

4.6.2 Pedestrian and Bicycle Traffic Volumes

As presented in an earlier section, crosswalks are provided at mid-block crossings, signalized intersections, unsignalized intersections and at major driveways.

Pedestrian and bicycle counts were collected over a three-day period (from 7:00 to 9:00 AM and 4:00 to 6:00 PM) along the corridor at **mid-block crosswalk** crossing locations as well as five (5) non-crosswalk locations provided by Orange County. The highest set of pedestrian and bicycle volumes for mid-block crossings were observed at the non-crosswalk crossings approximately 335 feet north of Fir Drive adjacent to the Nature's Own Bakery Outlet store driveway. The observed counts were consistently high during all the count periods. The second highest set of pedestrian and bicycle volumes were observed to occur at the existing crosswalk located approximately 160 feet north of Figwood Lane. Again, the observed counts were consistent during the AM peak period but higher during the PM peak period.

Pedestrian and bicycle counts were collected at **signalized intersections** during the 7:00-9:00 AM, 11:00 AM -1:00 PM mid-day, 2:00-4:00 PM school and 4:00-6:00 PM peak periods. At the signalized intersections along the study area, the highest pedestrian and bicycle traffic volumes were observed at two intersections, Silver Star Road (SR 438) and Belco Drive, with the highest counts occurring during the Mid-Day and School peak periods. It should be noted that Evans High School is located just east of Belco Drive.

Pedestrian and bicycle counts were also collected at **unsignalized intersections** during 7:00-9:00 AM, 11:00 AM -1:00 PM mid-day and 4:00-6:00 PM peak periods. At the unsignalized intersections along the study area, the highest pedestrian and bicycle traffic volumes were observed at the intersection of Spring Hill Drive, which is located just north of Belco Drive. The highest counts occurring during the AM and PM peak periods. It should be noted that Evans High School is located just southeast of Spring Hill Drive.

Major driveway pedestrian and bicycle counts were collected for the AM period (7:00 to 9:00) and PM period (4:00 to 6:00) for pedestrians and bicyclists crossing each driveway at six of major driveway locations on Pine Hills Road. The peak-hour major driveway pedestrian and bicycle counts which were observed in the PM period at Faith Christian Center Church (22 pedestrian/bicycle crossings).

Figure 4.9 illustrate the pedestrian and bicycle counts at mid-block crossings, signalized intersections, unsignalized intersections, and driveways during the peak hour for each of the AM, mid-day, PM, and in certain instances, school hours.

More details on pedestrian and bicycle count information can be found in *Technical Memorandum No. 3—Existing Conditions* (see **Appendix C**).

