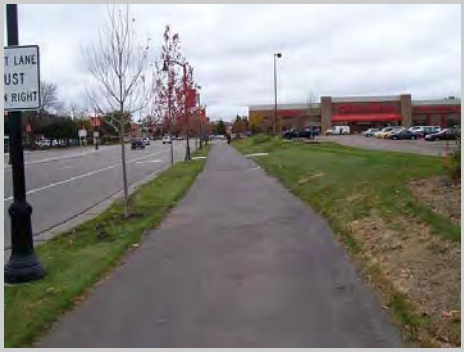
Buffered Bike Lane



Protected (by curb) Bike Lane

Protected (by parking lane) Bike Lane

Sidepath



Sidepath

NOTE: Bicycle facility terminology may mean different things to different individuals. Several terms are used somewhat interchangeably. The following conventions may apply:

- ***Buffered bike lane*** usually refers to a bicycle facility with a painted "shy zone" between cyclists and motorists
- ***Protected bike lane*** usually refers to a bicycle facility with a physical barrier of some sort (parked cars, curb, etc.) between cyclists and general purpose lanes.
- ***Cycletrack*** is a term often used synonymously with protected bike lane, but it may also imply a bicycle facility with a more substantial physical barrier (i.e. including street furniture, bike racks, landscaping, etc.) or a facility located on a medium-height curb. It may also refer to a two-way facility.
- ***Sidepath*** usually refers to an off-street, two-way facility parallel to a roadway, but separated from traffic by a curb or boulevard. Sidepaths are often mixed-use facilities allowing pedestrian use.

Benefits:

- Segregated bicycle facilities allow cyclists and motorists to travel at their desired speeds, allowing motorists to pass cyclists (or vice versa) without sharing a travel lane
- May encourage bicycle usage by less experienced cyclists
- May decrease the stress level of cyclists by removing them from faster moving traffic
- May remind persons exiting parked vehicles to look for cyclists before opening car doors
- May reduce bicycle crash rates along corridors
- May encourage cyclists to ride safely (i.e. with traffic, not on the sidewalk)
- May encourage cyclists to modify their desired route to use the bicycle facility

Segregated Bicycle Facilities

Protected (by curb) Bike Lane

Protected (by parking lane) Bike Lane

Drawbacks:

- Bicycle lanes may create new conflict points within intersections that are uncommon and unfamiliar to both motorists and cyclists (for example, right-turning motorists crossing the bicycle lane where cyclists are proceeding through the intersection), and thus many users may be inexperienced or unaware of the dangers
- May require more maintenance than general purpose lanes to keep them clear of debris, snow, leaves, etc.
- Some motorists may incorrectly interpret bicycle lanes as a message that cyclists aren't legally allowed to other areas of the roadway
- Cyclists in bicycle lanes protected by a row of parked cars may be less visible to motorists
- Some cyclists may feel a false sense of security within bicycle lanes and become less alert or aware of other roadway users

Other Info:

- Bicycle lanes are typically only used on roadways where it is undesirable for motorists and cyclists to equally share roadway space. Bicycle lanes are not recommended for low-volume, low-speed, residential roadways.
- As sidepaths are generally (though not always) mixed use facilities, cyclists on sidepaths are expected to operate like pedestrians. At intersections, sidepaths are generally treated as pedestrian crossings and cyclists are subject to the same rules that apply to pedestrians. For this reason, sidepaths are generally well-suited only for inexperienced cyclists, or light recreational use. A significant exception to this general rule is in locations where the sidepath remains unbroken by curb cuts, access points, or roadway intersections for a significant distance.
- Bicycle lanes are often colored blue or green —especially in areas where conflicts with vehicles are anticipated.
- COST: Usually requires restriping entire roadway—$5,000—$20,000 per mile, not including engineering studies or signal modifications

Pedestrian Refuge Island

Photo by Complete Streets via flickr

Photo by Dan Burden

NOTE: if implementation of a pedestrian refuge island requires narrowing the travel lanes or causing vehicle path deflection, then it may also be referred to as ***center island narrowing***.

Benefits:

- Allows pedestrians to cross one direction of vehicle traffic at a time
- Reduced number of pedestrian crashes
- Increased pedestrian visibility
- May reduce vehicle speeds along corridor

Drawbacks:

- Requires space that could otherwise be used by left-turning vehicles
- May provide a false sense of security to users who require more space than the island provides (cyclists pulling trailers, parents with large strollers, tandem cyclists, etc.)

