ATTACHMENT 2 - 134-0220-NC WHITNEY RD

Whitney Road Intersection and Sidewalk Evaluation

Whitney Road Drainage and Safety Enhancements Phase II

Prepared For:

Pinellas County
Department of Environment and Infrastructure
Division of Engineering and Technical Services
Survey and Mapping Section
State of Florida

14 S. Fort Harrison, 6th Floor
Clearwater, FL 33756

Prepared by:

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY
107 Hampton Road, Suite 190 • Clearwater, FL 33759
727-726-0005
Florida Certificate of Authorization
No. 9086

October 2012

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EXECUTIVE SUMMARY

Pinellas County Environment & Infrastructure Division (County) contracted with Lockwood, Andrews, and Newnam, Inc. (LAN), to provide conceptual design and traffic engineering analysis for sidewalk enhancements along Whitney Road and intersection improvements at the intersection of Whitney and Wolford Roads. The primary goals of this effort are to create a continuous pedestrian corridor along Whitney Road from US 19 to the easterly side of Long Branch Creek, terminating at Hidden Springs Place, and evaluate potential intersection improvements at Whitney and Wolford Roads to increase capacity and improve safety.

Recommendations

Sidewalk Improvements - It is recommended that the County construct additional sidewalk on the north side of Whitney Road between Sapphire Lane and Wolford Road. The existing sidewalk south of the drainage ditch from Long Branch Lane to the private driveway at the Whitney Road and Wolford Road intersection is not adequate. Obscured from roadway by trees, it is not illuminated and thus would not be a recommended pedestrian route for safety reasons. Proposed sidewalk improvements require reducing the proposed shoulder along Whitney Road to six feet wide, realigning and shifting Whitney Road to the south, and constructing a curb on the north side of Whitney Road from Oak Street North to Wolford Road. Additionally, Whitney Road should be restriped to the proposed 22-foot wide section from 220 feet east of Oak Street North to Wolford Road.

Pinellas County requested that a pedestrian bridge to carry non-motorized traffic across Long Branch Creek be evaluated. An approximate 70-foot span is recommended for this location. The majority of existing sidewalk is on the north side of Whitney Road east of Sapphire Lane. Segments to the west are proposed to improve mobility across Whitney Road. It is recommended that existing sidewalk and curb ramps be retrofitted with detectable warnings to meet Americans with Disabilities Act (ADA) guidelines. Finally, pavement markings are proposed at all crosswalks.

Whitney Road / Wolford Road Intersection – Improvements at this location would include increasing capacity for vehicular traffic while increasing safety for pedestrian traffic. A traffic signal warrant analysis (TSWA) was completed using procedures from the Manual on Uniform Traffic Control Devices (MUTCD); the results show that a traffic signal is not warranted at the Whitney Road intersection with Wolford Road.

LAN developed and evaluated two options for intersection improvements. Both options revise the alignments and remove stop control for the two Whitney Road approaches. The sister infrastructure project to enclose the drainage channel west of Long Branch Creek will remove vegetation in this area that restricts sight distances along Whitney Road; so these modifications will improve the intersection efficiency in a safe manner. The distinction between the options is in whether or not to provide right turn channelization to allow more vehicles to travel through the intersection concurrently. The analysis would determine if one option was preferable to the other in terms of capacity, types of crashes experienced, and/or cost.

Option 1 - The primary features of Option 1 are right-turn channelization (right turn bay) on the southbound Wolford Road approach and the westbound Whitney Road approach.

Option 2 - Right-turn channelizations on Whitney and Wolford Roads are not included in Option 2; however the alignment of the Wolford Road intersection approach has been made more perpendicular than can be afforded with Option 1, better facilitating left turns from southbound Wolford Road onto eastbound Whitney Road.

Traffic Analysis – LAN conducted a traffic operation analysis using Synchro software; results showed that both Options 1 and 2 (both using two-way stop control) would result in lower overall intersection

delays than the current configuration. In addition, no significant delay would result for Wolford Road Traffic.

Recommendation - Option 1 is the recommended alternative. While Option 1 requires right-of-way (ROW) and Option 2 does not, and Option 1 is slightly more expensive, Option 1 provides a greater reduction in overall intersection delay while also increasing intersection capacity (via the channelization included in Option 1). Additionally, in terms of crash history, one of the two incidents reported over the three year period may have benefited from the Option 1 channelized right turn movements. However, the overall number of crashes is too small to establish a conclusive trend in this regard.

Implementing the preferred two-way stop control configuration of the intersection will also require clearing 0.1 acres of vegetation north of Whitney Road for adequate intersection sight distance and approximately five feet of ROW west of Wolford Road to accommodate the sidewalk and southbound right turn channelization. Clearing the vegetation is crucial in providing clear lines of sight, if the vegetation is not cleared, the intersection should remain with all-way stop control due inadequate sight distance.

Total cost for sidewalk and intersection improvements is approximately $248,000 in 2012 dollars. Plan sheets are included as Appendix A, and detailed cost estimates are presented in Appendix B.

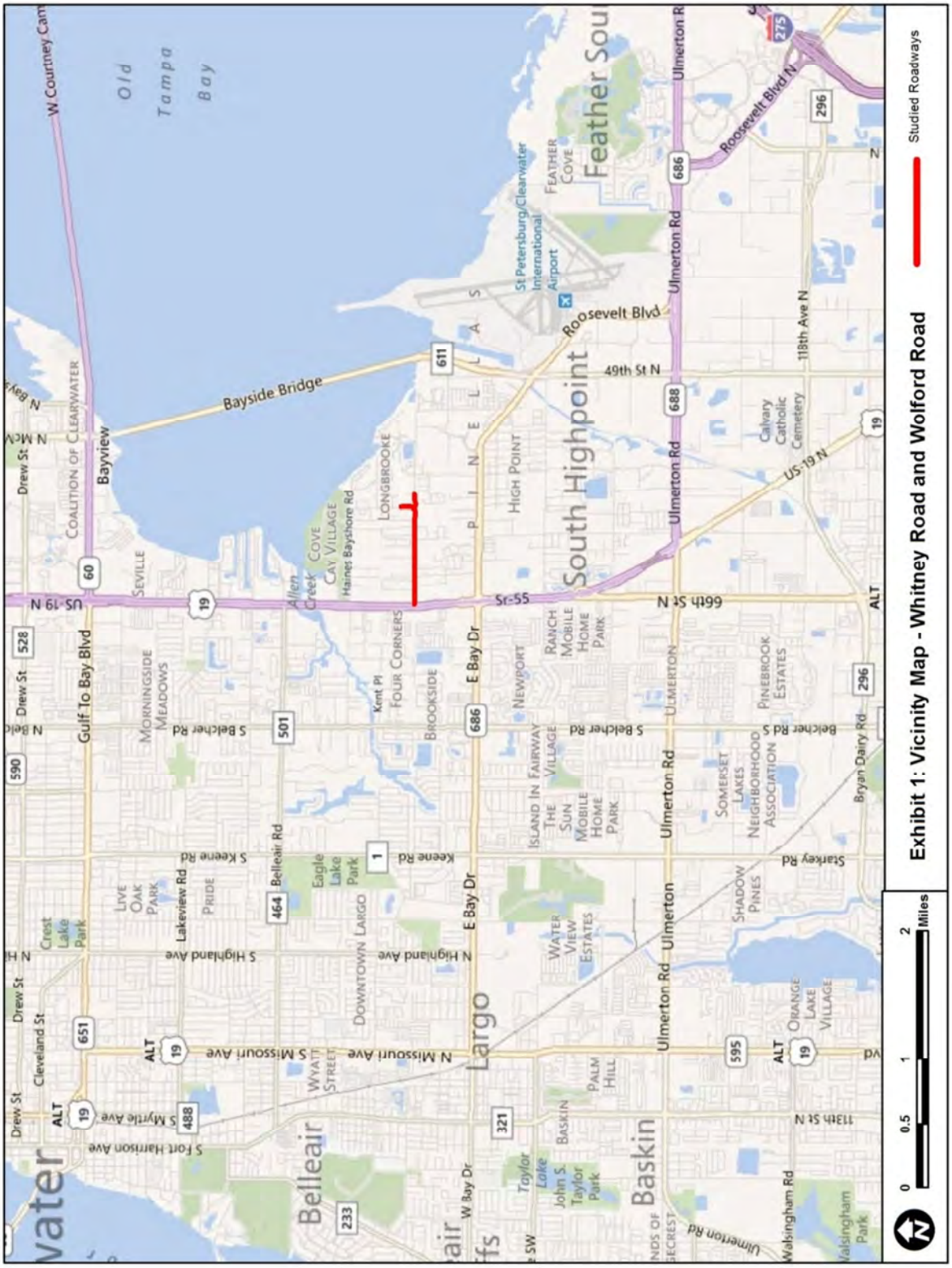


Figure ES-1 – Project Location

(source: Bing Maps, 2010)

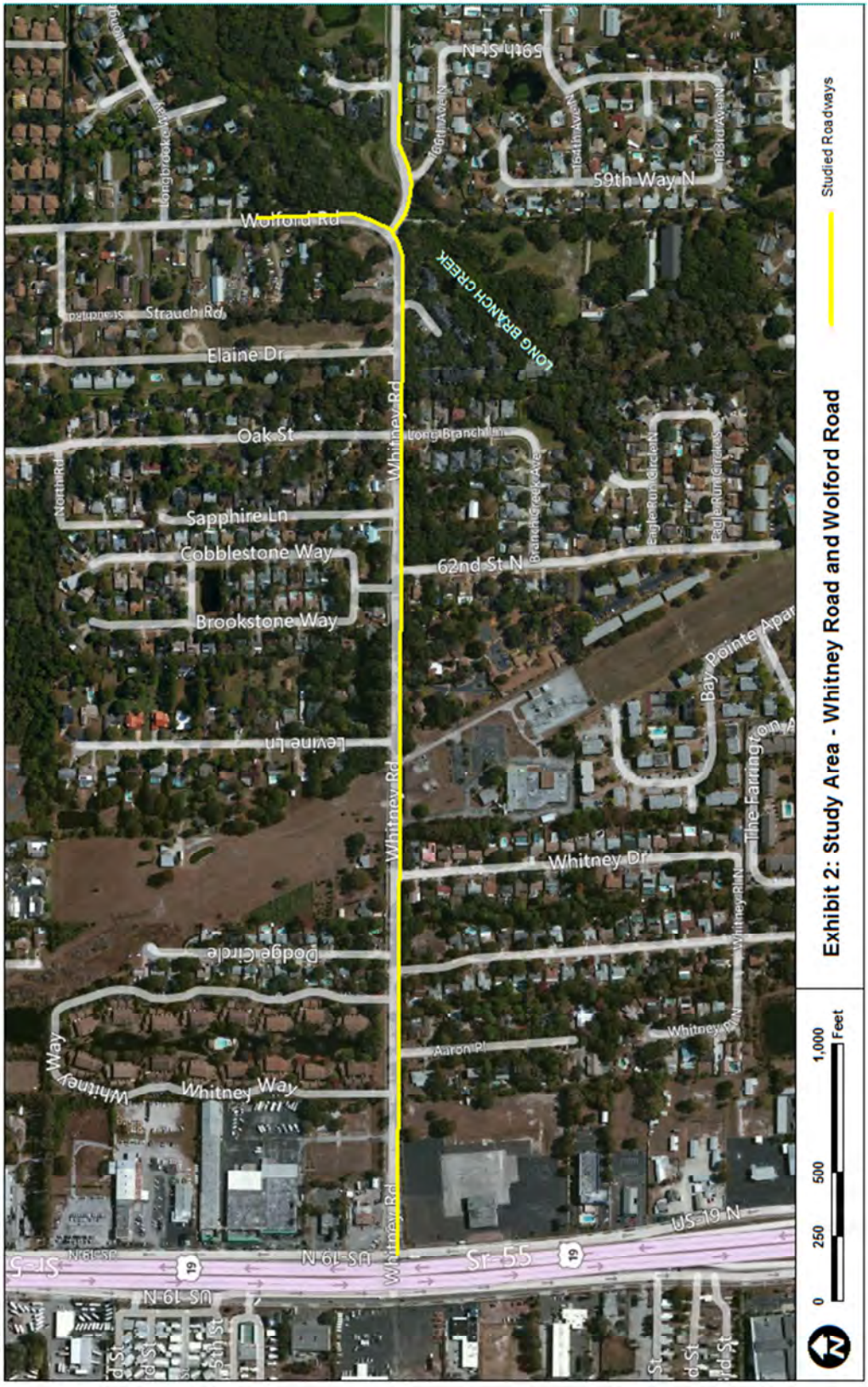


Figure ES-2 – Study Area Roadways

(source: Bing Maps, 2010)

1.0 PROJECT BACKGROUND AND AREA CONDITIONS

Pinellas County Environment & Infrastructure Division (County) contracted with Lockwood, Andrews, and Newnam, Inc. (LAN), to provide conceptual design and traffic engineering analysis for sidewalk enhancements along Whitney Road and intersection improvements at the intersection of Whitney and Wolford Roads. See Figure 1 for a location map. The primary goals of this effort are to create a continuous pedestrian corridor along Whitney Road, from US 19 to the easterly side of Long Branch Creek, terminating at Hidden Springs Place, and evaluate potential intersection improvements at Whitney and Wolford Roads to increase capacity and improve safety.