Figure 4.9: Pedestrian and Bicycle Movement Counts



Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

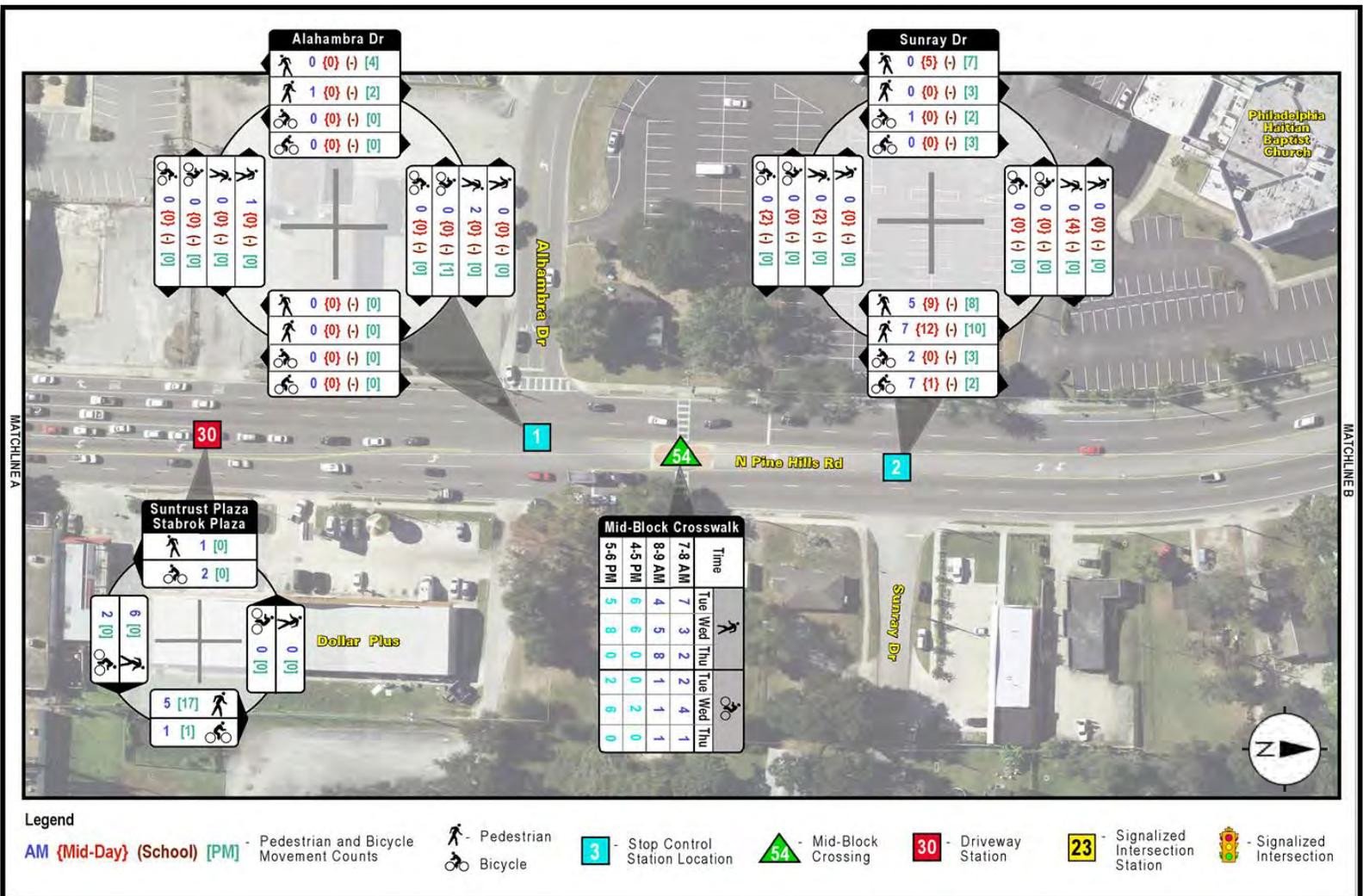


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

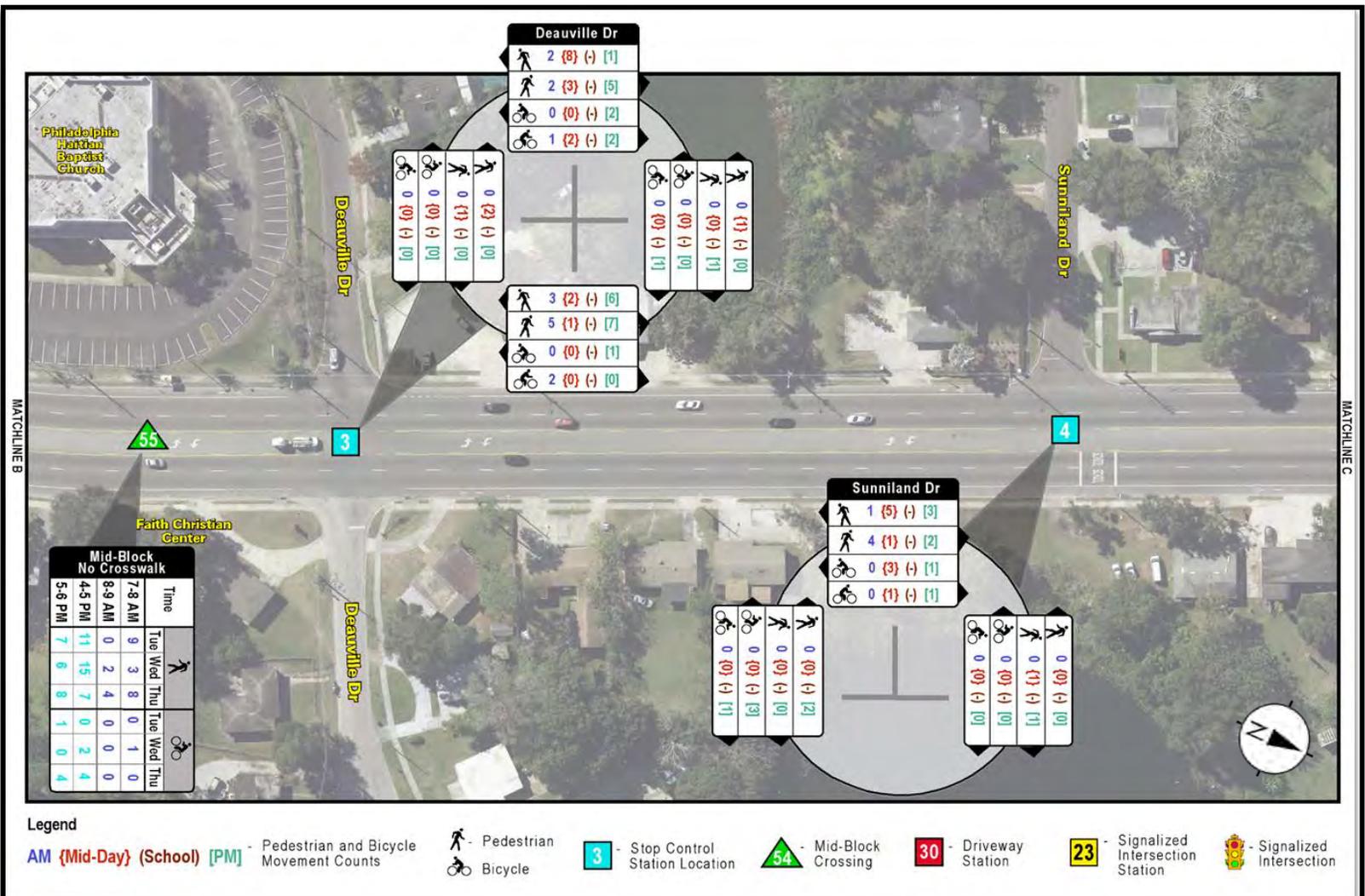