Other Info:

- May be used at mid-block or intersection locations
- Should be a minimum of 4' wide, though wider is preferred, and should be large enough to accommodate the anticipated number of pedestrians
- May be used in combination with pedestrian signals
- COST: $5,000—$30,000 if no conflicts with utilities

Median / Landscaped Median

Photo by Dan Burden

Benefits:

- Provides a waiting area and safe zone for crossing pedestrians (see Pedestrian Refuge Island)
- Provides an opportunity for landscaping and public art
- Provides an opportunity for mid-block crossings to allow bicycles and pedestrians to cross where vehicles are not permitted to make turning movements
- Reduces the number of conflict points between bicycles, pedestrians, and vehicles by reducing the availability of turning movements by drivers
- Provides a traffic calming element

Drawbacks:

- Requires space that could otherwise be used by other roadway users
- Can cause circuitous routes by vehicles by eliminating some turning movements
- In some studies, vehicle speeds have increased because drivers no longer feel threatened by oncoming traffic
- Landscaping requires consistent maintenance

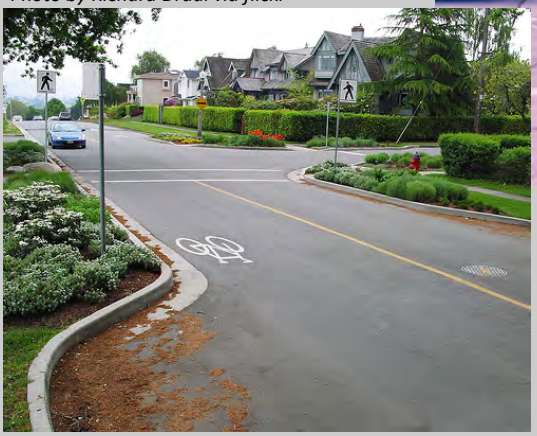
Other Info:

- On new roadways, Minnesota State-Aid standards require medians to be a minimum of 4' wide and may require a minimum reaction distance between the travel lane and the curb.
- COST: $15,000—$30,000 if no conflicts with utilities

Bump-out / Curb Extension / Choker / Neckdown

Photo courtesy of WalkingInfo.org

Photo by Richard Drdul via flickr



NOTE: Intersection and mid-block crossing implementation of this strategy is usually referred to as ***bump-outs***, ***bulb-outs***, ***curb extensions***, or ***neck-downs***. Mid-block implementation (without a crosswalk) is usually referred to as a **choker**. If narrowing begins from the center of the roadway, it is usually referred to as ***center island narrowing***.

Benefits:

- Reduces the overall width of the street
- Creates protected on-street parking
- Allows pedestrians to more easily "see around" parked vehicles to assess oncoming traffic
- Provides additional space for landscaping, utility or signal poles, trash bins, and other street furniture
- Reduces speed of right-turning vehicles by reducing turning radius
- Draws additional attention to pedestrians waiting to cross at intersections

Drawbacks:

- May create difficult right turns for larger vehicles

Other Info:

- May be implemented along with raised, colored, or textured crosswalks
- Minnesota State-Aid standards permit bump-outs, but a design variance may be needed if curbs encroach on minimum required clear zones.
- COST: $5,000—$20,000 if no significant drainage issues

Mid-block Crosswalk

NOTE: Photo shows implementation in combination with a ***choker***.

Photo by Richard Drdul via flickr

Benefits:

- Allows pedestrians to cross at a location without crossing turning lanes or navigating turning vehicles
- Usually combined with a choker or a pedestrian refuge island, and may easily be combined with pedestrians signals, raised crosswalks, and speed tables
- Allows easy implementation of pedestrian signals

Drawbacks:

- Places crossing pedestrians where drivers may not be expecting them
- May not be convenient for pedestrians

Other Info:

- May be implemented along with raised, colored, or textured crosswalks
- Mid-block crossings are most successfully implemented in locations where there is already significant demand for a pedestrian crossing.
- COST: $300—$1,000 for paint, $5,000—$25,000 for pedestrian ramps, signs, etc.

Diagonal Diverter

Photo by Richard Drdul via flickr

- ***Diagonal diverters*** place a barrier diagonally across an intersection, disconnecting legs of the intersection.
- ***Truncated diagonal*** diverters are similar, but they restrict one fewer motorized right-turn

Benefits:

- May significantly reduce traffic volumes on impacted roadways
- Restricts movements by motorized vehicles while retaining bicycle and pedestrian movement
- Allows pedestrians to move travel along both original roadway corridors through the intersection without crossing any roadways
- Provides opportunities for landscaping

Drawbacks:

- Limits vehicle accessibility and causes circuitous routes by drivers—especially those unfamiliar with the area
- May increase traffic volume on other nearby streets by providing fewer through routes to accommodate existing traffic volumes

Other Info:

- COST: $15,000—$100,000 depending on size, drainage, landscaping, etc.