Within the study area (Figure 2), Whitney Road is an east-west oriented, two-lane, undivided road with a drainage channel on the south side. Surrounding land use is predominately single-family residential with commercial development at US 19. Wolford Road is a north-south oriented, two-lane undivided road with ditch drainage in this vicinity. Presently, the Wolford Road intersection with Whitney Road has skewed approaches and is controlled by stop signs facing all approaches. Major features within the study area include a power line easement approximately 1,900 feet east of US 19; and Long Branch Creek which crosses Whitney Road immediately east of Wolford Road.

Sidewalks along the Whitney Road are generally present on one side; however, there are two significant gaps between US 19 and the end of the corridor: Sapphire Lane to Long Branch Lane/Oak Street North and across Long Branch Creek. Two disjointed sections of sidewalk exist on the north side of Whitney Road east of Sapphire Lane There is also a stub section of sidewalk west of Long Branch Lane on the south side of the Whitney Road drainage easement, obscured from the road by vegetation.

The gap at Long Branch Creek is caused by sidewalk gap of approximately 460 feet from west of the creek to west of Hidden Springs Place. Because of the proximity of the Whitney Road crossing of Long Branch Creek to its intersection with Wolford Road, addressing the gap in pedestrian accommodations at the creek was conducted as part of the development of alternative designs for the intersection. The Whitney Road culvert crossing of Long Branch Creek represents a significant design constraint in establishing a continuous pedestrian corridor along Whitney Road. A new pedestrian crossing will need to be part of the structure, or a new bridge crossing of the creek.

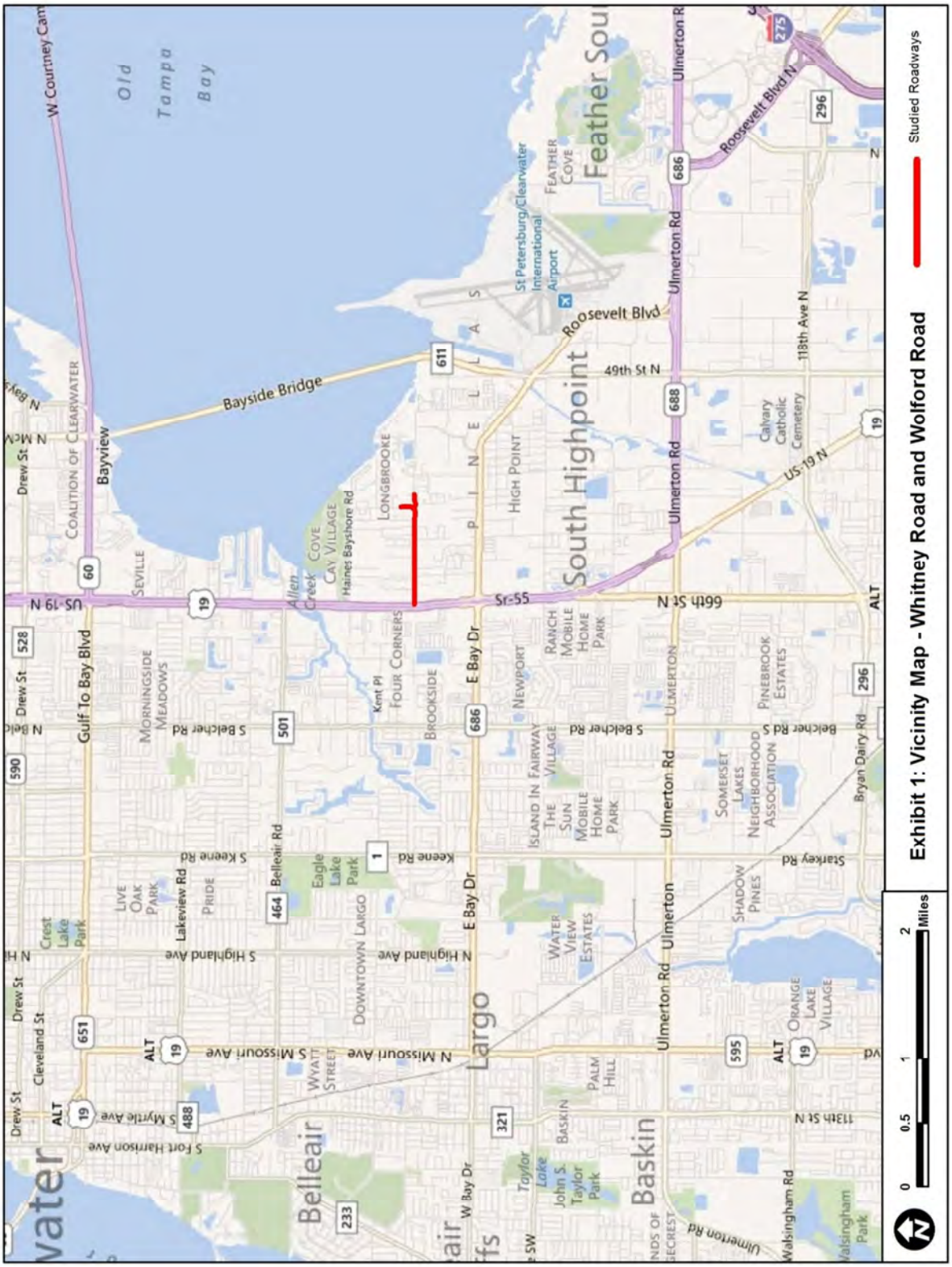


Figure 1 - Project Location
(source: Bing Maps, 2010)

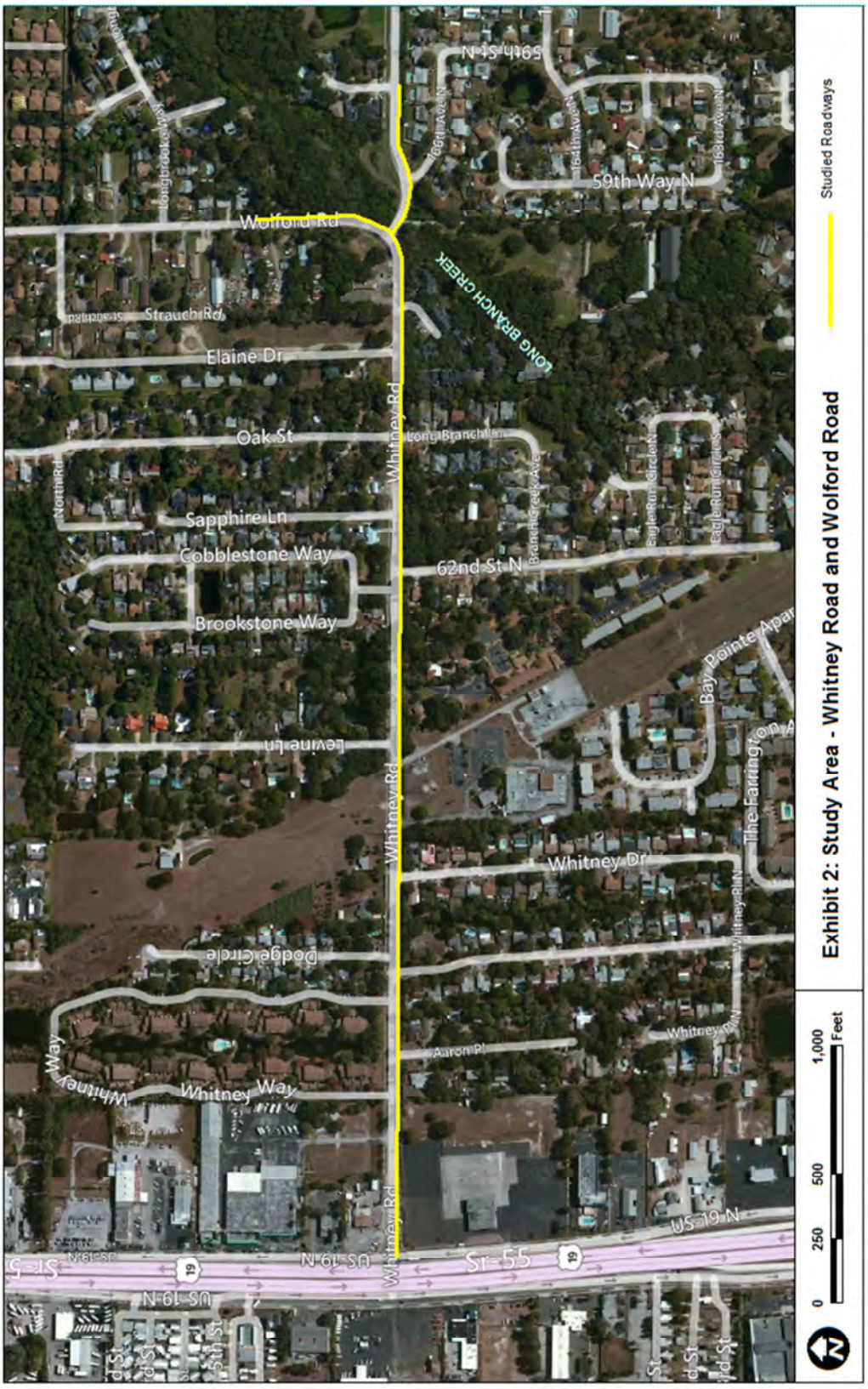


Figure 2 – Study Area Roadways
(source: Bing Maps, 2010)

2.0 SIDEWALK IMPROVEMENTS ANALYSIS

The sidewalk improvements analysis performed by LAN included inventorying existing pedestrian facilities, evaluated sidewalk gap connectivity, and reviewed compliance issues related to the Americans with Disabilities Act (ADA). Existing pedestrian facilities within the study corridor include sidewalks, curb ramps, bus stops, and the bridge crossing Long Branch Creek. Connectivity deficiencies are locations where a sidewalk does not exist, or the existing sidewalk is isolated from the rest of the sidewalk sections along Whitney Road. Locations where a sidewalk or curb ramp exists, but does not meet ADA criteria, are defined as having access deficiencies. Examples are curb ramps that do not have detectable warnings, or where sidewalk sections are offset more than ¼ inch in elevation. In general, connectivity issues are addressed by adding new pedestrian facilities, such as extending a sidewalk to a bus stop. Accessibility issues are generally addressed by upgrading existing infrastructure, such as adding a detectable warning surface.

2.1 Sidewalks Inventory

Continuous sidewalks along the Whitney Road corridor are in three locations: US 19 to Sapphire Lane, Long Branch Lane to Long Branch Creek, and Hidden Springs Place to end of the corridor, where Whitney Road curves south to become Bolestra Road. In the segment between US 19 and Sapphire Lane, sidewalks are of sufficient width and in fair to good condition based on field observations (summarized in Table 1) and engineering judgment. The sidewalk along the northern side of Whitney Road has a discontinuity in alignment approximately 50 feet east of Sapphire Lane (see Figure 3). An additional 70 feet of sidewalk is cast flush with the back of the curb across the frontage of the adjoining property and stops approximately 150 feet west of Oak Street North.

Table 1 – Sidewalk Condition Assessment

Side	From	To	Condition	Width (feet)	Visible/Potential Problems
North	US 19	Whitney Way (W)	Good	6	Driveway cross slopes
North	Whitney Way (W)	Whitney Way (E)	Good	5	None
North	Whitney Way (E)	Dodge Circle	Good	5	None
North	Dodge Circle	Levine Lane	Good	5	None
North	Levine Lane	Brookstone Way	Good	5	None
North	Brookstone Way	Sapphire Lane	Fair	5	Encroaching vegetation Edge changes
South	Whitney Drive	Levine Lane	Good	5	None

West of Long Branch Lane, a sidewalk begins south of the drainage channel, approximately 40 feet from the Whitney Road southern edge of pavement. The sidewalk continues approximately 900 feet eastward to the Wolford Road intersection, and is obscured from Whitney Road by a continuous line of trees, constituting a pedestrian safety concern (see Figure 4).

A 45-foot long triple box culvert crossing, shown in Figure 5, for Long Branch Creek is east of the Wolford Road intersection. The potential to realign Whitney Road, or add pedestrian accommodations over this structure, is constrained by existing guardrail and inlets. East of Long Branch Creek, the nearest sidewalk on Whitney Road is approximately 200 feet east of the creek on the north side of the road. There are small dry retention depressions on both sides of the road; however the embankments are set back from the edges of pavement, and not only allow for the placement of sidewalks, but also can be serviceable locations for bus stops as well.

Figure 3 - Sidewalk Break East of Sapphire Lane

Figure 4 - Sidewalk Terminus West of Long Branch Creek

Within the study area, sidewalks are provided on the cross streets that intersect with Whitney Road with the following exceptions: West Whitney Way, Aaron Place, East Whitney Way, Levine Lane, and

Wolford Road. Despite the presence of sidewalks on the cross streets, there is only one designated location to cross Whitney Road east of US 19, a crosswalk located approximately 150 feet east of Whitney Drive at the entrance road to 2735 Whitney Road (presently Abilities Incorporated of Florida). Additionally, crosswalks are not striped on any of the cross streets. This could potentially create a problem at Brookstone Way, which intersects Whitney Road as a median divided two lane road. There is no sidewalk extending through the median, nor is there a crosswalk in front of the median to indicate where pedestrians are expected to travel.

There is a general lack of sidewalks along Wolford Road, excluding an approximately 250-foot long section adjacent to Longbrooke subdivision that connects to sidewalks along Longbrooke Way. Future extension of the Wolford Road sidewalk will likely remain on the east side of the road north of Whitney Road. During the field visit on December 19, 2011, pedestrians were observed walking in the Wolford Road right-of-way (ROW) on the east side of the road.