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

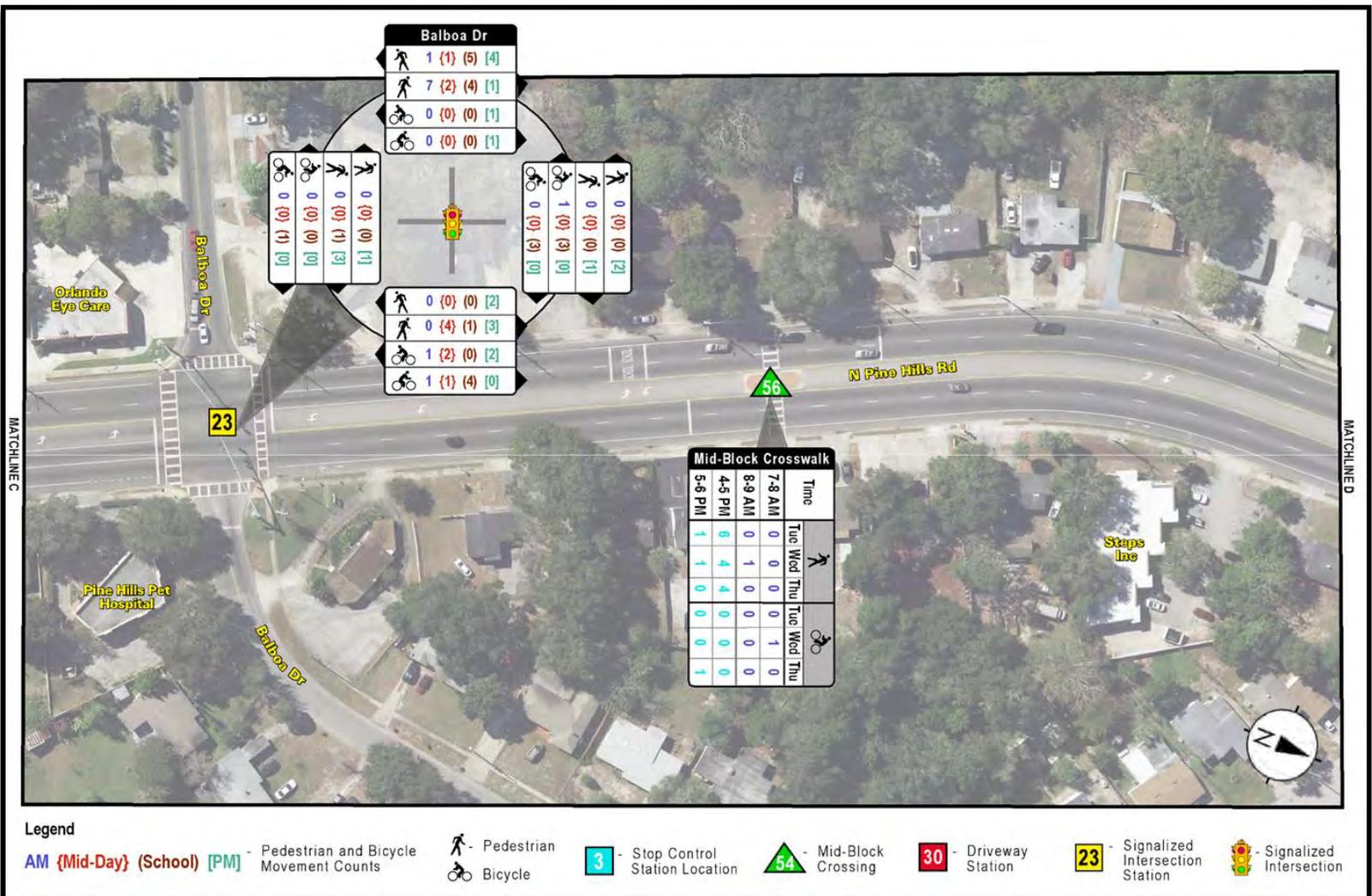


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

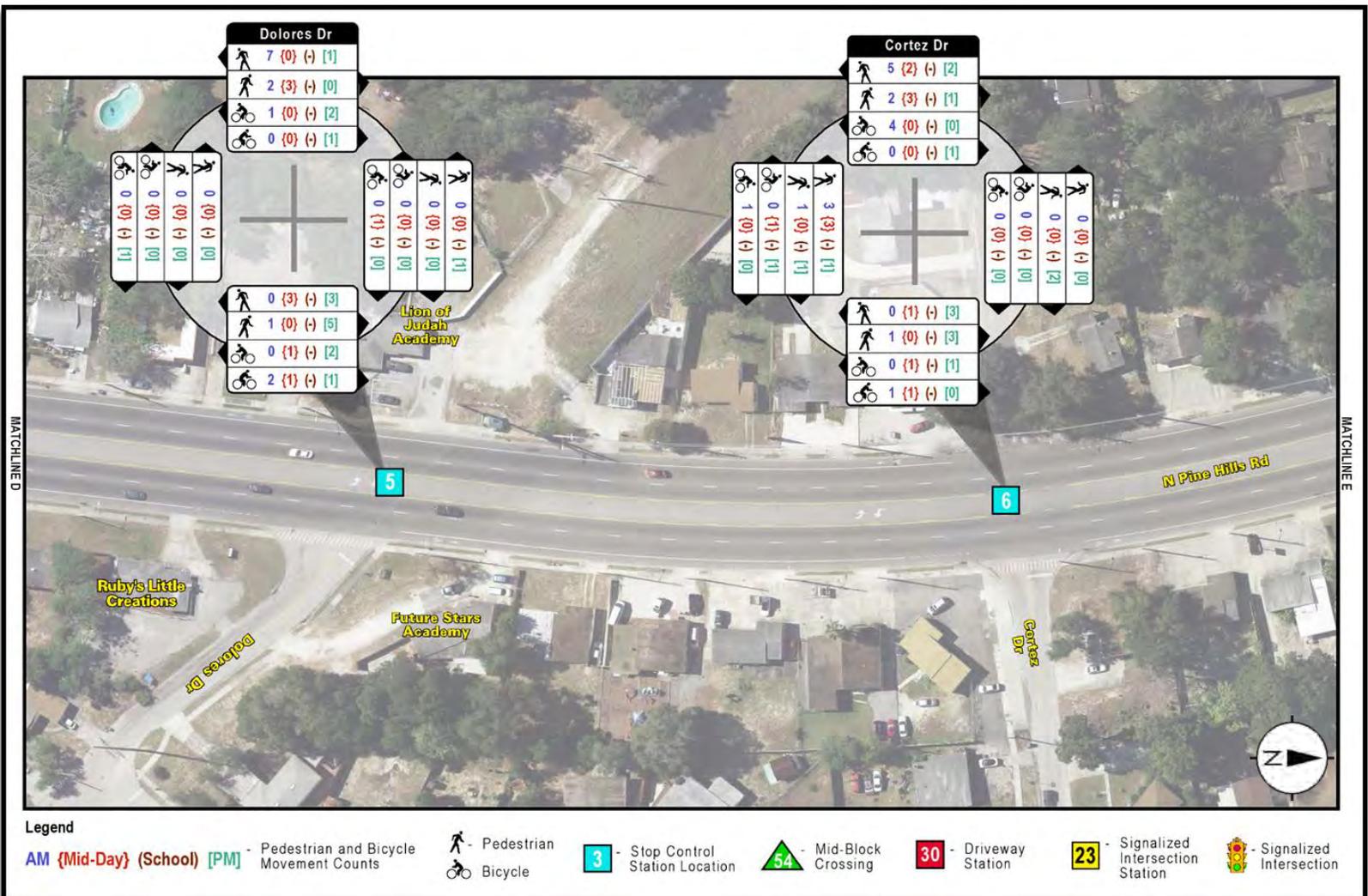


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