Speed Hump / Speed Table / Speed Bump

Photo by Dwernertl via Wikipedia

NOTE:

- ***Speed Bumps*** are commonly found in parking lots, are 1'-3' in length, and generally not recommended for implementation on roadways.
- ***Speed Humps*** range from 8'-15' in length and feature a rounded top.
- ***Speed Tables*** range from 8'-15' length and feature a flat top.

Photo by trafficcalming.org

Benefits:

- Very effective at slowing traffic
- May be constructed out of asphalt, concrete, or rubber (prefabricated rubber installation is becoming increasingly popular)
- Speed tables are commonly combined with crosswalks, chokers, or neckdowns to aid pedestrian crossing
- May be used to discourage through-traffic

Drawbacks:

- May be easily damaged by snow plows
- May cause damage to vehicles
- May cause driver irritation or be problematic for some drivers with back, spine, or neck injuries
- May require modifications to roadway drainage patterns

Other Info:

- Speed Tables do not slow traffic as much as Speed Humps and are used where less traffic calming is desired
- COST: $15,000—$100,000 for a speed table depending on materials (concrete is more costly than asphalt. $1,000 for an asphalt speed hump.

Roundabout

Photo via WSB & Associates

Benefits:

- Can reduce vehicle and pedestrian delay at intersections (pedestrians always have right-of-way in unsignalized crosswalks)
- Can reduce the number and severity of crashes at intersections
- Can reduce traffic speeds through intersection
- Approach splitter islands allow pedestrians to cross one direction of traffic at a time and may be used in combination with pedestrian signals
- Bicycle "escape ramps" allow cyclists to either merge with through traffic or leave the roadway to traverse the intersection as a pedestrian on the side-walks

Drawbacks:

- May be difficult for large vehicles to navigate around
- Landscaping must be maintained
- Can be intimidating for some pedestrians if vehicles choose not to stop for pedestrians
- Motorists exiting roundabout may not be aware of pedestrians or be prepared to stop
- Bicycle lanes are not continued through a roundabout—some inexperienced cyclists may not be comfortable merging with through traffic
- Safety concerns for pedestrians with visual impairments

Other Info:

- Implementing a roundabout generally requires a full reconstruction of the intersection
- There is ongoing debate among professionals regarding the benefits
- COST: The construction costs will vary widely depending on many factors. Costs have been as low as $300,000 in some locations. Project costs often range as high as $1,000,000—$2,000,000 depending on location, right-of-way costs, utilities, drainage, etc.

Traffic Calming Circle

Photo by trafficcalming.org

Benefits:

- Traffic calming circles are easy to implement and usually don't require any other modifications to the intersection
- Path deflection reduces traffic speeds of automobiles, but not bicycles
- Reduces speeds of left-turning vehicles substantially

Drawbacks:

- Difficult for large vehicles to navigate around
- Circle can be unsightly if not maintained

Other Info:

- Traffic Calming Circles are generally implemented in low-traffic, low-speed, residential neighborhoods and are sometimes called "neighborhood traffic circles."
- May be installed through full-depth reconstruction or through a superficial addition.
- In some areas, large vehicles are permitted to complete a left-turn by circumnavigating the circle in a counterclockwise direction when no other vehicles are present
- COST: $5,000—$15,000

Grade Separation / Tunnel / Bridge

Photo by Elkman via Wikipedia

Photo by Aboutmovies via Wikipedia

Photo via Nat. Trans. Enhancements Clearinghouse

Benefits:

- Eliminates conflicts between pedestrians, bicycles, and automobiles
- May be used to facilitate crossing barriers other than roadways (rivers, ravines, railroads, etc.)
- Can be designed as an iconic community asset or neighborhood gateway
- Enables slower, younger, or more vulnerable roadway users to cross roadways
- May be the only option on roadways where stopping traffic isn't an option (freeways, major highways, etc.)