Figure 5 - Long Branch Culvert Crossing

2.2 Curb Ramp Inventory

Existing curb ramps, inventoried in Table 2, do not meet current ADA guidelines. Sidewalks are generally four feet wide and narrower along 166th Avenue North; whereas the American Association of State Highway and Transportation Officials (AASHTO) and applicable FDOT standards now acknowledge the need for five-foot wide sidewalks in residential areas, owing to the need to accommodate wheelchairs to change direction and to provide passing space. Almost all curb ramps at intersections do not have detectable warning surfaces, with the exception of the ramp in the northeast quadrant of the Sapphire Lane intersection (Figure 6). The intermittent nature of vehicle traffic in the study area and the flat terrain both make it easy for visually impaired pedestrians to stray into the roadway inadvertently. Having two-foot wide detectable warning strips with distinctively contrasting color relative to the sidewalk and pavement will be helpful in this regard and necessary to meet ADA requirements.

Table 2 - Existing Curb Ramp Summary

Intersection	Curb Ramps	ADA Condition
US 19	NW	No Detectable Warning
	NE	No Detectable Warning
	SE	No Detectable Warning
Whitney Way (W)	W	No Detectable Warning
	E	No Detectable Warning
Aaron Place	None	
Whitney Way (E)	W	No Detectable Warning
	E	No Detectable Warning
Dodge Street	None	
Dodge Circle	W	No Detectable Warning
	E	No Detectable Warning
Whitney Drive	W	No Detectable Warning
	E	No Detectable Warning
Pedestrian Crossing East of Whitney Drive	N	No Detectable Warning
	S	No Detectable Warning
Levine Lane	W	No Detectable Warning
	E	No Detectable Warning
Brookstone Way	W	No Detectable Warning
	E	No Detectable Warning
62nd Street North.	None	
Sapphire Lane	W	No Detectable Warning
	E	
Oak Street North	None	
Long Branch Lane	W	No Detectable Warning
	E	No Detectable Warning
Whitney Oaks Boulevard	none	
Arbor Drive	W	No Detectable Warning
	E	No Detectable Warning
Wolford Road	none	
166th Avenue North	W	No Detectable Warning Under 4 feet wide

Figure 6 - Curb Ramps With and Without Detectable Warnings

2.3 Bus Stops Inventory

The Whitney Road corridor is served by Route 79 as part of the Pinellas Suncoast Transit Authority (PSTA) route network. Bus stop information is listed in Table 3.

Table 3 - Existing Bus Stops

Stop	Direction	Pole	Pad	Sidewalk Access	Other Notes
US 19	WB	Y	Y	Y	Bench
US 19	EB	Y	N	N	Bench
Dodge Circle	WB	Y	N	Y	Bench
Aaron Drive	EB	Y	N	N	
Levine Lane	WB	Y	Y	Y	Bench
West of Levine Lane	EB	Y	Y	Y	Bench, Pedestrian Crossing
West of Brookstone	WB	Y	Y	Y	Bench
62nd Street N.	EB	Y	N	N	
Oak Street	WB	N	Y	Y	Bench
Long Branch Lane	EB	Y	N	N	
166th Avenue N.	EB	Y	N	N	Bench
Hidden Springs Place	WB	Y	N	Y	Bench

(WB - Westbound, EB - Eastbound)

The proximity of the drainage channel affords little opportunity to locate benches or bus pads for waiting eastbound patrons on the south side of Whitney Road. In addition, several stops do not have sidewalk pads or connections to the sidewalk network, as shown in Figure 7. Transit service is not provided along Wolford Road.

Figure 7 - Bus Stop East of 166th Avenue North

2.4 Sidewalk Improvements and Cost Estimates

After reviewing connectivity and deficiencies of sidewalks, curb ramps, and bus stops, the following sidewalk improvements plan was developed. Approximately 1,200 feet of new sidewalk will be required to address the identified deficiencies. Plan sheets in Appendix A show proposed sidewalk, curb ramps, signing, striping, and structure. All new sidewalks and curb ramps should be constructed to satisfy ADA requirements. Figure 8 depicts the following sidewalk improvements (highlighted in yellow):

- Approximately 150 feet of sidewalk on the south side of Whitney Road east of US 19 to provide access to the PSTA bus stop,
- Extending the a sidewalk along Dodge Street approximately 50 feet to create an accessible crossing on Whitney Road,
- Realigning the sidewalk east of Sapphire Lane to eliminate the break,
- Approximately 700 feet of sidewalk from west of Oak Street North to Wolford Road (sidewalk in the vicinity of the intersection will be addressed in later sections)
- Extending the existing sidewalk south of the drainage ditch to Long Branch Creek
- Construction of a 70-foot pedestrian bridge over Long Branch Creek,
- An approximately 80-foot connection between 166th Avenue North and the proposed pedestrian bridge, and
- Approximately 200 feet of sidewalk on the north side of Whitney Road extending east to the existing sidewalk at Hidden Springs Drive.
- Sidewalks on the east side of Wolford Road are being extended northward to the northern limits of reconstruction (approximately 200 feet).

Figure 8 - Sidewalk Improvement Projects

In addition to the proposed sidewalks, detectable warning strips are proposed at all curb ramps and crosswalks on public roads. Crosswalks should be striped to delineate areas where pedestrians should walk.. Further, accessible pedestrian crossings are proposed at Dodge Street, Long Branch Lane, and 166th Avenue North. These crossings should also include advance warning signs (such as depicted in Figure 9) to alert drivers.

Figure 9 - MUTCD Compliant Advance Warning Sign

A separate bicycle/pedestrian bridge will be required to safely convey traffic across Long Branch Creek. Such a structure would be better situated on the south side of the culvert crossing, given the proximity of existing sidewalks to the east and west, more favorable terrain, and relative lack of utility conflicts. On the north side of the crossing are two visible utilities, an 8-inch potable water pipeline and valve, and a 16-inch reclaimed pipeline (visible in Figure 5). Both are pressure pipelines; there also exist overhead power transmission lines. Constructing the pedestrian bridge on the south side of the culvert crossing may require removal of mangrove trees and additional environmental mitigation. Any required environmental mitigation or acquisition of an environmental resources permit (ERP) should be coordinated with County staff during final design.

Pinellas County staff identified an existing pedestrian bridge along Sunset Point Road near Macomber Avenue that potentially could be relocated to the Whitney Road crossing of Long Branch Creek. Although it appears to be well designed for the purpose, its approximate 110-foot length is longer than is called for between 166th Avenue North and the driveway immediately west of the creek. A 70-foot span is suitable for this location and is recommended. In addition to the cost to fabricate and place the structure is the cost associated with constructing new headwalls in close proximity to the culvert wing walls. Planning level cost estimate for all pedestrian improvements (sidewalks, crosswalks, signing, and structure) is estimated to be $195,000 in 2012 dollars. A breakdown of the costs may be found in Appendix B.

Cost estimates do not consider potential utility impacts and relocations. A Level D Utility Survey, performed by the County in 2005, was used to determine utility impacts within the project limits. Multiple utilities exist along the north side of Whitney Road from US 19 to Hidden Springs Drive. These could be impacted by the Whitney Road sidewalk improvements. Prominent utilities along Whitney Road within the project limits include the following, with a detailed assessment in Table 4:

- 230 kV overhead electric lines (Progress Energy) crossing at 320 ft east of Whitney Drive
- 36" water line (City of St. Petersburg) crossing at 280 ft east of Whitney Drive
- 14" underground electric conduit (Progress Energy) crossing 40 feet west of Levine Lane
- 18" sewer (City of Largo) from Brookstone Way to Wolford Road
- 30" sewer (City of Largo) from Wolford Road to Hidden Springs Drive
- 2 - 4" underground telephone conduits (Verizon) from US 19 to Hidden Springs Road

Table 4 - Sidewalk Improvements Utility Impacts Assessment

Sidewalk Location	Nearby Utilities - Potential Impacts in BOLD
150' extension from US 19	**UG Electric - Progress Energy** Water - Pinellas County
Dodge Street extension and Whitney Road Crossing	OH Electric - Progress Energy **UG Telephone - Verizon** **UG Cable - Bright House** **UG Electric - Progress Energy** Sewer (15") - City of Largo
Sapphire Lane Realignment	**OH Cable - Bright House** **OH Electric - Progress Energy** **UG Telephone - Verizon** **OH Coaxial - Knology Broadband** **OH Fiber Optic - Knology Broadband** Sewer (18") - City of Largo
Long Branch Lane extension to Whitney Road	UG Telephone - Verizon Water (8") - Pinellas County
700' from Oak Street North to Wolford Road	**OH Cable - Bright House** **OH Electric - Progress Energy** **UG Telephone - Verizon** **OH Coaxial - Knology Broadband** **OH Fiber Optic - Knology Broadband** Sewer (18") - City of Largo
Long Branch Creek Pedestrian bridge	None
80' from Pedestrian Bridge to 166th Street N.	Water (8") - Pinellas County UG Telephone - Verizon
200' from 166th St. N. to Hidden Springs Dr	Sewer (8") - City Largo Water (8") - Pinellas County OH Electric - Progress Energy **UG Telephone - MCI** Reclaimed (16") - City of Largo

Sidewalk Location	Nearby Utilities - Potential Impacts in BOLD
	Sewer (30") - City of Largo
200' of sidewalk on Wolford Rd to intersection reconstruction	Sewer (8") - City of Largo Water (8") - Pinellas County OH Electric - Progress Energy **UG Telephone - MCI** Reclaimed water (16") - City of Largo Sewer (30") - City of Largo

UG = Underground, OH = Overhead

Electric, coaxial, cable, and fiber optic lines are carried by utility poles along the north side of Whitney Road. These utility poles will need to be protected during construction, however relocation is not expected. In addition, two 4" underground telephone conduits are adjacent to the utility poles. If the depth of these conduits is less than one foot, they will be impacted during construction.

3.0 INTERSECTION IMPROVEMENTS ANALYSIS

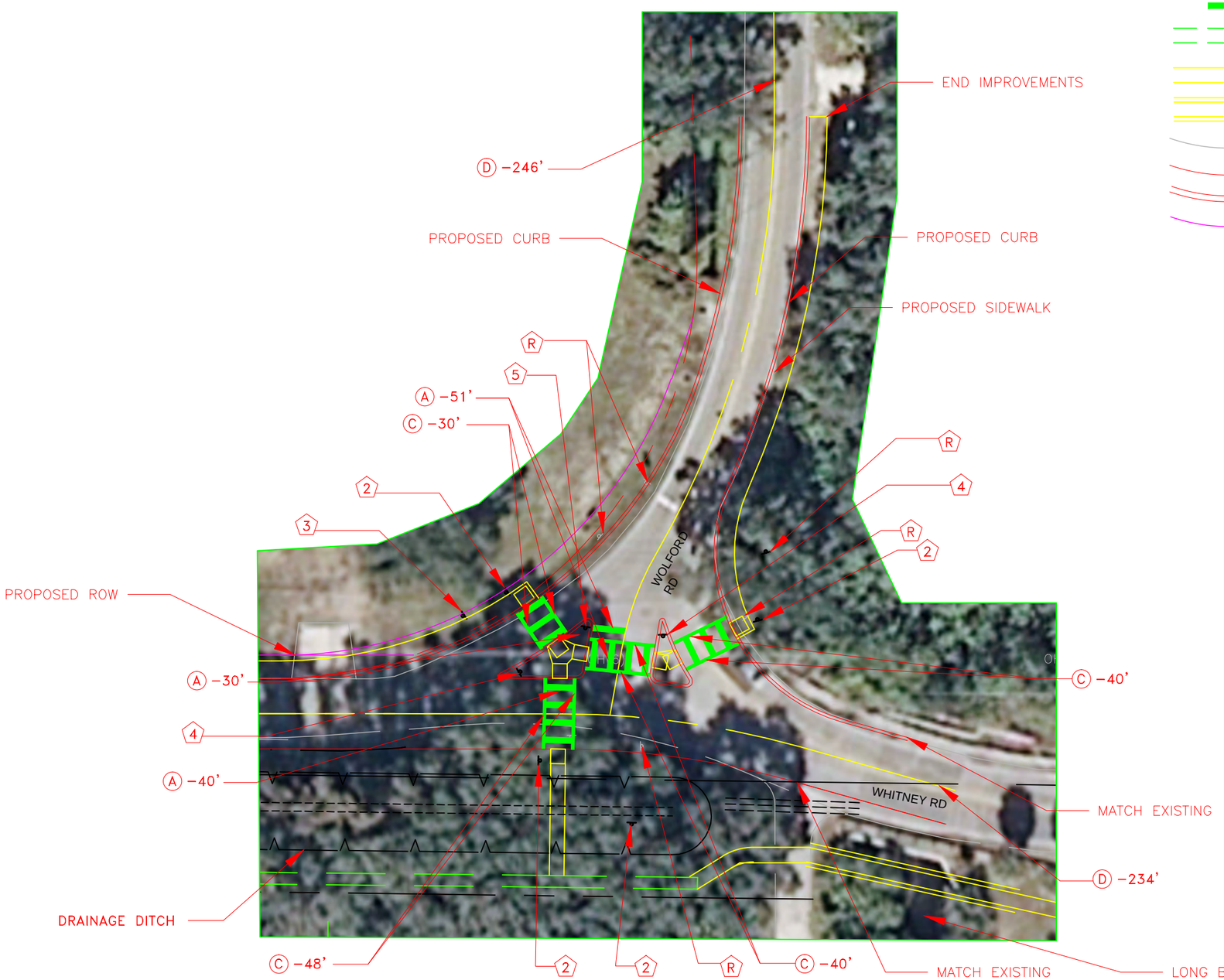
Alternative intersection reconfiguration options were evaluated relative to experienced and anticipated Year 2017 traffic volumes, crash data, and expected construction costs with the goal of increasing capacity and/or improving safety. The proposed drainage project provides an impetus to improve the intersection of Whitney Road and Wolford Road by removing vegetation that limits sight distances along the Whitney Road approaches and allowing for roadway realignments to encroach upon the existing drainage channel. This being the case, alternative intersection improvements developed for the intersection explored realigning Whitney Road east and west of Wolford Road to remove the all-way stop control (i.e., stop control would only remain facing the Wolford Road approach under these conditions). The following constraints and assumptions were used in the development of intersection options:

- Existing conditions at the culvert crossing are matched by the design.
- The force main north of the culvert (visible in Figure 5) will not be impacted.
- Tree and vegetation removal east of Wolford Road. A driver stopped at Wolford Road will need to see a vehicle approximately 100 feet east of 166th Avenue North in order to safely execute a left turn.