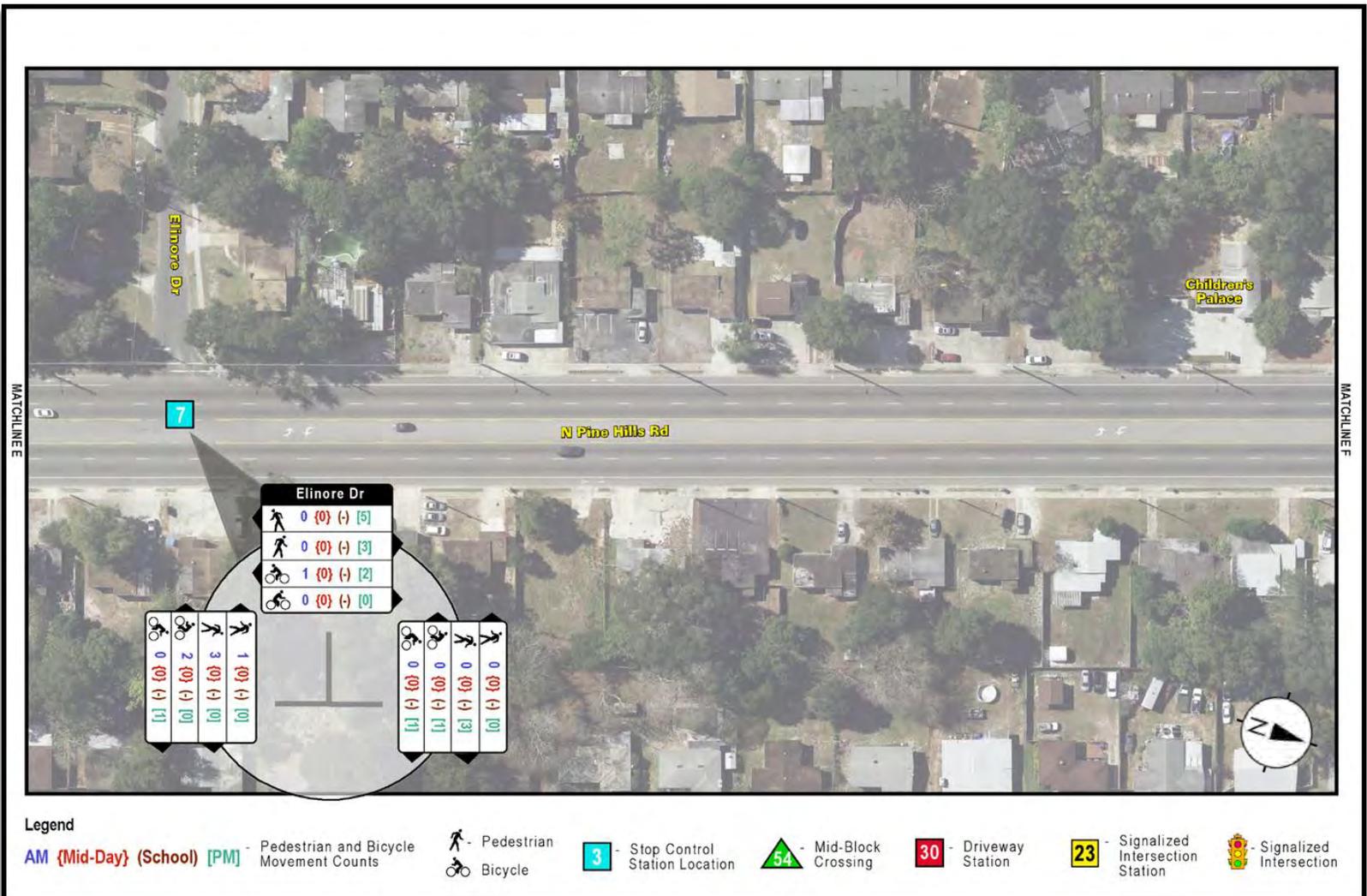


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

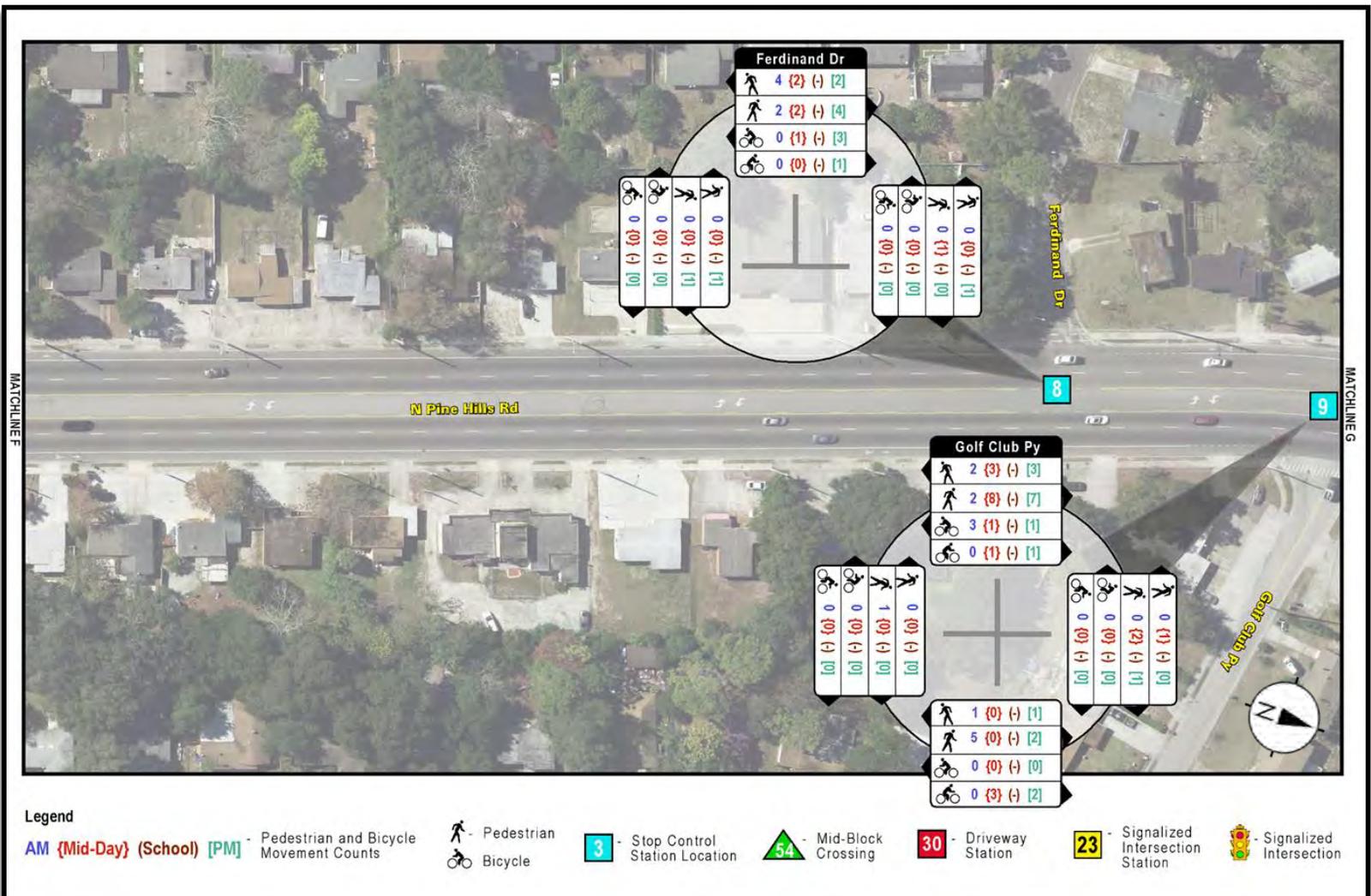


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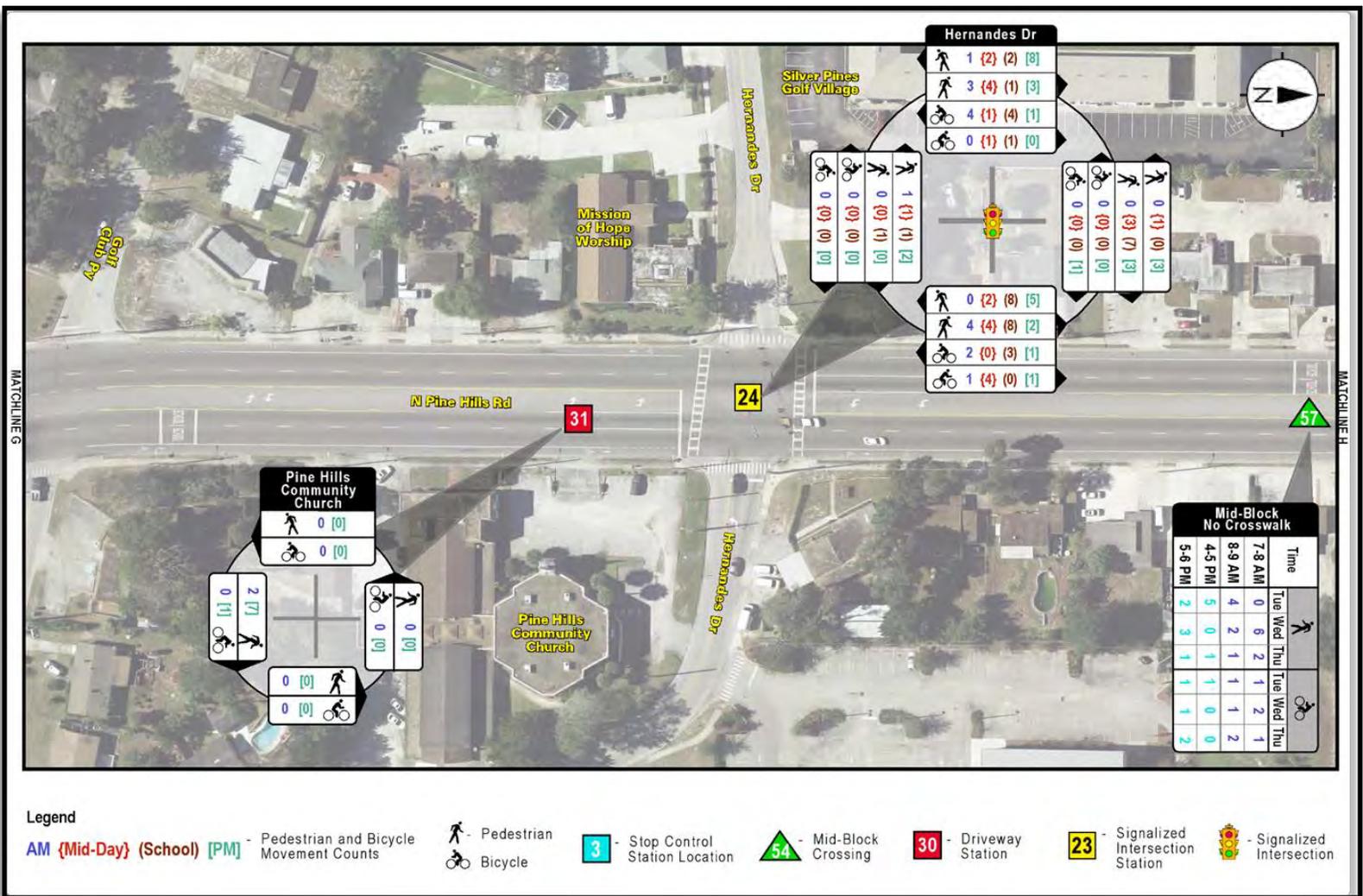