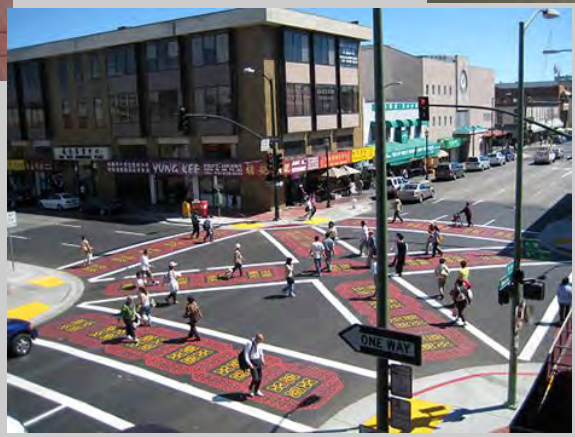
Drawbacks:

- Often requires additional travel distance and/or time for bicyclists and pedestrians
- Some bicyclists and pedestrians may view it as inherently less convenient and choose not to use it unless at-grade crossing is prohibited
- Can be visually intrusive or prone to vandalism
- Ramps and/or stairs may be difficult or unpleasant for some users
- If crosswalks or other at-grade crossing enhancements are removed in conjunction with the construction of the bridge or tunnel, crossing becomes less safe or convenient for cyclists and pedestrians who choose to cross at-grade anyway
- May stunt redevelopment on adjacent parcels
- May require additional land acquisition for ramps, stairs, or elevators

Other Info:

- COST: $1,000,000 +

Colored / Textured / Raised Crosswalk



NOTE:

- The crosswalk in the above photo requires pedestrians to turn slightly towards oncoming traffic when they reach the median to raise pedestrian awareness.
- The photo at left demonstrates an exclusive pedestrian signal phase ("pedestrian scramble") where pedestrians are allowed to cross any direction, including diagonally.

Benefits:

- Colored, textured, and raised crosswalks draw additional attention to pedestrians and alert drivers to the presence of additional roadway users
- May visually enhance the pedestrian environment and provide visual cues for pedestrians
- Raised crosswalks incorporate traffic-calming measures of a traffic table

Drawbacks:

- Some pavement paints can be slippery when wet
- Pavers may require additional maintenance and paint may require frequent reapplication

Other Info:

- Crosswalks may be accentuated using various combinations of paint, pavers, bricks, colored concrete, or colored asphalt, including several retro-reflective options
- The current MUTCD does not recognize colored or textured crosswalks as "marked" crosswalks. Without retro-reflective horizontal or longitudinal stripes meeting MUTCD standards, the crossing is legally an "unmarked" crossing. However, colors and textures may be used within "marked" crosswalks.
- COST: $2,000—$20,000

Advance Stop / Yield Line / Bicycle Box

NOTE:

- An ***advance stop line*** is placed further from a bicycle or pedestrian crossing than is typical (10'-20').

- An advance stop line used in conjunction with bicycle lanes creates a ***Bike Box*** - a storage area for cyclists to wait at the front of the queue at traffic signals

Benefits:

- Allows drivers to see the entire crosswalk from the stop line, which reduces the occurrence of "multiple-threat" collisions for pedestrians and cyclists in crosswalk
- Bicycle boxes aid left-turning cyclists and help reduce conflicts between cyclists making through movements and drivers making right-turn movements (commonly called the "right hook" collision)

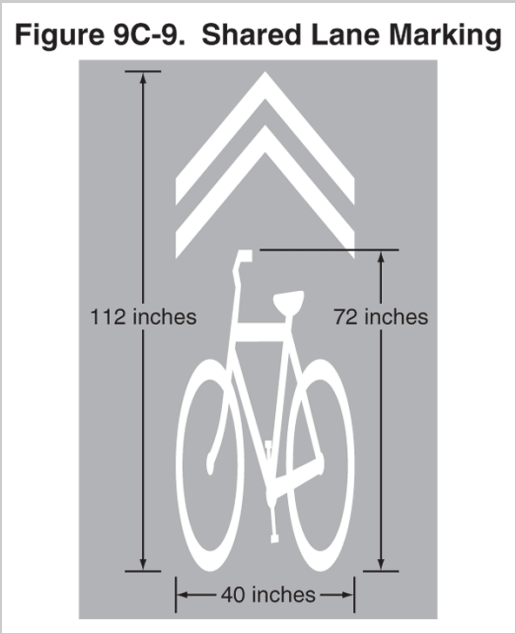
Drawbacks:

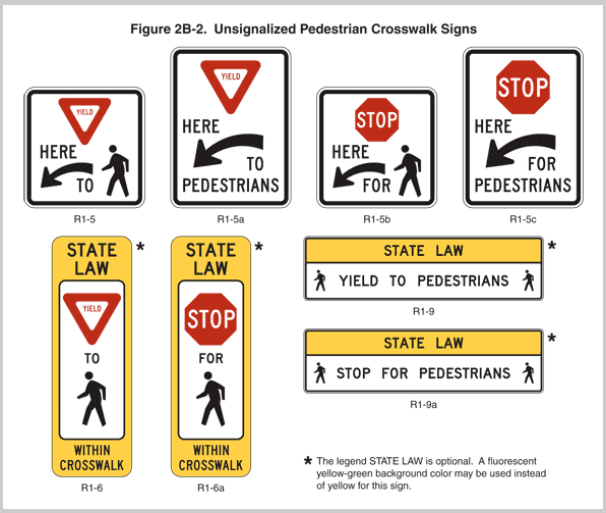
- Slightly reduced storage for stopped vehicles at traffic signals (one vehicle less per lane)

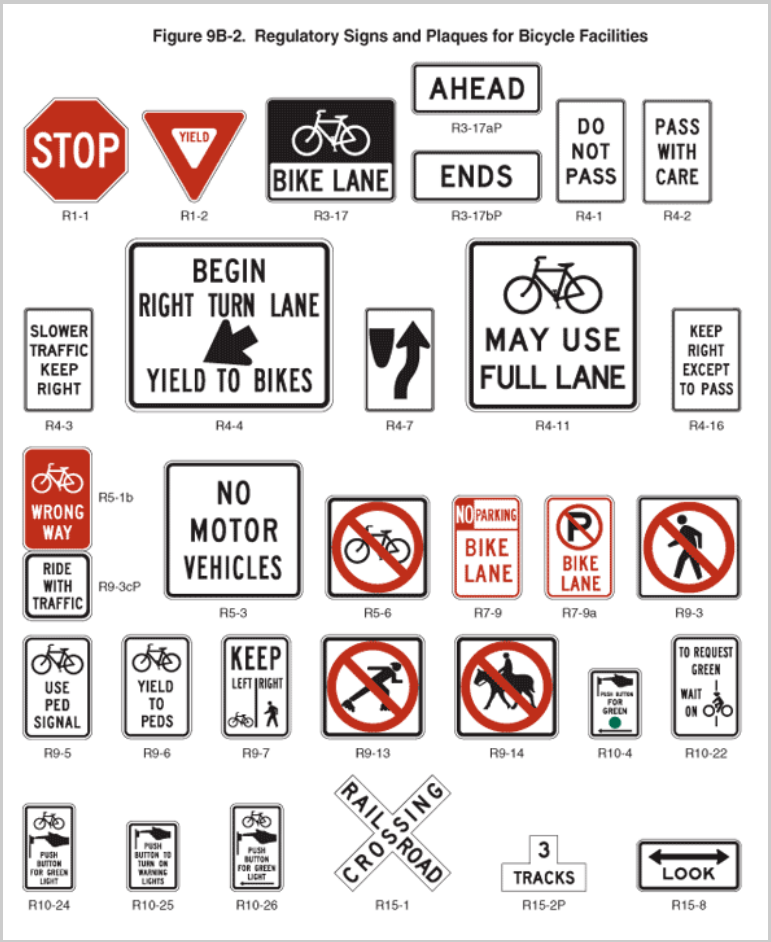
Other Info:

- Bicycle boxes may or may not be painted green or blue
- COST: $10,000 for a painted bike box, $300 for advance stop line

MUTCD Pedestrian and Bicycle Signing / Striping







NOTE: This is only a small sampling of the signage and striping available in the 2009 MUTCD. View the entire MUTCD at http://mutcd.fhwa.dot.gov/index.htm

Benefits:

- Regulatory and warning signs can be used to direct the actions of cyclists, pedestrians, and drivers.
- Guide and route signs benefit cyclists and pedestrians who are unfamiliar with the area
- Failure to provide appropriate signage may be viewed as a liability

Drawbacks:

- In some cases, overuse of signage may reduce the effectiveness as drivers begin to ignore warnings

Other Info:

- Wayfinding signs are also included in the MUTCD and can be critical to encouraging bicycling—especially for recreational cyclists
- COST: $100—$500 for each sign

Driver Feedback Sign

Photo by WSDOT via Wikipedia

Photo by WSB & Associates

Benefits:

- Can draw drivers attention to their speed and encourage drivers to stay within the speed limit
- Reduces the average vehicle speeds
- Reduces the percentages of vehicles exceeding the speed limit
- May reduce crashes and fatalities
- Particularly effective in School Zones
- Allows for speed data logging

Drawbacks:

Other Info:

- Signs may be solar powered or hardwired and can give customized responses. Communities may desire special conventions for displaying excessively slow or fast speeds.
- COST: $3,000—$6,000 for the sign (depending on whether AC or solar power is used). Installation costs when a permanent AC power source is used will vary widely.