Even though pedestrian improvements along Whitney Road have already been examined, the need exists to take a more detailed look at pedestrian accommodations through the intersection for all approaches, since these can vary with each option. As observed in the previous section, the nearest sidewalk on Wolford Road is well north of Whitney Road (approximately 500 feet) on the east side of the street and that pedestrians were observed on the east side of the road during a field visit to the study area. This being the case, a new crosswalk across Whitney Road will be required west of Long Branch Creek. Given the limited sight distance and slope of the creek embankment, it is preferable to cross Whitney Road west of Wolford Road, and then cross the Wolford Road approach. This approach, used in both options, also allows for sidewalk connections to be made in the future on both sides of Wolford Road.

The primary features of Option 1 are right-turn channelizations (right turn bays) on the southbound and westbound approaches. Channelizing right turns provides increased capacity for the intersection, allowing the different turning movements for each approach to proceed unimpeded by each other. It also reduces the likelihood of some crashes occurring by reducing the probability of rear end crashes, and segregating movements with traffic islands. As a result of providing the westbound Whitney Road right turn channelization, the intersection was moved slightly to the west, so a reverse curve on the southbound Wolford Road approach was required. Approximately five feet of additional right-of-way on the west side of Wolford Road would also be required. The planning level cost estimate for Option 1 is $53,000.

Right-turn channelizations are not included in Option 2. However, this configuration allows southbound Wolford Road to approach Whitney Road at a right angle, without adding a reverse curve, and no additional right-of-way would be required. The planning level cost estimate for Option 2 is approximately $52,000, which is lower due to the need to construct less new pavement, although more existing pavement is being removed. A thirty percent contingency is included in these estimates. Unit cost information for these construction estimates was obtained from a County-provided bid submittal sheet for intersection improvements at Bellaire Road and Keene Road (Project code 000343A_1938). The FDOT's Master Pay Item List, as of March 6, 2012, was used if an item was not in the bid submittal sheet.



SYMBOL LEGEND

- PEDESTRAIN CROSSWALK STRIPING
- STOP BAR STRIPING
- EXISTING SIDEWALK
- PROPOSED SIDEWALK
- PROPOSED PEDESTRAIN BRIDGE
- EXISTING EDGE OF PAVEMENT
- PROPOSED EDGE OF PAVEMENT
- PROPOSED CURB
- PROPOSED ROW

STRIPING LEGEND

- (A) PAINTED PAV MRK–24" SLD WHITE
- (B) PAINTED PAV MRK–8" SLD WHITE
- (C) PAINTED PAV MRK–12" SLD WHITE
- (D) PAINTED PAV MRK–4" DBL SLD YELLOW
- (E) PAINTED PAV MRK – 4" SLD WHITE
- (F) REMOVE PAV MRK–4" SLD
- (G) REMOVE PAV MRK–4" DBL SLD
- (H) REMOVE PAV MRK–12" SLD
- (I) REMOVE PAV MRK–24" SLD

SIGNING LEGEND

- (R) REMOVE EXISTING SIGN
- (#) PROPOSED SIGN
- (E) EXISTING SIGN TO BE RELOCATED

SIGN LEGEND

2 — W11–2 (30 x 30") / W16–7P (24 x 12")

3 — YIELD — R1–2 (36 x 36 x 36")

4 — DO NOT ENTER — R5–1 36 x 36 x 36"

5 — STOP — R1–1 (30 x 30")

6 — W1–7 (48 x 24")

GRAPHIC SCALE
0 20 40 80
SCALE: 1" = 40'

N

LEGAL DISCLAIMER:
THIS PRODUCT IS FOR INFORMATIONAL PURPOSES ONLY AND MAY NOT HAVE BEEN PREPARED FOR OR BE SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES. IT DOES NOT REPRESENT AN ON–THE–GROUND SURVEY AND REPRESENTS ONLY THE APPROXIMATE RELATIVE LOCATION OF PROPERTY BOUNDARIES AND UTILITIES.

	BY	DATE	
			DESIGN SECTION
			DESIGNED
			DRAWN
			CHECKED

WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

WHITNEY AT WOLFORD INTERSECTION IMPROVEMENTS OPTION 1

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

OCT. 16, 2012
DATE

EXHIBIT:

SYMBOL LEGEND

- PEDESTRAIN CROSSWALK STRIPING
- STOP BAR STRIPING
- EXISTING SIDEWALK
- PROPOSED SIDEWALK
- PROPOSED PEDESTRAIN BRIDGE
- EXISTING EDGE OF PAVEMENT
- PROPOSED EDGE OF PAVEMENT
- PROPOSED CURB
- PROPOSED ROW

STRIPING LEGEND

- (A) PAINTED PAV MRK–24" SLD WHITE
- (B) PAINTED PAV MRK–8" SLD WHITE
- (C) PAINTED PAV MRK–12" SLD WHITE
- (D) PAINTED PAV MRK–4" DBL SLD YELLOW
- (E) PAINTED PAV MRK – 4" SLD WHITE
- (F) REMOVE PAV MRK–4" SLD
- (G) REMOVE PAV MRK–4" DBL SLD
- (H) REMOVE PAV MRK–12" SLD
- (I) REMOVE PAV MRK–24" SLD

SIGNING LEGEND

- (R) REMOVE EXISTING SIGN
- (#) PROPOSED SIGN
- (E) EXISTING SIGN TO BE RELOCATED

SIGN LEGEND

2 — W11–2 (30 x 30")
W16–7P (24 x 12")

3 — STOP
R1–1 (30 x 30")

4 — W1–7 (48 x 24")

GRAPHIC SCALE
0 20 40 80
SCALE: 1" = 40'

N

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	BY	DATE			
			DESIGN SECTION	.	.
			DESIGNED		
			DRAWN	.	.
			CHECKED	.	.

WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

WHITNEY AT WOLFORD INTERSECTION IMPROVEMENTS OPTION 2

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

OCT. 16, 2012
DATE

EXHIBIT:

3.1 Data Collection and Traffic Analysis Methodology

Traffic conditions were evaluated using 48-hour ADTs provided by the County and conducted on January 10-11, 2012. Volumes on January 10th were higher and used in the traffic analysis. Two analyses were performed: a Traffic Signal Warrant Analysis (TWSA) and intersection operational analysis. A TSWA uses procedures outlined in the 2009 Manual on Uniform Traffic Control Devices (MUTCD) to determine if a signal is warranted. The warrant procedures, along with engineering judgment, determine if a signal should be constructed at the intersection.

A detailed intersection operational analysis was performed using Synchro software. Synchro uses procedures outlined in the Highway Capacity Manual 2010 (HCM 2010) to determine meaningful measures of effectiveness (MOEs) concerning average vehicle delay and level-of-service (LOS). A general explanation of the concept of LOS is that it is similar to grades in school; "A" is the best, and "F" the worst. LOS D is considered acceptable for peak hour operations in urban areas and LOS C is generally considered acceptable for peak hour operations in rural areas. The borderline between LOS E and LOS F is considered the capacity for any intersection.

Delay for each approach is calculated based on a number of factors including: volume, lane geometrics, percentage of trucks, peak hour factor, number of lanes, signal operations, and pedestrian flow. The overall intersection LOS is computed as a weighted average of the control delay for each of the movements for signalized and all-way stop control. For two-way stop control, intersection LOS is determined by delay on the controlled approach. LOS breakpoints for unsignalized and signalized intersections are listed in Table 4 below.

Table 5 - LOS Criteria

	Control Delay (sec/veh)	
LOS	Unsignalized	Signalized
A	≤ 10	≤ 10
B	> 10 and ≤ 15	> 10 and ≤ 20
C	> 15 and ≤ 25	> 20 and ≤ 35
D	> 25 and ≤ 35	> 35 and ≤ 55
E	> 35 and ≤ 50	> 55 and ≤ 80
F	> 50	> 80

(source: HCM 2010)

3.2 Traffic Signal Warrant Analysis

A Traffic Signal Warrant Analysis (TSWA) was prepared for the intersection provides a list of signal warrants considered and results based on the day with higher traffic volumes (January 10, 2012).

Crash data was provided by the County for this study. While Warrant 7 (see Table 6) was not satisfied by the crash data, one accident may be susceptible to correction due a change in intersection configuration. During that accident, a vehicle on southbound Wolford Road approached at a high rate of speed. While making a wide right turn, it hit a vehicle in the northbound lane. A southbound channelized right turn may have prevented this accident.

Table 6 - TSWA Results

Warrant	Result
Warrant 1 - Eight Hour Vehicular Volumes	No
Warrant 2 - Four Hour Volumes	No
Warrant 3 - Peak Hour	No
Warrant 4 - Pedestrian Volumes	n/a
Warrant 5 - School Crossing	n/a
Warrant 6 - Coordinated Signal System	n/a
Warrant 7 - Crash Experience	No
Warrant 8 - Roadway Network	n/a
Warrant 9 – Intersection Near a Grade Crossing	n/a

Based upon these findings, a traffic signal is not warranted at the Whitney Road intersection with Wolford Road. The intersection did not meet any of the volume-related warrants (Warrants 1, 2, and 3). While pedestrian counts were not taken, Warrant 4 is likely not satisfied due to surrounding land use. Further, channelization of traffic to accommodate the turning movements during the peak hours of traffic will help forestall the need to signalize the intersection in the future. The remaining warrants are not applicable to this intersection.

3.3 Traffic Operations Analysis

Four scenarios were analyzed for AM and PM conditions:

- 2012 Existing
- 2017 No Build
- 2017 Option 1
- 2017 Option 2

Future year volumes were calculated with traffic growth rates (Table 7) from the travel demand model (TDM) provided by the County.

Table 7 - TDM Volumes & Growth Rates

Year	Direction	Road and Segment			
		Whitney	Whitney	Wolford	Whitney
		East of US 19	West of Wolford	At Whitney	East of Wolford
2006	1	3,402	1,831	835	2,463
	2	4,567	2,955	888	2,411
	Total	7,969	4,786	1,723	4,874
2035	1	4,109	3,124	2,402	5,086
	2	5,629	4,555	2,230	5,007
	Total	9,738	7,679	4,632	10,093
Annual Traffic Growth		0.7%	1.6%	3.5%	2.5%

Intersection delay (second per vehicle) and intersection LOS for all scenarios are listed in Table 8. Based on the volumes used for this study, traffic operation is satisfactory regardless of No Build, Option 1, or Option 2. Intersection delay is improved by both Build Options due free-flow operations. Intersection

LOS, which is determined by only the stop-controlled approaches, declines to LOS C during the AM due to the need for the approach volume on Wolford Road to secure acceptable gaps in the Whitney Road traffic. Lower intersection delay for both peak hours in Option 1 relative to Option 2 is caused by the right-turn channelization. Based on the results in Table 8, lower overall intersection delays are achieved with two-way stop control without causing significant delay to Wolford Road. Detailed Synchro results are in Appendix C.

Table 8 - LOS Results

	AM		PM	
Condition	**Int. Delay**	**LOS**	**Int. Delay**	**LOS**
2012 Existing	10.6	B	10.5	B
2017 No Build	11.8	B	11.6	B
2017 Build Option 1	7.8	C	4.1	B
2017 Build Option 2	10.8	C	5.3	C

3.4 Drainage and Habitat

The drainage ditch on the south side of Whitney Road near the intersection with Wolford Road is approximately six feet deep with an average top width of 23 feet, and has side slopes of 0.5:1 - 1:1 (rise to run). It lies eight feet from the eastern edge of pavement line inside of a 68 foot right of way. To prevent an impact to the receiving channel of the Whitney Road Ditch, a grassed swale is proposed to be constructed above the box culverts. An eight-foot wide shoulder will be provided. These proposed improvements will start approximately 200 feet east of Long Branch Lane and are proposed to terminate at the 48" outfall at Long Branch Creek. Final design of these improvements will require Stormwater Pollution Prevention Plans (SWPPP), Erosion Control Plans, and potentially a NPDES (National Pollution Discharge Elimination System) permit.