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

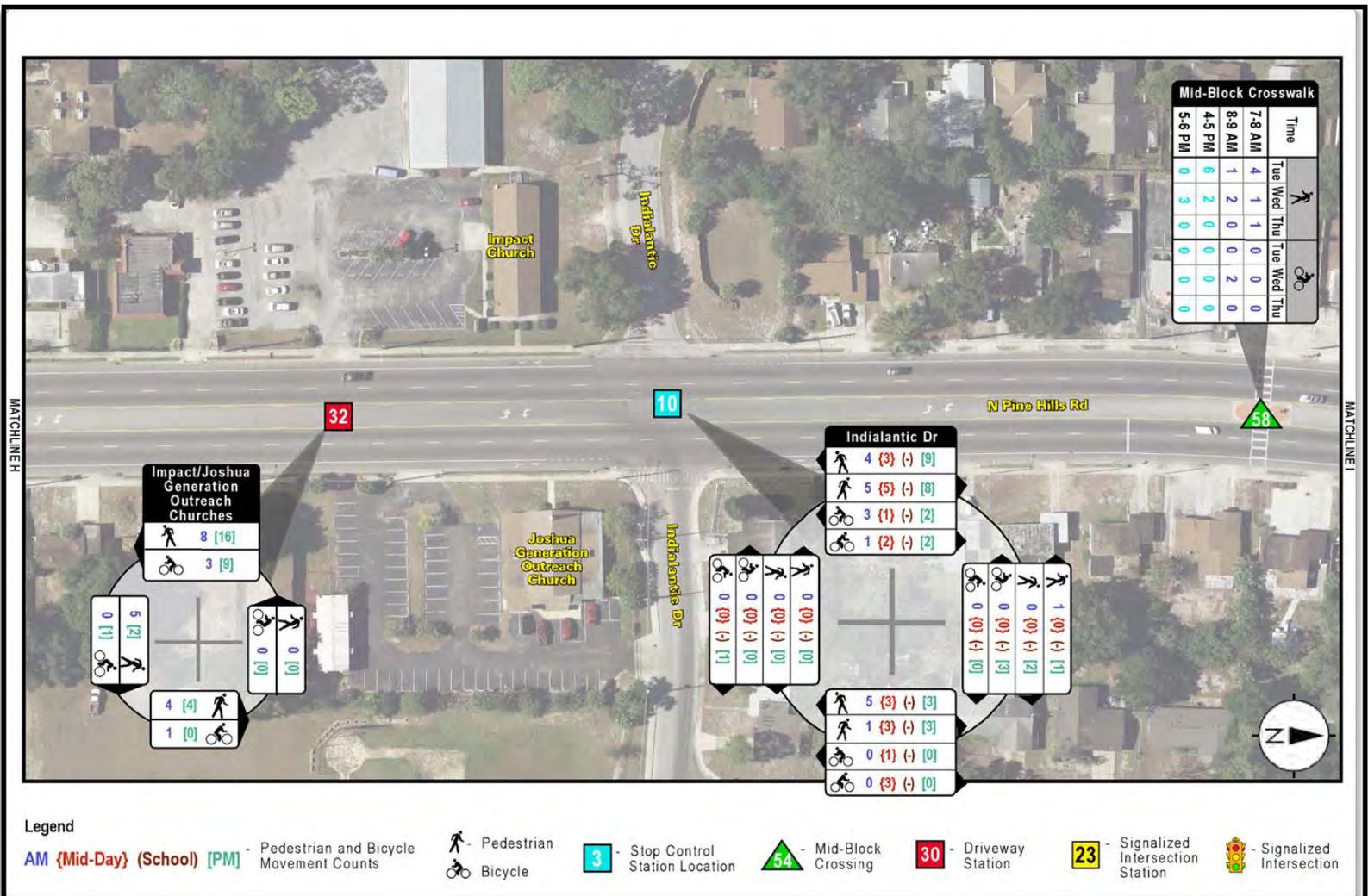


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

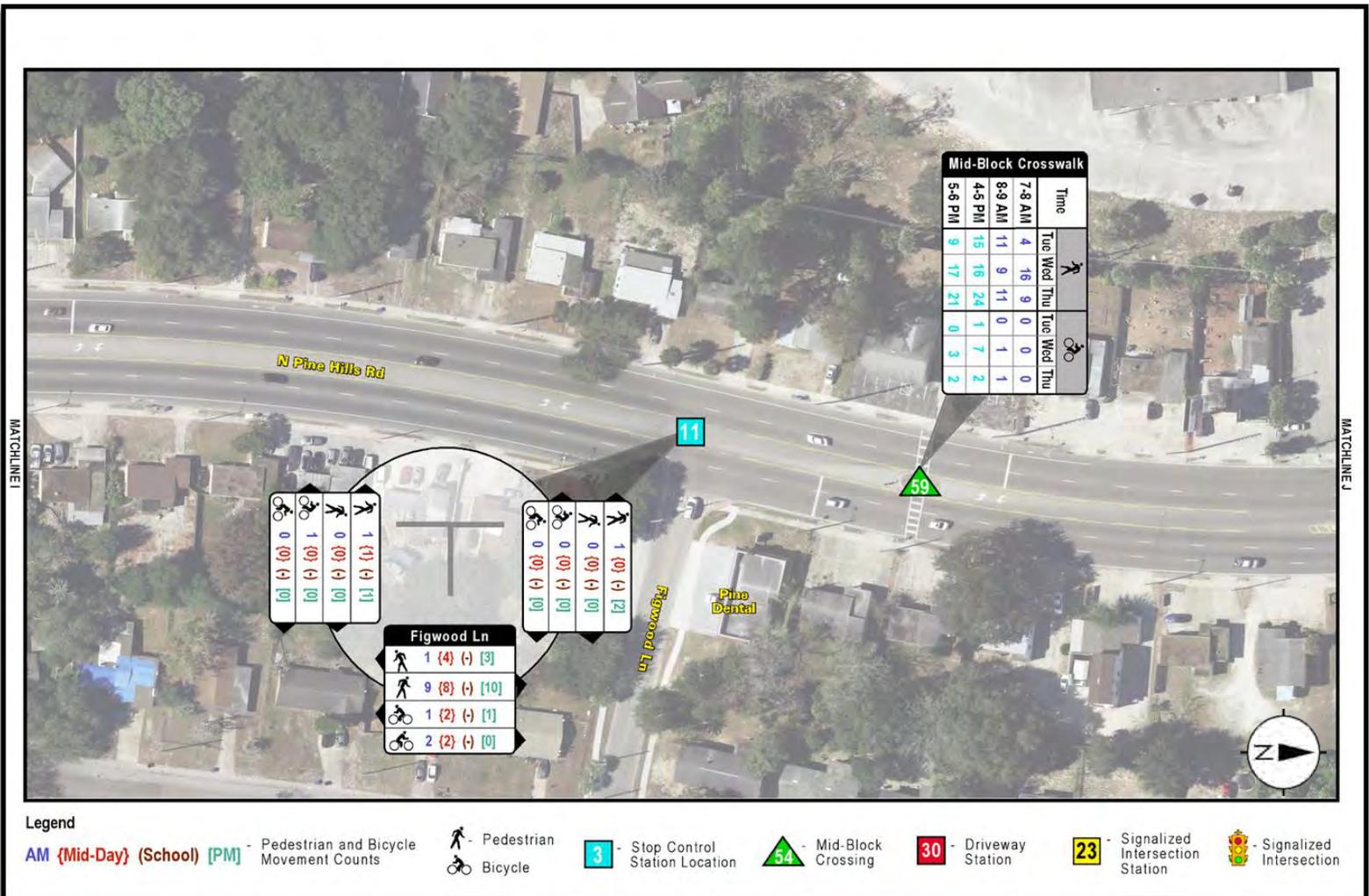


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