Pedestrian Signal / Bicycle Signal

Pedestrian Countdown Signal

APS Pushbutton

HAWK Signal


Bicycle Signal

NOTE: A ***leading pedestrian interval*** is a strategy that allows pedestrians to begin crossing a roadway several seconds before motorists are given a green light. The head start allows pedestrians to assert their presence in the intersection while vehicles are still stopped. After motorists receive a green light, they must wait for pedestrians to clear the intersection before beginning their desired

Benefits:

- Pedestrian countdown signals let pedestrians know how much time they have to cross and reduces crossings initiated during the "don't walk" phase
- Accessible Pedestrian Signals (APS) provide audible and tactile (vibration) indication of when it is or is not appropriate to cross in accordance with ADA regulations to aid persons with hearing and visual impairments
- High-intensity Activated crossWalK (HAWK) signals flash only when a pedestrian is present and draws a high-level of attention to pedestrians
- Bicycle signals may be used to avoid conflicts between motorists and bicyclists. Despite being a relatively new technology within the U.S., they are fairly self-explanatory.
- **In-pavement bicycle sensors** may be used to allow cyclists to be recognized by actuated traffic signals

Drawbacks:

- HAWK and bicycle signals are still considered experimental treatments.

Other Info:

- Mn/DOT guidelines require APS on all new traffic signals under Mn/DOT jurisdiction
- COST: $6,000 for APS components, installation costs will vary widely

Pedestrian Scale Street Lighting

Photo by Richard Drdul via flickr

Benefits:

- Provides lighting of appropriate scale, brightness, and direction to improve pedestrian visibility
- Enhances the visual appeal of buildings, landscaping, and streetscaping
- Encourages night sky visibility
- Enhances pedestrian safety

Drawbacks:

Other Info:

- There are many new energy-saving technologies available to provide lighting for pedestrians including LED lights and solar-powered lights
- COST: $5,000 per light where a power source is already available. Costs of installing new lights, including new power sources can vary greatly.

Chicane

Photo by Richard Drdul via flickr

Benefits:

- Slows traffic speeds by requiring vehicles to navigate around the curb extensions
- Narrows roadway width to a single lane requiring vehicles to take turns navigating the S-curves
- Provides opportunities for landscaping
- Calms traffic without prohibiting any specific movements or excluding any group of users

Drawbacks:

- May make maintenance tasks like street plowing or cleaning more difficult

Other Info:

- COST: $10,000—$30,000

Bicycle Boulevard

NOTE: **Bicycle boulevard** refers to a street that uses any number of traffic calming and bicycle enhancement measures to provide an attractive route that prioritizes the needs of cyclists above those of all other roadway users. The specific enhancements applied to roadways to create bicycle boulevards varies greatly between case studies, however all bicycle boulevards have some combination of the following characteristics:

- Low traffic volumes at slow speeds
- Discouragement of non-local motor vehicle traffic
- Assigning intersection right-of-way to cyclists whenever possible
- Traffic control to assist cyclists crossing major cross streets
- A distinctive designation (via signs, pavement markings, or other measure to ensure that all roadway users are aware of the bicycle boulevard designation

Benefits:

- Provides a high-quality route for cyclists that allows them to move more quickly than on typical low-volume roadways
- Prioritizes the safety of cyclists at intersections
- Discourages non-local traffic on local roadways
- Provides an attractive on-street cycling opportunity for less experienced cyclists

Drawbacks:

- Bicycle boulevards often involve prohibiting various vehicle movements and diverting traffic, which can result in driver frustration and circuitous routes for motorists.

Other Info:

- Bicycle boulevards are created on streets that are already low-volume, low-speed roadways to minimize the disruption to the existing roadway network.
- Bicycle boulevards are often designated on streets running parallel to major arterials to provide an alternative route for cyclists
- Segregated bicycle facilities are typically not included on bicycle boulevards because cyclists are expected to ride in the general purpose lanes, which are often unmarked.
- COST: Costs will vary greatly depending on the individual strategies used to calm traffic and the length of the street. Bicycle boulevards have been created for as little as $50,000 to install sharrows and additional signage.