A habitat assessment of the project study area was conducted by an Earth Resources environmental scientist on January 5, 2012. The purpose of the assessment was to delineate the jurisdictional boundaries of wetlands and surface waters within the project area in accordance with state and federal rules, describe the habitats as well as determine the presence of state or federally protected species or their habitat. The Habitat assessment memo may be found in Appendix B of the Whitney Road Drainage and Safety Enhancements Preliminary Design Memorandum, March 2012. The habitat assessment memorandum recommends that non-native plant species be removed reasonably in accordance with Chapter 166-53 of the Pinellas County Land Development Code. ERI will assist the project team in the environmental portions of submittals to the US Army Corps of Engineers (ACOE) and SWFWMD.

3.5 Right-of-Way Needs and Utilities

Parcel lines provided by the County depict property lines approximately four feet north of the existing edge of pavement. Insufficient ROW on the north side would require Whitney Road be moved to accommodate a sidewalk. Whitney Road is only 20 feet wide, thus any changes to the roadway should also widen the typical section to 22 feet. A six-foot wide sidewalk is proposed because there is not a buffer between the sidewalk and curb. The new typical section would include a 22' roadway, 1' curb, and 6' sidewalk. To accommodate this typical section, it is recommended that the shoulder be reduced to six feet wide and acquisition of an additional three feet to the north. Property impacts should be limited to the relocation of mail boxes.

At the Whitney Road/Wolford Road intersection, Option 1 requires approximately 7.5 feet of ROW to the west of Wolford Road to accommodate the sidewalk and southbound right turn channelization. Total additional ROW required is approximately 1,150 sf. Option 2 does not require any ROW acquisition.

Cost estimates do not include utility impacts and relocation. Potential utility impacts for each intersection option are listed in Table 9. Impacts to sanitary sewer and water lines are presumed to be limited to adjustment of manholes and covers.

Table 9 - Intersection Options Utility Assessment

Intersection Alternative	Nearby Utilities - Potential Impacts in BOLD
Option 1	OH Cable - Bright House OH Electric - Progress Energy **UG Telephone - Verizon** OH Coaxial - Knology Broadband OH Fiber Optic - Knology Broadband **Sewer (30") - City of Largo** **Sewer (18") - City of Largo** **2x Water (8") - City of Largo**
Option 2	OH Cable - Bright House OH Electric - Progress Energy **UG Telephone - Verizon** **Sewer (30") - City of Largo** **Sewer (18") - City of Largo** **2x Water (8") - City of Largo**

3.6 Recommended Alternative

Option 1 is the recommended alternative. Capacity is enhanced relative to Option 2 by allowing right turning and left turning vehicles to approach the intersection simultaneously for the westbound and southbound directions. Resulting overall intersection delays are also better for Option 1 than both the existing condition and Option 2. Lastly, though the sample size was too small to determine trends in the crash data, one of the two reported crashes was of a type that may benefit from the Option 1 improvements. Although ROW is needed, and the construction costs are expected to be slightly higher, mainly due to additional pavement requirements, the cost differential is less than 2% of the overall project ($248,000 vs. $247,000).

4.0 CONCLUSIONS AND RECOMMENDATIONS

Existing sidewalks between US 19 and Sapphire Lane are adequate. Almost all curb ramps require installation of a detectable surface to meet ADA requirements, but the curb ramps are otherwise in acceptable condition. Most bus stops within the corridor do not provide full access amenities to PSTA bus patrons – defined here as a pole marking the stop, sidewalk access, and pad to edge of pavement. Of the 12 bus stops within the study area, only four provide full access amenities to bus patrons. Ten of the 12 PSTA bus stops will have full access amenities after recommended improvements are constructed. The two bus stops without full access amenities, the eastbound stops at Aaron Drive and Oak Street North, do not have the space to construct additional sidewalks due to the proximity of the Whitney Road drainage ditch.

Table 10 - PSTA Bus Stop Improvements

Stop	Direction	Improvement	Existing	Proposed
US 19	WB	None	Y	Y
US 19	EB	Extend sidewalk from US 19	N	Y
Dodge Circle	WB	Build pad at edge of pavement	N	Y
Aaron Drive	EB	None	N	N
Levine Lane	WB	None	Y	Y
West Levine Lane	EB	None	Y	Y
West of Brookstone	WB	None	Y	Y
62nd Street North	EB	None	N	N
Oak Street North	WB	Add Pole	N	Y
Long Branch Lane	EB	Extend Long Branch Lane sidewalks, relocate stop	N	Y
166th Avenue North	EB	Extend sidewalk from 166th Avenue North	N	Y
Hidden Springs Place	WB	Build pad at edge of pavement	N	Y

It is recommended that the County construct additional sidewalk on the north side of Whitney Road between Sapphire Lane and Wolford Road. The existing sidewalk south of the drainage ditch from Long Branch Lane to the private driveway at the Whitney Road and Wolford Road intersection is not adequate. Obscured from the roadway by trees, it is not illuminated and thus would not be a recommended pedestrian route for safety reasons. Proposed sidewalk improvements require reducing the proposed shoulder to six-feet wide, realigning and moving Whitney Road to the south, and constructing a curb on the north side of Whitney Road. Additionally, Whitney Road should be restriped to the proposed 22-feet wide section.

There does not appear to be sufficient width on the culvert to construct a six-foot sidewalk between edge of pavement and the guardrail. Additionally, one of the inlets will have to be adjusted to accommodate a potential sidewalk. A new pedestrian bridge south of Whitney Road is recommended to carry pedestrian traffic across Long Branch Creek. Pedestrians would be able to access 166th Avenue North in the Greenbrook Estates subdivision, or continue along Whitney Road via a new crosswalk east of 166th Avenue North. A pedestrian bridge is recommended instead of a sidewalk adjacent to crossing on the southern side.

With regard to the studied intersection improvements, Option 1 is the recommended alternative. While Option 1 requires right-of-way (ROW) and Option 2 does not, and Option 1 is slightly more expensive,

Option 1 provides a greater reduction in overall intersection delay while also increasing intersection capacity (via the channelization included in Option 1). Additionally, in terms of crash history, one of the two incidents reported over the three year period may have benefited from the Option 1 channelized right turn movements. However, the overall number of crashes is too small to establish a conclusive trend in this regard.

Implementing the preferred two-way stop control configuration of the intersection will also require clearing 0.1 acres of vegetation north of Whitney Road for adequate intersection sight distance and approximately five feet of ROW west of Wolford Road to accommodate the sidewalk and southbound right turn channelization. Clearing the vegetation is crucial in providing clear lines of sight, if the vegetation is not cleared, the intersection should remain with all-way stop control due inadequate sight distance.

References

1. *Highway Capacity Manual 2010*, Transportation Research Board, National Research Council, Washington D.C., 2010.

Appendix A

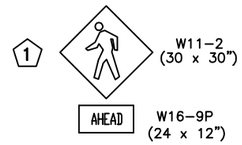
Plan Sheets

STRIPING LEGEND

- (A) PAINTED PAV MRK–24" SLD WHITE
- (B) PAINTED PAV MRK–8" SLD WHITE
- (C) PAINTED PAV MRK–12" SLD WHITE
- (D) PAINTED PAV MRK–4" DBL SLD YELLOW
- (E) PAINTED PAV MRK – 4" SLD WHITE
- (F) REMOVE PAV MRK–4" SLD
- (G) REMOVE PAV MRK–4" DBL SLD
- (H) REMOVE PAV MRK–12" SLD
- (I) REMOVE PAV MRK–24" SLD

SIGNING LEGEND

- (R) REMOVE EXISTING SIGN
- (#) PROPOSED SIGN
- (E) EXISTING SIGN TO BE RELOCATED



GRAPHIC SCALE

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SCALE: 1" = 40'

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	BY	DATE			
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WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

SIDEWALK IMPROVEMENTS

US 19 TO WHITNEY WAY

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

MAY 1, 2012
DATE

EXHIBIT:

STRIPING LEGEND

- (A) PAINTED PAV MRK–24" SLD WHITE
- (B) PAINTED PAV MRK–8" SLD WHITE
- (C) PAINTED PAV MRK–12" SLD WHITE
- (D) PAINTED PAV MRK–4" DBL SLD YELLOW
- (E) PAINTED PAV MRK – 4" SLD WHITE
- (F) REMOVE PAV MRK–4" SLD
- (G) REMOVE PAV MRK–4" DBL SLD
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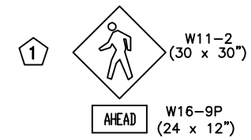

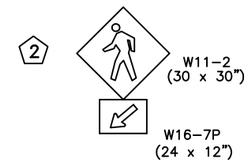

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WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

SIDEWALK IMPROVEMENTS DODGE ST. TO LEVINE LN.

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

MAY 1, 2012
DATE

EXHIBIT:

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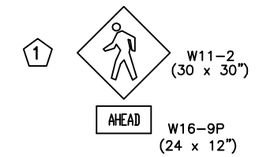

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WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

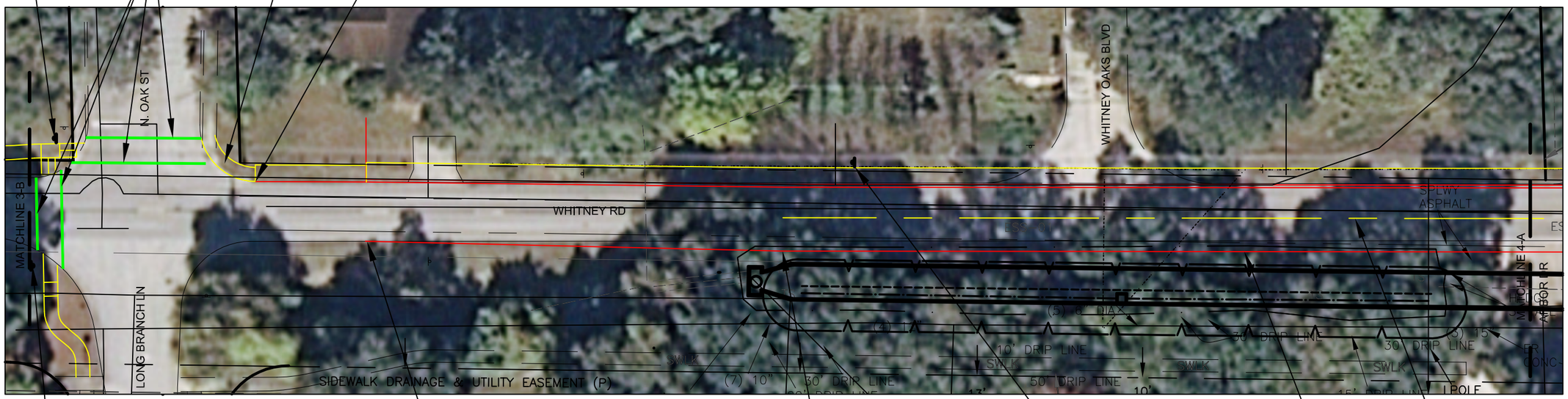
SIDEWALK IMPROVEMENTS

LEVINE LN. TO LONG BRANCH LN.

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

MAY 1, 2012
DATE

EXHIBIT:



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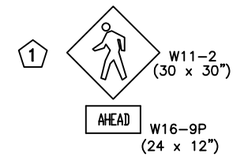

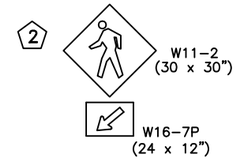

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WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

SIDEWALK IMPROVEMENTS

LONG BRANCH LN. TO 166TH AVE. N.

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

MAY 1, 2012
DATE

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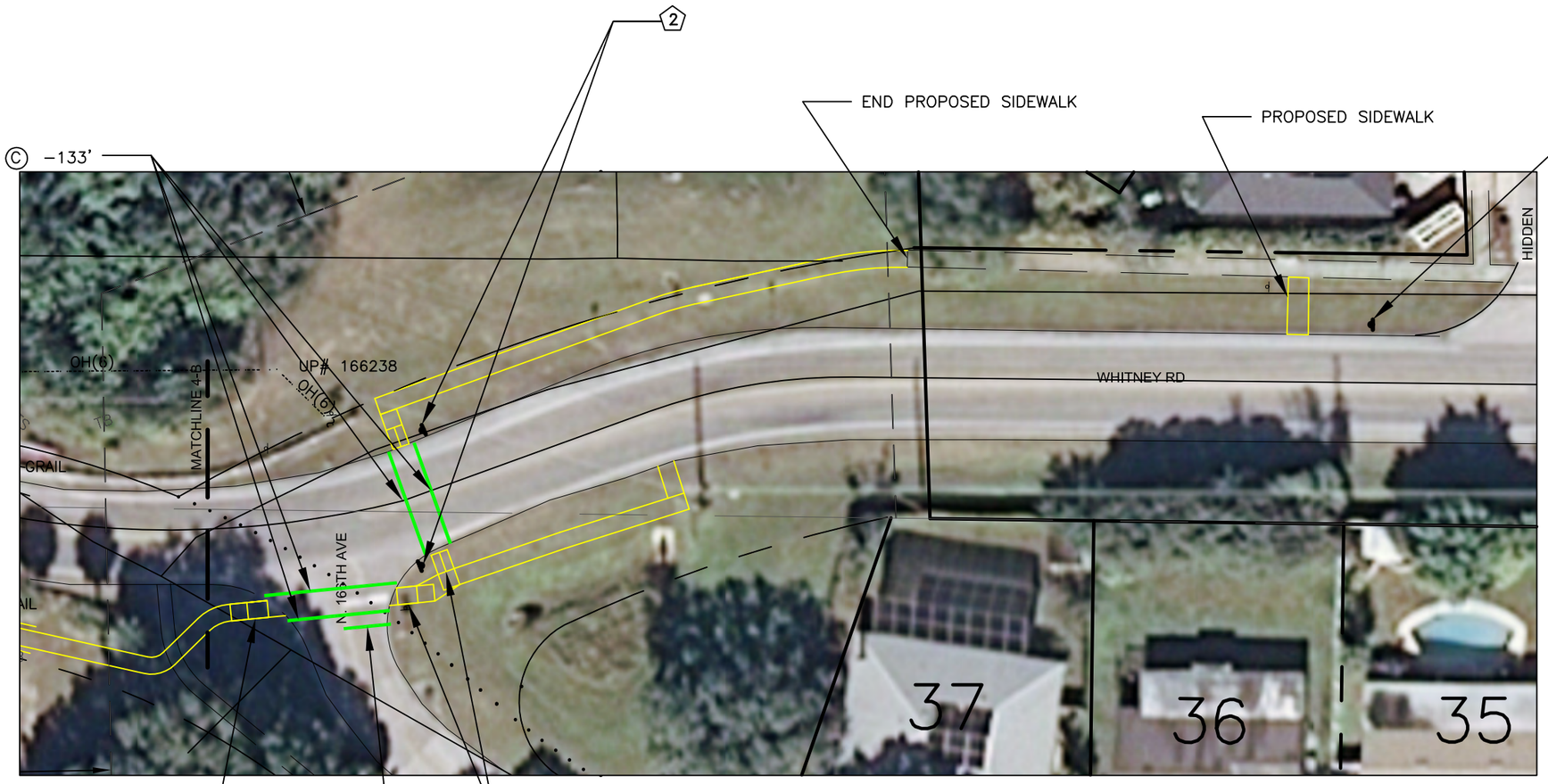