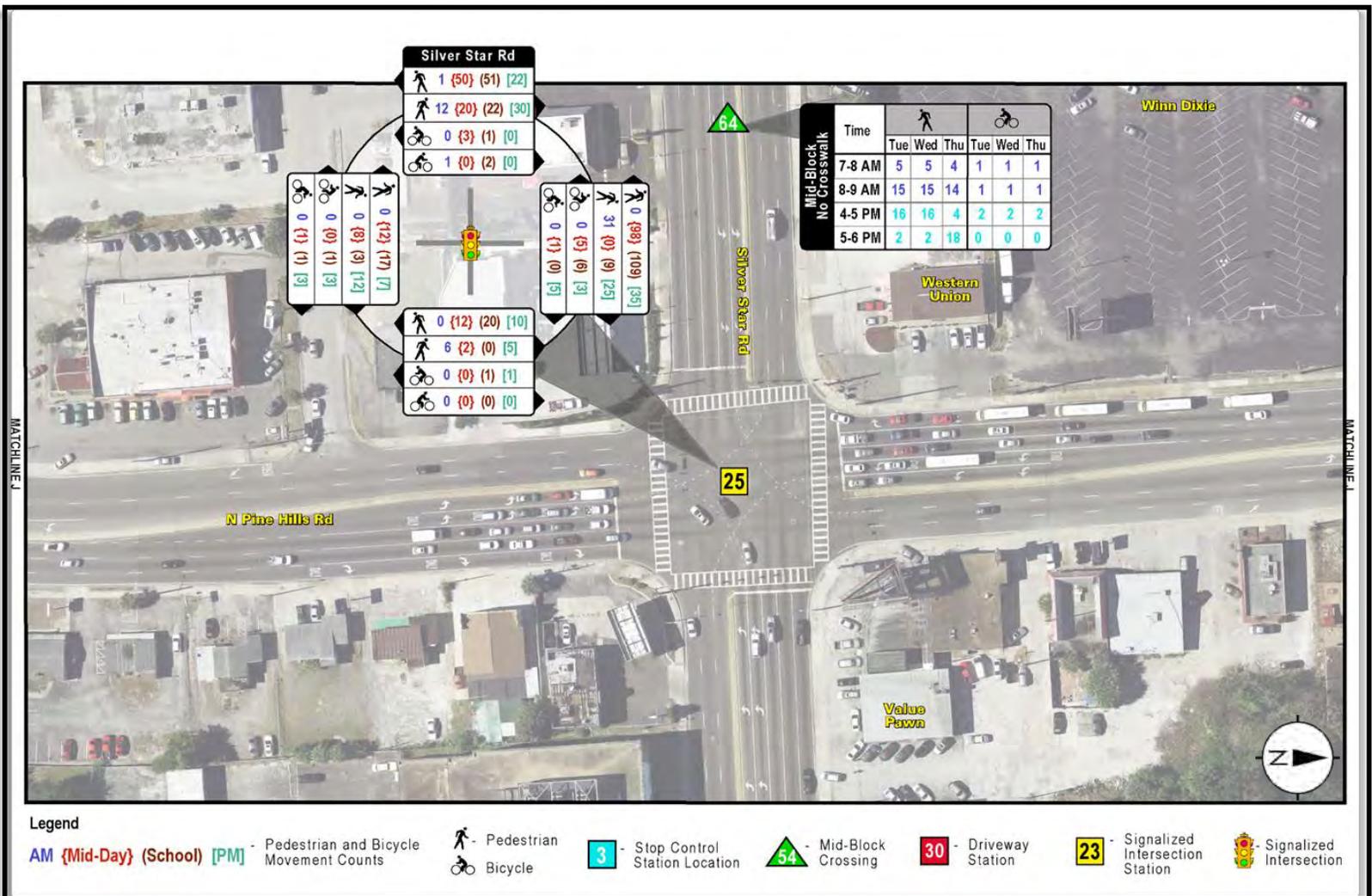


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

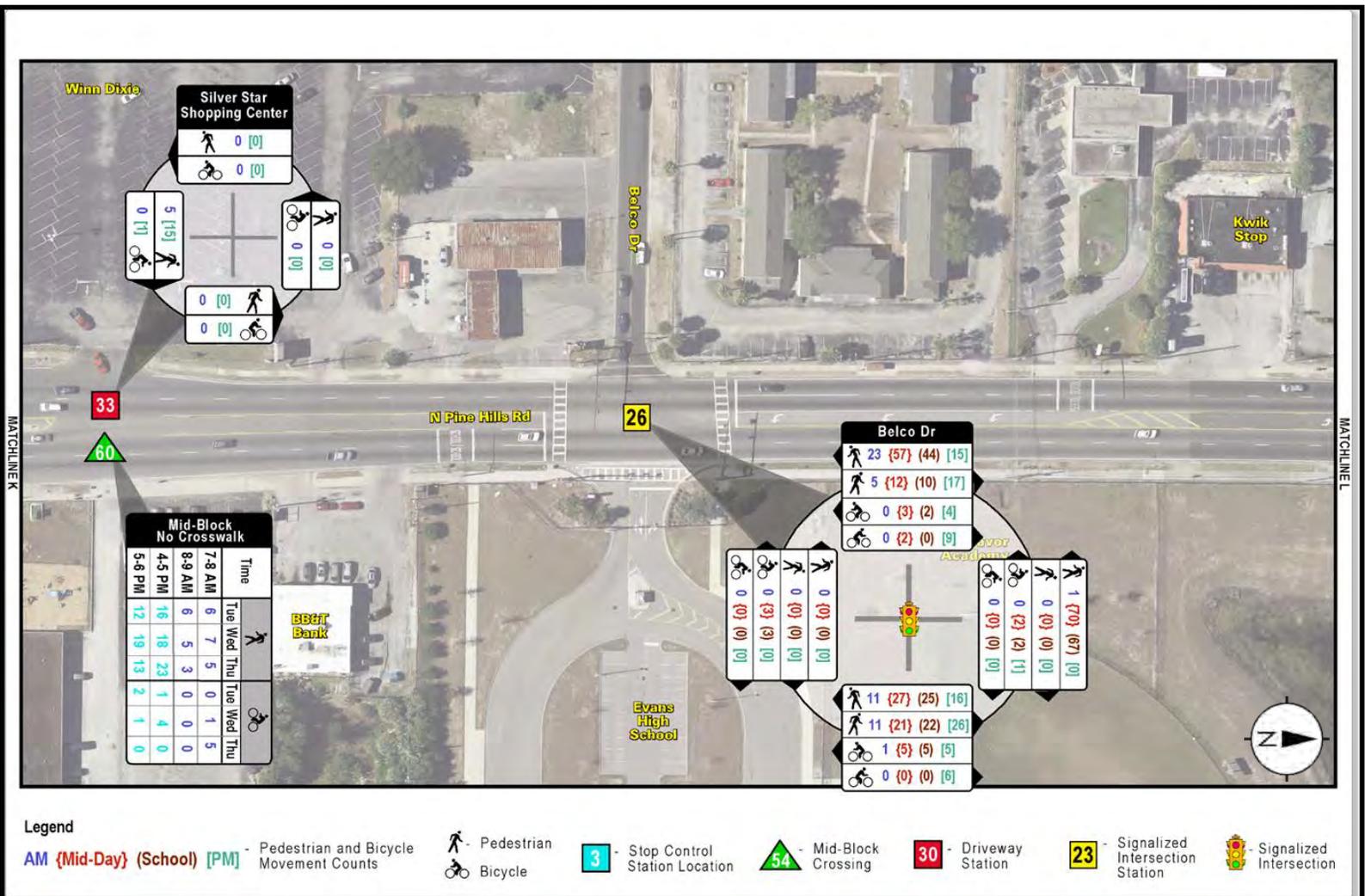


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

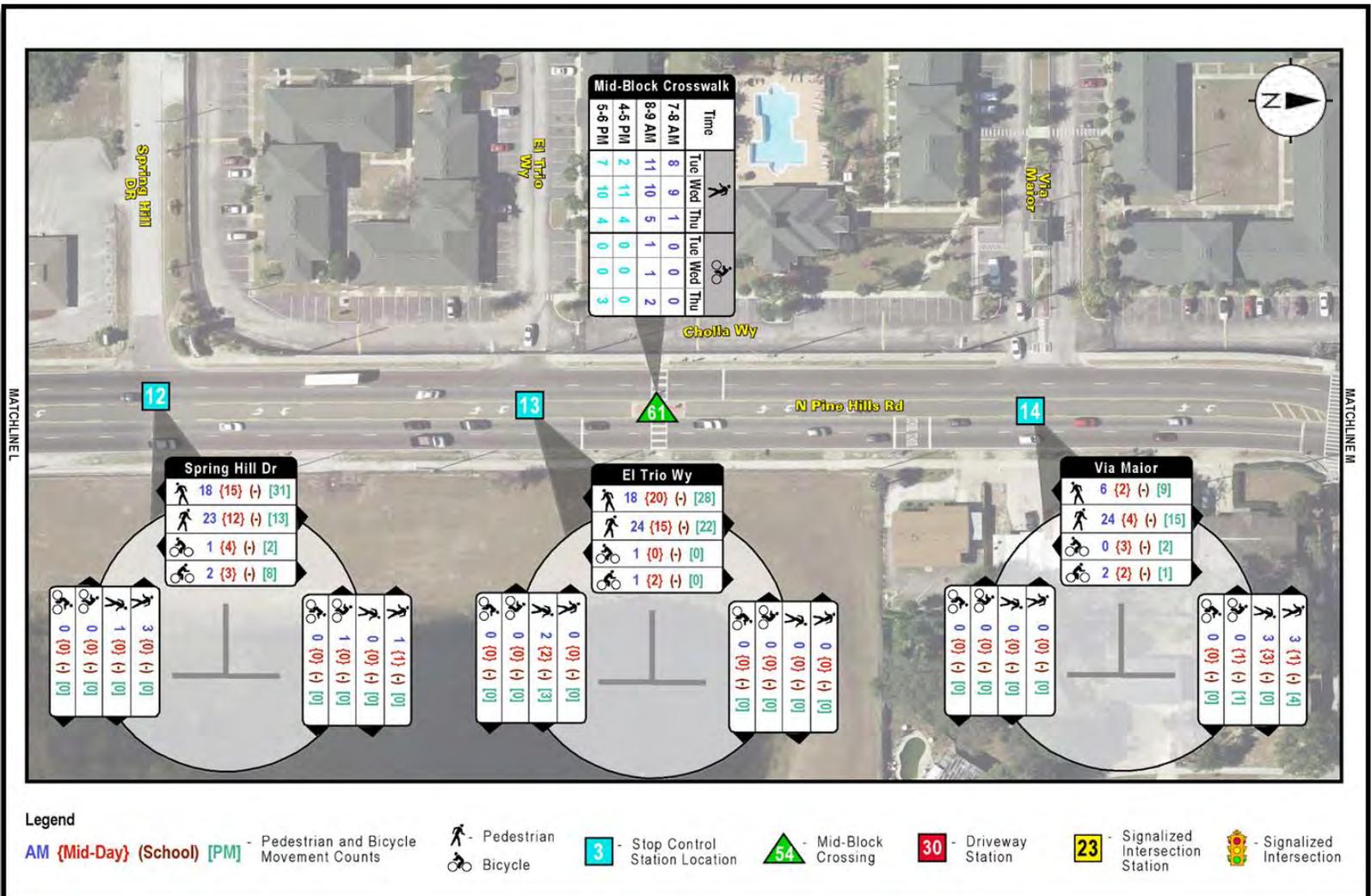


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