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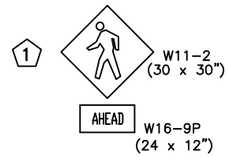

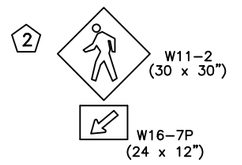

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WHITNEY ROAD SIDEWALK AND INTERSECTION IMPROVEMENTS

SIDEWALK IMPROVEMENTS

166TH AVE. N. TO END

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

MAY 1, 2012
DATE

EXHIBIT:

Appendix B

Cost Estimate

Whitney Road Sidewalk and Intersection Evaluation
Planning Level Cost Estimates
Prepared 8/22/12

ITEM	Pinellas County Pay Item Number	FDOT Item Number	Item Description	Unit Price*	UNITS	Sidewalk Improvements by Sheet						Intersection Alternatives			
						SW1	SW2	SW3	SW4	SW5	Sidewalk Cost	OPTION 1	Option 1 Cost	OPTION 2	Option 2 Cost
CLEARING & GRUBBING		0110 1 1	REMOVE TREE	$500.00	EA	0	0	0	0	0	$0	5	$2,500	5	$2,500
REMOVE PAVEMENT		0110 4	REMOVAL OF EXISTING CONCRETE PAVEMENT	$15.00	SY	0	0	0	106	0	$1,587	70	$1,050	400	$6,000
PROPOSED PAVEMENT		0350 2 3	CEMENT CONC PAVT REINFORCED, 8"	$109.00	SY	0	0	0	0	0	$0	156	$17,004	103	$11,227
PROPOSED SIDEWALK		0522 1	SIDEWALK CONCRETE, 4" THICK	$26.00	SY	90	37	116	478	169	$23,154	240	$6,240	240	$6,240
REMOVE SIGN		0700 48 60	SIGN PANELS, REMOVE	$40.00	EA	0	0	0	0	0	$0	5	$200	5	$200
RELOCATE EXISTING SIGN		0700 48 48	SIGN PANELS RELOCATE, 15 OR <	$136.00	EA	2	0	0	0	0	$272	0	$0	0	$0
ADD SIGN		0700 20 11	SINGLE POST SIGN, F&I, LESS THAN 12 SF	$200.00	EA	1	3	1	3	3	$2,200	7	$1,400	3	$600
ADD TACTILE SURFACE		0527 1	DETECTABLE WARNING ON EXISTING WALKING SURFACE, RETROFIT	$330.00	EA	6	6	3	0	0	$4,950	0	$0	0	$0
PROPOSED CURB		0520 1 7	CONCRETE CURB & GUTTER, TYPE E	$11.00	LF	0	37	0	636	0	$7,403	659	$7,249	509	$5,599
PAINTED PAV MRK - 6" SLD WHITE	710-11-121		PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, SOLID, 6"	$0.15	LF	0	0	0	1,058	0	$159	0	$0	0	$0
PAINTED PAV MRK - 6" DBL SLD YELLOW		0710 11211	PAINTED PAVEMENT MARKINGS, STANDARD, YELLOW, DOUBLE SOLID, 6"	$0.30	LF	0	0	0	436	0	$131	500	$150	394	$118
PAINTED PAV MRK - 12" SLD WHITE	710-11-123		PAINTED PAVEMENT MARKING, STD, WHITE, SOLID, 24"	$0.60	LF	182	162	191	154	133	$493	158	$95	119	$71
PAINTED PAV MRK - 24" SLD WHITE	710-11-125		PAINTED PAVEMENT MARKING, STD, WHITE, SOLID, 12"	$1.40	LF	0	0	0	0	24	$34	151	$211	111	$155
RIPRAP, RUBBLE, W/FILTER FABRIC	530-2200		RIPRAP, RUBBLE, W/FILTER FABRIC	$215.00	TON	0	0	0	2	0	$430				
SODDING, ST. AUGUSTINE	575-0112		SODDING, ST. AUGUSTINE	$5.50	SY	68	18	80	193	132	$2,701	128	$704	275	$1,513
TURBIDITY BARRIER, FLOATING	104-16		TURBIDITY BARRIER, FLOATING	$6.30	LF	0	0	0	100	0	$630	0	$0	0	$0
FENCE, STAKED SILT, FDOT TYPE III	104-18		FENCE, STAKED SILT, FDOT TYPE III	$0.70	LF	170	80	170	678	300	$979	558	$391	577	$404
		0400 2 5	CONCRETE CLASS II, SUBSTRUCTURE	$630.00	CY	0	0	0	8	0	$5,103		$0		$0
		0425 11	MOVE DRAINAGE STRUCTURE	$1,786.00	EA	0	0	0	0	0	$0	0	$0	1	$1,786
REMOVAL OF EXISTING CONCRETE PAVE		0110 4	REMOVE SIDEWALK	$15.00	SY	0	0	0	25	0	$378	0	$0	0	$0
PEDESTRIAN BRIDGE			PEDESTRIAN BRIDGE	$1,200.00	LF	0	0	0	72	0	$86,400	0	$0	0	$0
SUBTOTAL			SUBTOTAL								$137,003		$37,194		$36,413
MOBILIZATION	101-0100		MOBILIZATION	10%	LS						$13,700		$3,719		$3,641
MAINTENANCE OF TRAFFIC	102-1000		MAINTENANCE OF TRAFFIC	2.5%	LS						$3,425		$930		$910
Contingency - 30%			CONTINGENCY - 30%	30%							$41,000		$11,000		$11,000
TOTAL			TOTAL								$195,128		$52,843		$51,965
ROUNDED TO THE NEAREST THOUSAND TOTAL COST BY ALTERNATIVE (COMBINED SIDEWALK/BRIDGE AND ROADWAY ELEMENTS)													$248,000		$247,000

* Sources:
Pinellas County Pay Items furnished for Project Code 000343A_1938 with Bid Open Date 5/15/12

Appendix C

Traffic Signal Warrant Analysis Procedures

(source: 2009 MUTCD)

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

01 **An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.**

02 **The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:**

Warrant 1, Eight-Hour Vehicular Volume
Warrant 2, Four-Hour Vehicular Volume
Warrant 3, Peak Hour
Warrant 4, Pedestrian Volume
Warrant 5, School Crossing
Warrant 6, Coordinated Signal System
Warrant 7, Crash Experience
Warrant 8, Roadway Network
Warrant 9, Intersection Near a Grade Crossing

03 **The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.**

Support:

04 Sections 8C.09 and 8C.10 contain information regarding the use of traffic control signals instead of gates and/or flashing-light signals at highway-rail grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

05 *A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.*

06 *A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.*

07 *A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.*

08 *The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed in Paragraph 2.*

09 *Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether an approach is considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.*

10 *Similar engineering judgment and rationale should be applied to a street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.*

11 *At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.*

12 *For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, should be considered as one intersection.*

Option:

13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

14 For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four sequential 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific one-hour periods.

15 For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

16 When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

17 Engineering study data may include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

18 The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of Paragraph 17:

A. Vehicle-hours of stopped time delay determined separately for each approach.
B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

01 The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

02 The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

03 It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

Standard:

04 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:**

A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or

B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option:

05 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

06 *The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.*

Standard:

07 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:**

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and

B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume

[b] Used for combination of Conditions A and B after adequate trial of other remedial measures

[c] May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Option:

08 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

01 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.**

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

Section 4C.04 Warrant 3, Peak Hour

Support:

01 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

02 **This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.**

03 **The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:**

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and

2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and

3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.

Option:

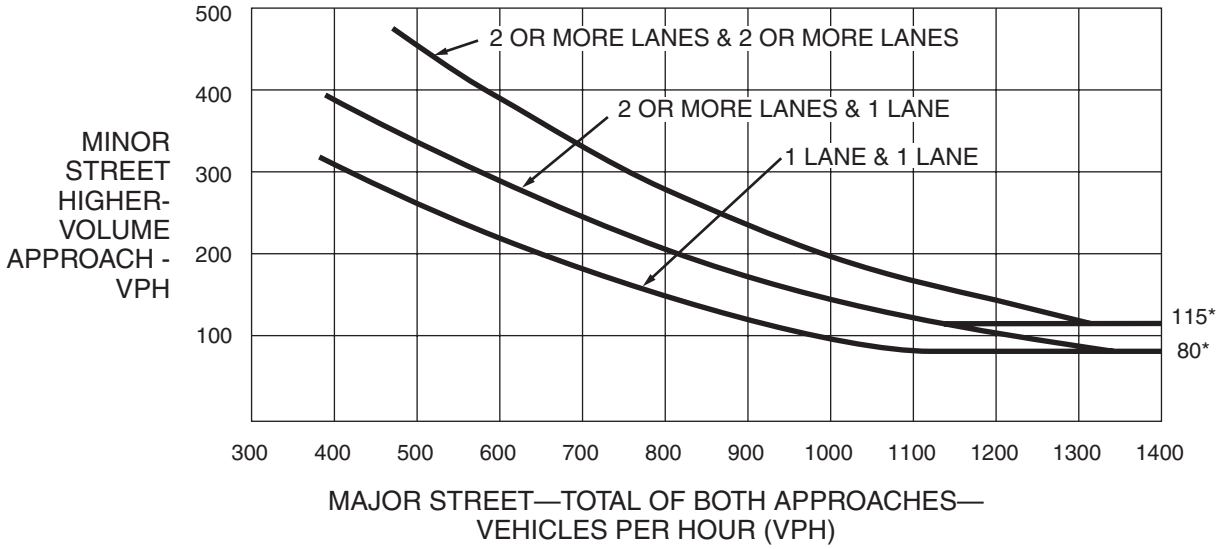
04 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to evaluate the criteria in the second category of the Standard.

05 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of this warrant are not met.

Guidance:

06 *If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.*

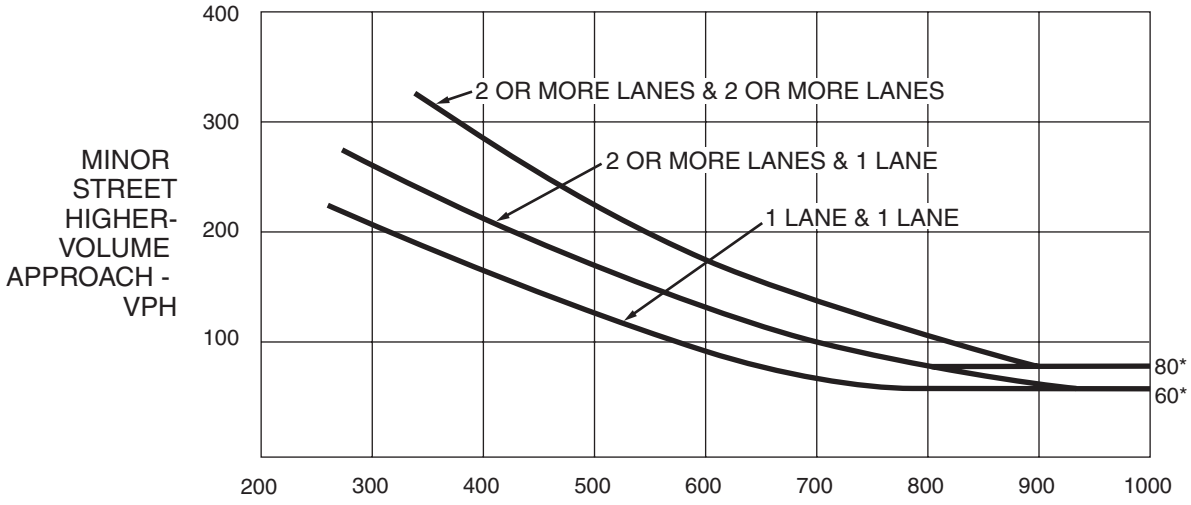
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

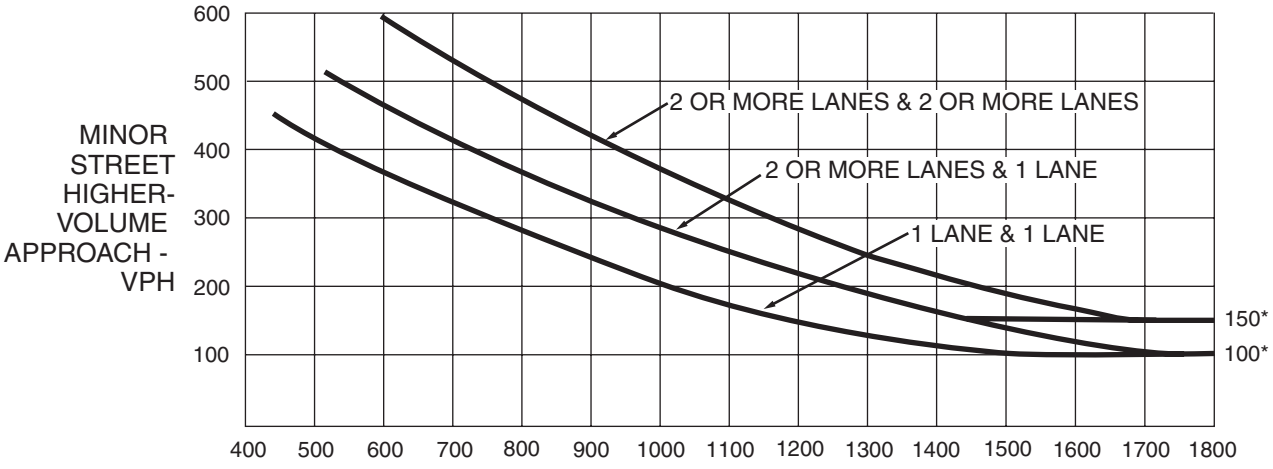
Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

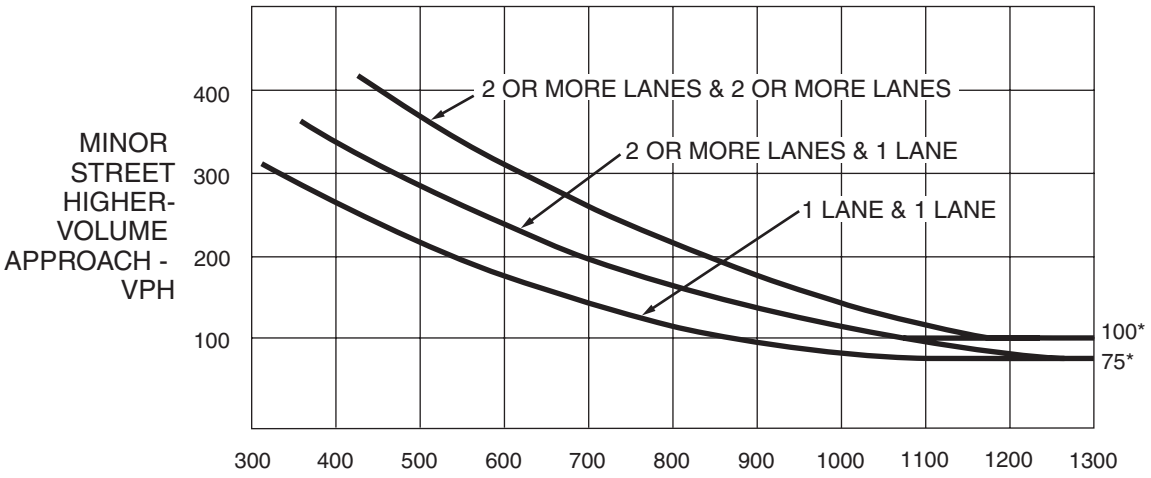
Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

01 The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

02 **The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that one of the following criteria is met:**

- **A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or**
- **B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 4C-7.**

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-6 may be used in place of Figure 4C-5 to evaluate Criterion A in Paragraph 2, and Figure 4C-8 may be used in place of Figure 4C-7 to evaluate Criterion B in Paragraph 2.

Standard:

04 **The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

05 **If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in Chapter 4E.**

Guidance:

06 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

- *A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
- *B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.*
- *C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.*

Option:

07 The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

08 A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street.

Section 4C.06 Warrant 5, School Crossing

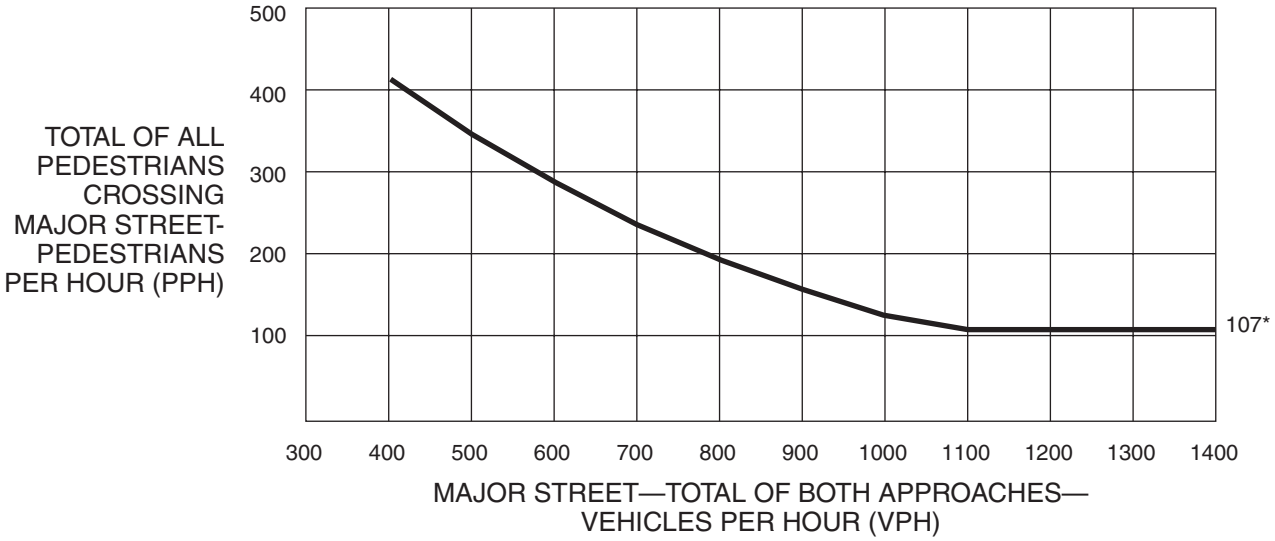
Support:

01 The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word “schoolchildren” includes elementary through high school students.

Standard:

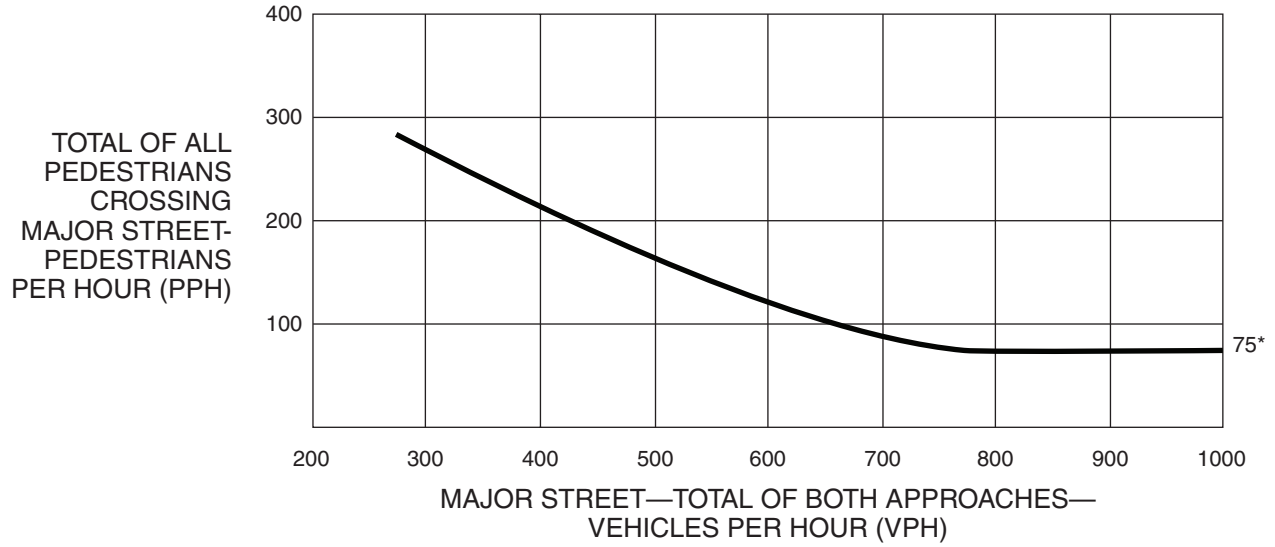
02 **The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 schoolchildren during the highest crossing hour.**

Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



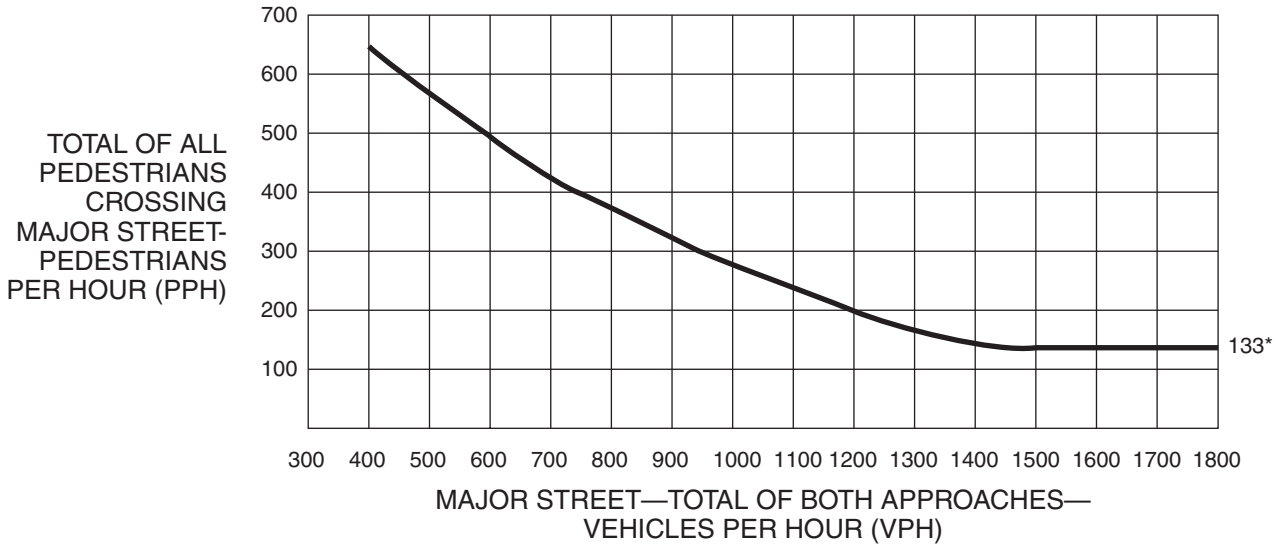
*Note: 107 pph applies as the lower threshold volume.

Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)



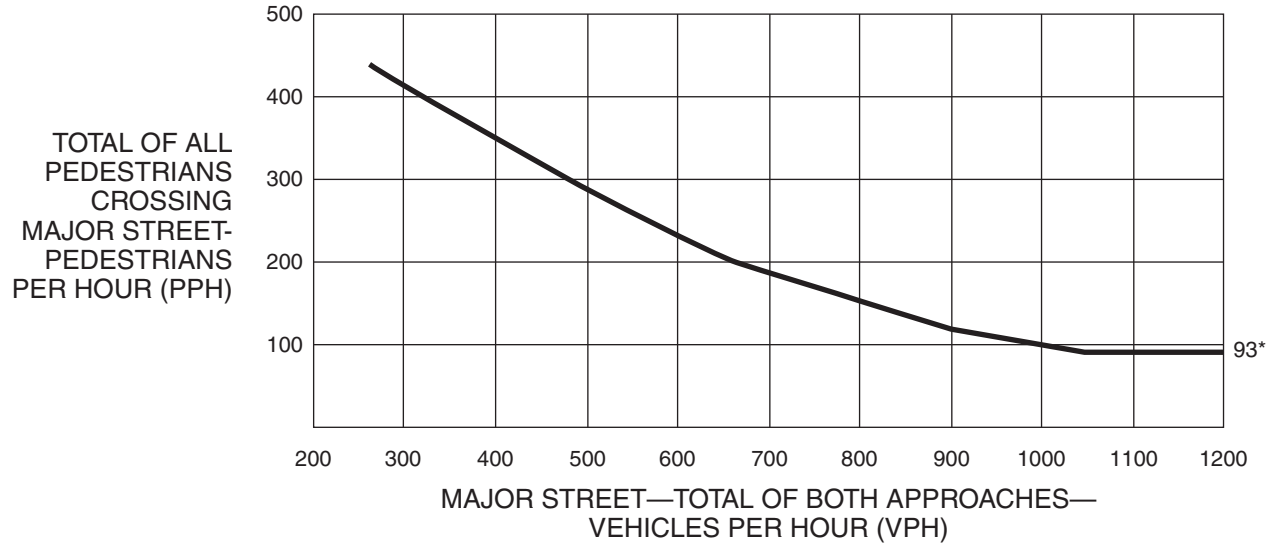
*Note: 75 pph applies as the lower threshold volume.