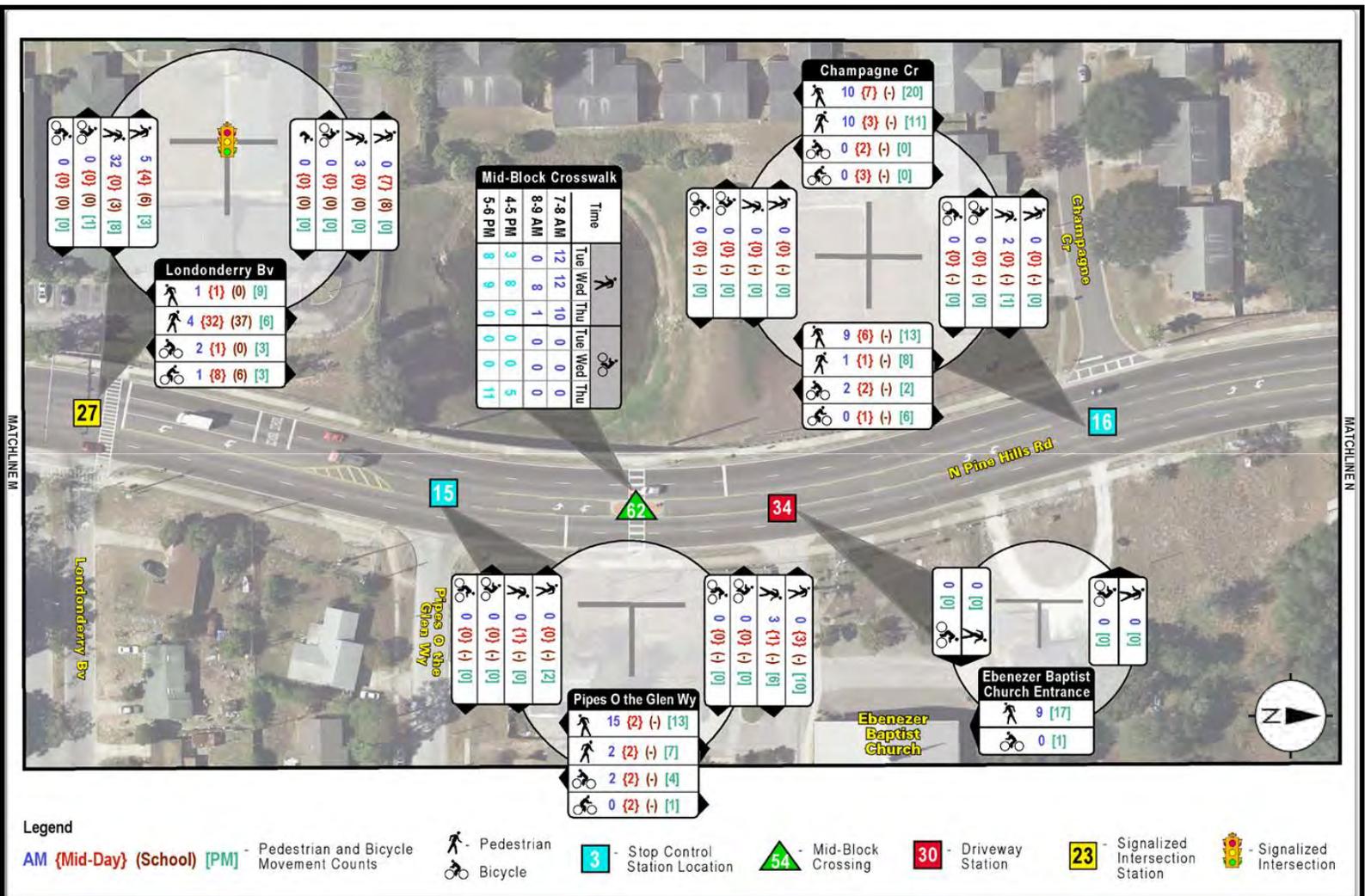


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

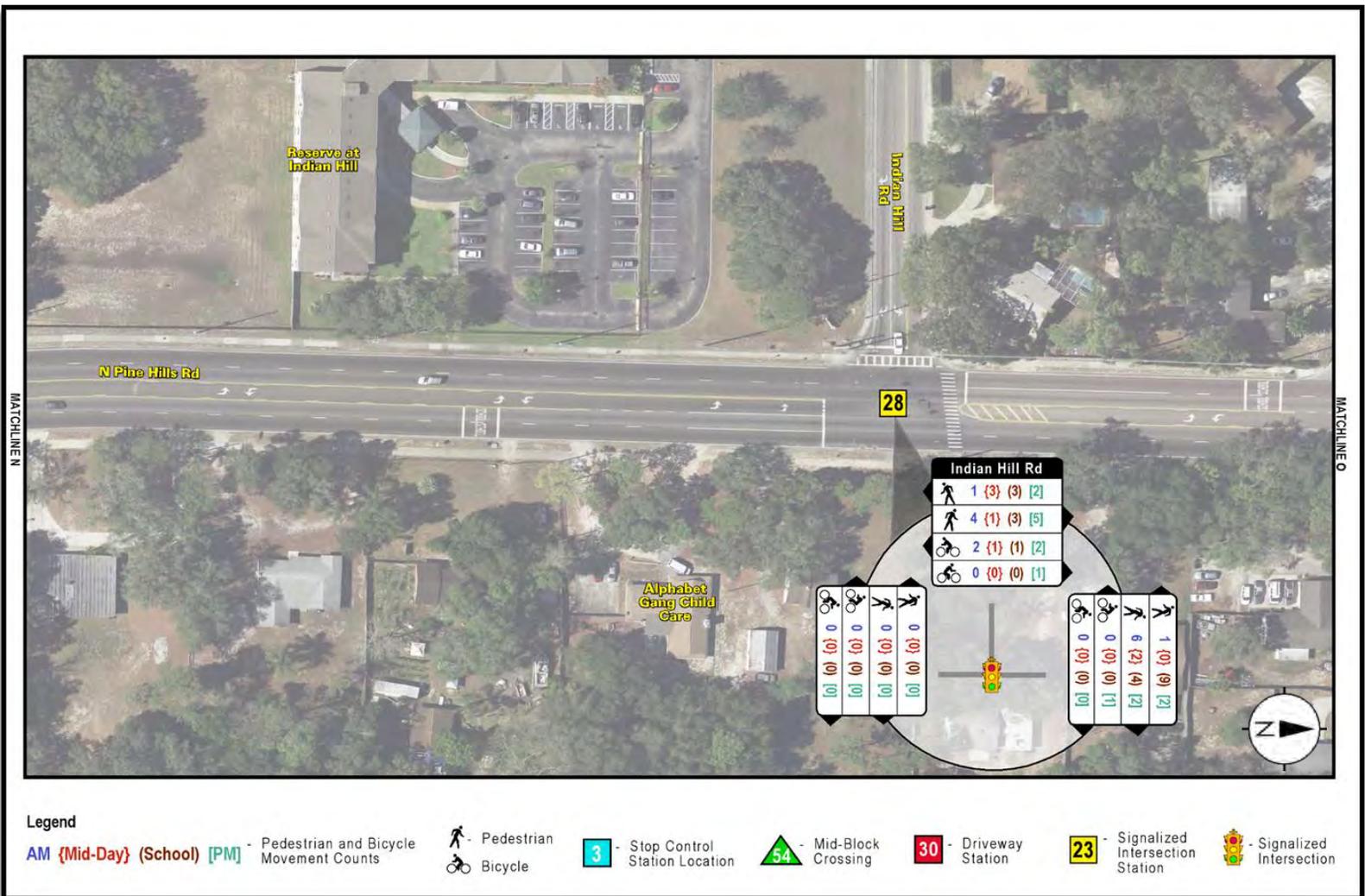


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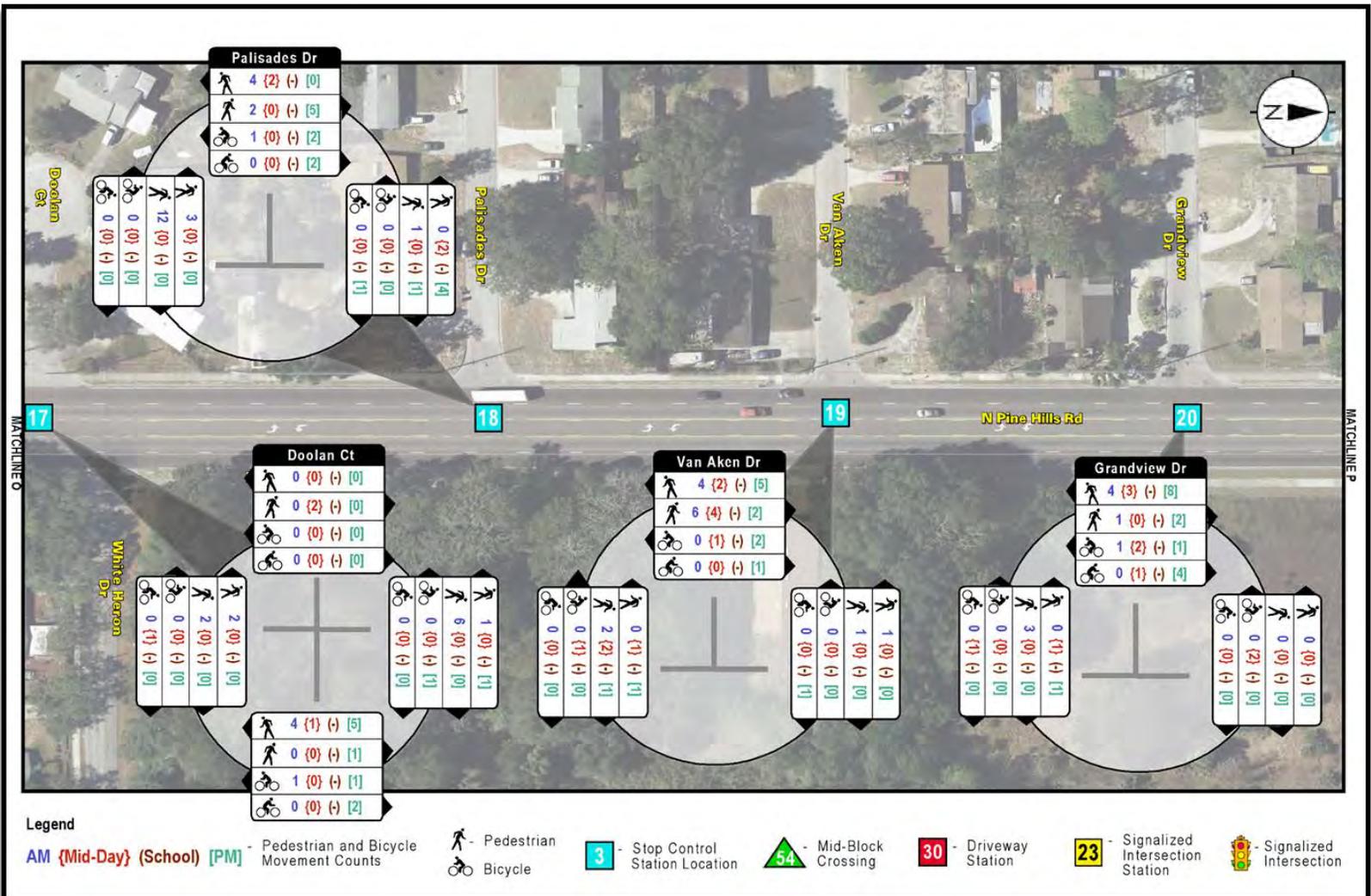