Figure 4C-7. Warrant 4, Pedestrian Peak Hour



*Note: 133 pph applies as the lower threshold volume.

Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)



*Note: 93 pph applies as the lower threshold volume.

03 **Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.**

04 **The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

Guidance:

05 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.

B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

01 Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:**

A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.

B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

Guidance:

03 *The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.*

Section 4C.08 Warrant 7, Crash Experience

Support:

01 The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:**

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and

B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and

C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network

Support:

01 Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:**

- **A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or**
- **B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).**

03 **A major route as used in this signal warrant shall have at least one of the following characteristics:**

- **A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.**
- **B. It includes rural or suburban highways outside, entering, or traversing a city.**
- **C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.**

Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

Support:

01 The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

Guidance:

02 *This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:*

- *A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or*
- *B. Reassigning the stop controls at the intersection to make the approach across the track a non-stopping approach.*

Standard:

03 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:**

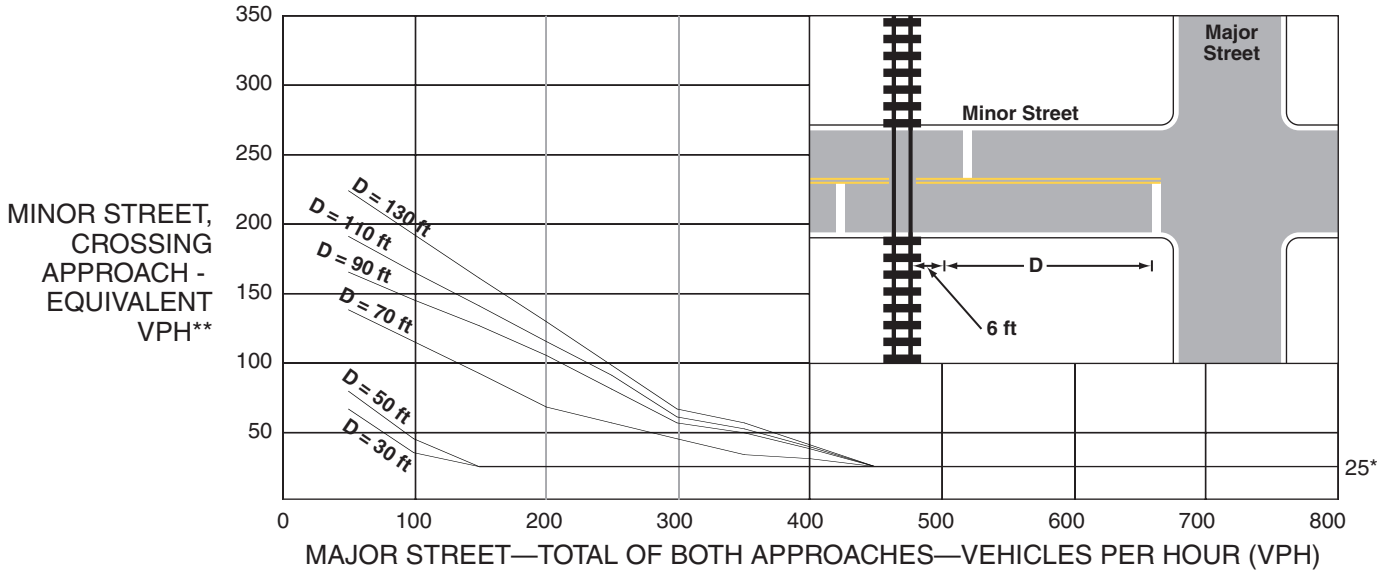
- **A. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and**
- **B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13.**

Guidance:

04 *The following considerations apply when plotting the traffic volume data on Figure 4C-9 or 4C-10:*

- *A. Figure 4C-9 should be used if there is only one lane approaching the intersection at the track crossing location and Figure 4C-10 should be used if there are two or more lanes approaching the intersection at the track crossing location.*

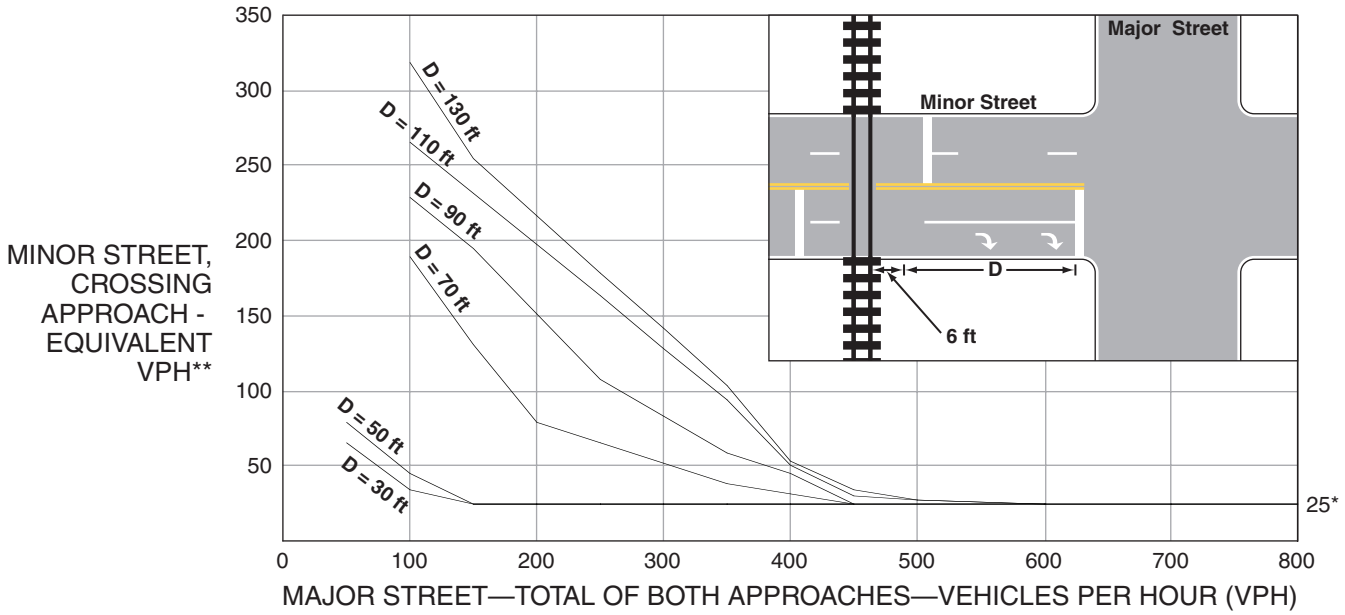
Figure 4C-9. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

B. After determining the actual distance D, the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for D = 90 feet.

C. If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.

Option:

05 The minor-street approach volume may be multiplied by up to three adjustment factors as provided in Paragraphs 6 through 8.

06 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-2 for the appropriate number of occurrences of rail traffic per day.

07 Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-3 for the appropriate percentage of high-occupancy buses.

08 Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-4 for the appropriate distance and percentage of tractor-trailer trucks.

Standard:

09 **If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, then:**

A. The traffic control signal shall have actuation on the minor street;

B. Preemption control shall be provided in accordance with Sections 4D.27, 8C.09, and 8C.10; and

C. The grade crossing shall have flashing-light signals (see Chapter 8C).

Guidance:

10 *If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, the grade crossing should have automatic gates (see Chapter 8C).*

Table 4C-2. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

Table 4C-3. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses

% of High-Occupancy Buses* on Minor-Street Approach	Adjustment Factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32

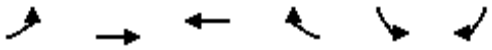
* A high-occupancy bus is defined as a bus occupied by at least 20 people.

Table 4C-4. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of Tractor-Trailer Trucks on Minor-Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.6% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

Appendix D

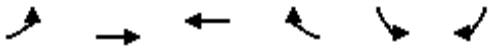
Synchro Results



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Stop	Stop		Stop	
Volume (vph)	87	120	124	61	183	91
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	95	130	135	66	199	99

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total (vph)	225	201	298
Volume Left (vph)	95	0	199
Volume Right (vph)	0	66	99
Hadj (s)	0.12	-0.16	-0.03
Departure Headway (s)	5.1	4.8	4.9
Degree Utilization, x	0.32	0.27	0.41
Capacity (veh/h)	666	694	690
Control Delay (s)	10.4	9.6	11.3
Approach Delay (s)	10.4	9.6	11.3
Approach LOS	B	A	B

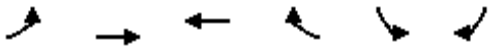
Intersection Summary			
Delay	10.6		
HCM Level of Service	B		
Intersection Capacity Utilization	47.1%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Stop	Stop		Stop	
Volume (vph)	105	141	129	195	70	100
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	114	153	140	212	76	109

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total (vph)	267	352	185
Volume Left (vph)	114	0	76
Volume Right (vph)	0	212	109
Hadj (s)	0.12	-0.33	-0.24
Departure Headway (s)	4.9	4.4	5.1
Degree Utilization, x	0.37	0.43	0.26
Capacity (veh/h)	693	779	637
Control Delay (s)	10.7	10.7	9.9
Approach Delay (s)	10.7	10.7	9.9
Approach LOS	B	B	A

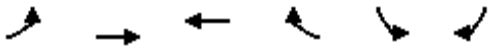
Intersection Summary			
Delay	10.5		
HCM Level of Service	B		
Intersection Capacity Utilization	52.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Stop	Stop		Stop	
Volume (vph)	87	120	124	61	183	91
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	102	141	152	75	237	118

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total (vph)	243	227	354
Volume Left (vph)	102	0	237
Volume Right (vph)	0	75	118
Hadj (s)	0.12	-0.16	-0.03
Departure Headway (s)	5.3	5.1	5.1
Degree Utilization, x	0.36	0.32	0.50
Capacity (veh/h)	634	661	665
Control Delay (s)	11.3	10.4	13.0
Approach Delay (s)	11.3	10.4	13.0
Approach LOS	B	B	B

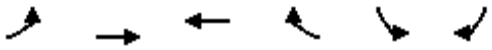
Intersection Summary			
Delay	11.8		
HCM Level of Service	B		
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Stop	Stop		Stop	
Volume (vph)	105	141	129	195	70	100
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	123	166	158	240	90	128

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total (vph)	289	398	218
Volume Left (vph)	123	0	90
Volume Right (vph)	0	240	128
Hadj (s)	0.12	-0.33	-0.24
Departure Headway (s)	5.1	4.6	5.3
Degree Utilization, x	0.41	0.51	0.32
Capacity (veh/h)	666	753	614
Control Delay (s)	11.6	12.2	10.7
Approach Delay (s)	11.6	12.2	10.7
Approach LOS	B	B	B

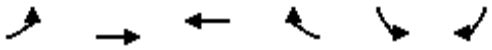
Intersection Summary			
Delay	11.6		
HCM Level of Service	B		
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	87	120	124	61	183	91
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	102	141	152	75	237	118
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	152				497	152
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	152				497	152
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	93				52	87
cM capacity (veh/h)	1428				494	894

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	243	152	75	354
Volume Left	102	0	0	237
Volume Right	0	0	75	118
cSH	1428	1700	1700	740
Volume to Capacity	0.07	0.09	0.04	0.48
Queue Length 95th (ft)	6	0	0	65
Control Delay (s)	3.6	0.0	0.0	15.8
Lane LOS	A			C
Approach Delay (s)	3.6	0.0		15.8
Approach LOS				C

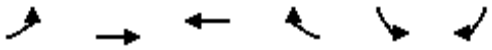
Intersection Summary			
Average Delay	7.8		
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	105	141	129	195	70	100
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	123	166	158	240	90	128
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	158				570	158
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	158				570	158
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	91				80	86
cM capacity (veh/h)	1421				441	887

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	289	158	240	218
Volume Left	123	0	0	90
Volume Right	0	0	240	128
cSH	1421	1700	1700	1070
Volume to Capacity	0.09	0.09	0.14	0.20
Queue Length 95th (ft)	7	0	0	19
Control Delay (s)	3.7	0.0	0.0	12.0
Lane LOS	A			B
Approach Delay (s)	3.7	0.0		12.0
Approach LOS				B

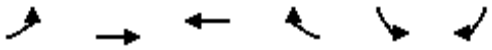
Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	36.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	87	120	124	61	183	91
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	102	141	152	75	237	118
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	227				535	190
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	227				535	190
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	92				49	86
cM capacity (veh/h)	1341				468	852

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	243	227	354
Volume Left	102	0	237
Volume Right	0	75	118
cSH	1341	1700	550
Volume to Capacity	0.08	0.13	0.64
Queue Length 95th (ft)	6	0	114
Control Delay (s)	3.7	0.0	22.6
Lane LOS	A		C
Approach Delay (s)	3.7	0.0	22.6
Approach LOS			C

Intersection Summary			
Average Delay	10.8		
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	105	141	129	195	70	100
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	123	166	158	240	90	128
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	398				690	278
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	398				690	278
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	89				76	83
cM capacity (veh/h)	1161				367	761

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	289	398	218
Volume Left	123	0	90
Volume Right	0	240	128
cSH	1161	1700	528
Volume to Capacity	0.11	0.23	0.41
Queue Length 95th (ft)	9	0	50
Control Delay (s)	4.2	0.0	16.5
Lane LOS	A		C
Approach Delay (s)	4.2	0.0	16.5
Approach LOS			C

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		