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts

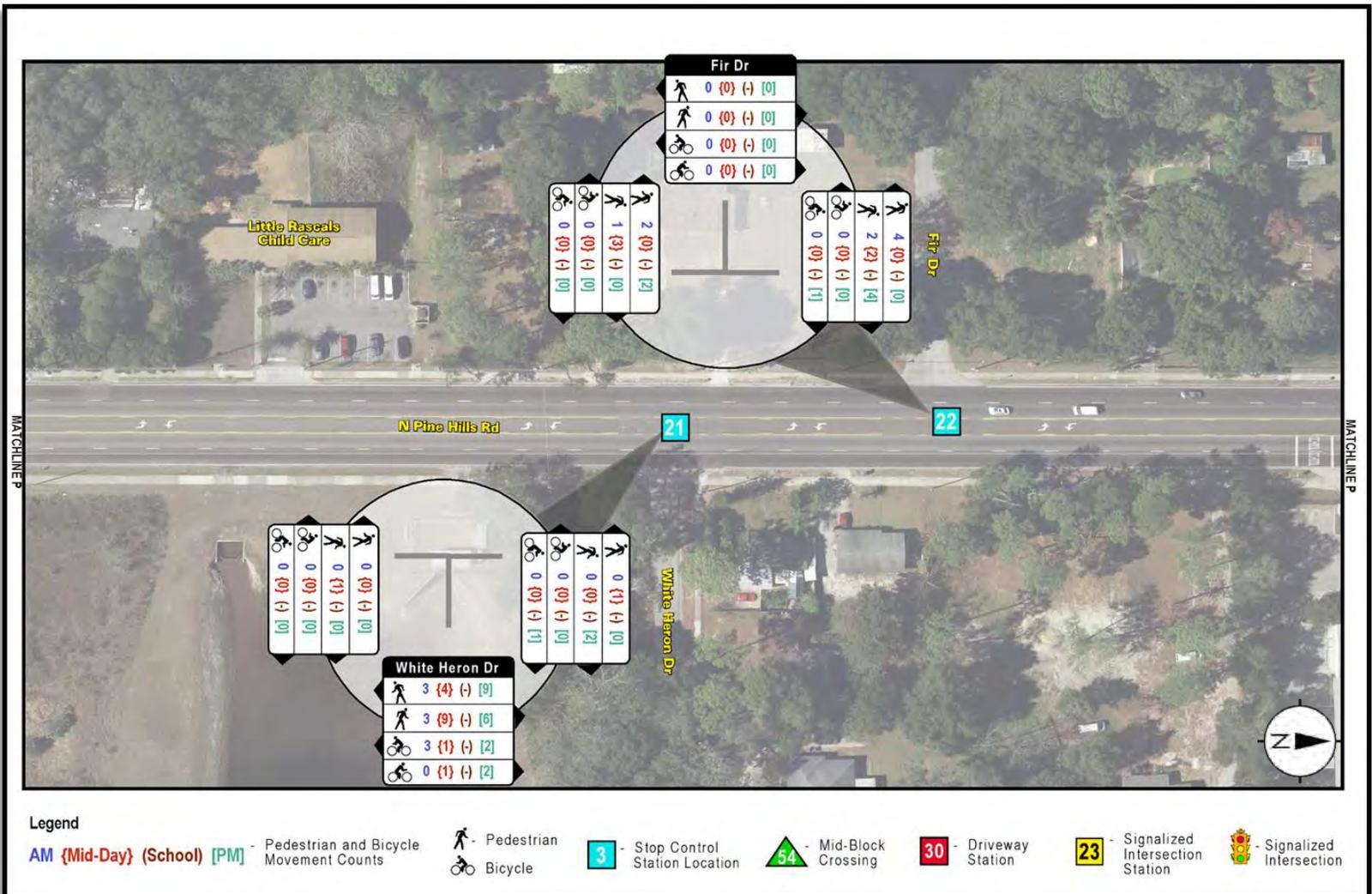
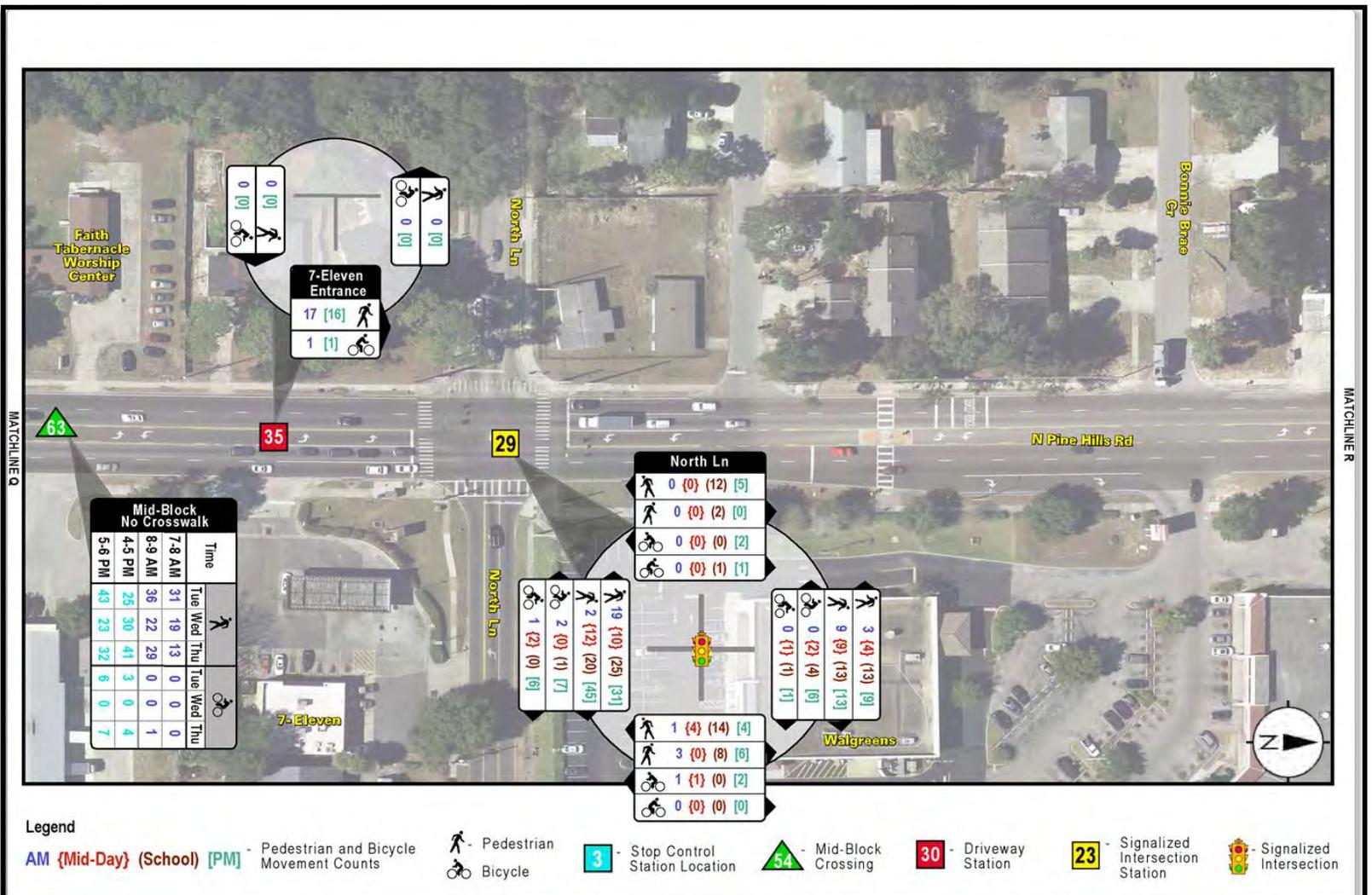


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts



4.6.3 Existing Corridor Operations Summary

The existing (2017) operational analysis was conducted to determine the Level of Service (LOS) for the Pine Hills Road study area intersections. The LOS for the study area intersections were determined using the procedures as outlined in the Highway Capacity Manual (HCM 2010) using Synchro Software (version 9.0) for both signalized and unsignalized intersections. The traffic signal timings used for the analysis were provided by Orange County.

In addition to the LOS for the automobile mode, the LOS for the pedestrian and bicycle mode was also evaluated for the mid-block crosswalks, the signalized intersections, the unsignalized intersections, and the major driveways. Approximately 50 percent of Pine Hills Road has dedicated bicycle lanes between Sunray Drive and Figwood Lane, within the project limits.

The pedestrian mode and bicycle mode make use of three important factors in determining the LOS for these modes. These are motorized vehicles, sidewalks for pedestrians and paved shoulders/bike lanes for bicycles. Unlike the automobile LOS, which is dependent on the number of other motorized vehicles on the roadway, the pedestrian and bicycle LOS is not determined by the number of additional pedestrians on the sidewalk or additional bicycles in the bike lane, rather it is primarily determined by the volume of motorized vehicles.

Level of Service for Automobiles

Per the Orange County Comprehensive Plan, the minimum peak hour LOS standard for Pine Hills Road is LOS E.

Based on the AM peak hour analysis results for the automobile LOS, all the signalized intersections along Pine Hills Road corridor, with the exception of the Silver Star Road intersection, are observed to operate at LOS D or better during the AM peak period. Silver Star Road operates at LOS E during AM peak period. Eight (8) of the unsignalized intersections have minor street approaches that operate at LOS F during the AM peak period. The eight unsignalized intersections are Alhambra Drive, Sunray Drive, Deauville Drive, Dolores Drive, Cortez Drive, Golf Club Parkway, Indialantic Drive and Heron Drive / Doolan Court.

Three (3) of the unsignalized intersections have minor street approaches that operate at LOS E during the AM peak period. The remaining 11 unsignalized intersection operate at LOS D or better during the AM peak period.

During the mid-day peak hour, the results for the automobile LOS indicated all the signalized intersections along Pine Hills Road corridor are observed to operate at LOS D or better during the Mid-Day peak period. Four (4) of the unsignalized intersections have minor street approaches that operate at LOS F during the Mid-Day peak period. The four unsignalized intersections are Alhambra Drive, Deauville Drive, Cortez Drive and Indialantic Drive.

Three (3) of the unsignalized intersections have minor street approaches that operate at LOS E during the Mid-Day peak period. The remaining 15 unsignalized intersection operate at LOS D or better during the Mid-Day peak period

During the school peak hour, the analysis results for the automotive LOS, all the signalized intersections along Pine Hills Road corridor, with the exception of the Silver Star Road intersection, are observed to operate at LOS D or better during the school peak period. Silver Star Road operates at LOS E during school peak period. During the PM peak hour, the analysis results for the automobile LOS, all the signalized intersections along Pine Hills Road corridor, with the exception of the Silver Star Road intersection, are observed to operate at LOS D or better during

the PM peak period. Silver Star Road operates at LOS E during PM peak period. Ten (10) of the unsignalized intersections have minor street approaches that operate at LOS F during the PM peak period. The ten unsignalized intersections are Alhambra Drive, Sunray Drive, Deauville Drive, Dolores Drive, Cortez Drive, Golf Club Parkway, Indialantic Drive, Pipes O the Glen Way, Champagne Circle, Heron Drive/Doolan Court.

The remaining 12 unsignalized have minor street approaches that operate at LOS D or better during the PM peak period.

It is important to note that HCM 2010 Unsignalized Intersections module of Synchro may provide a delay estimate for the minor approaches at unsignalized intersections that may not reflect the short gap acceptance behavior of drivers wanting to cross Pine Hills Road.

Level of Service for Pedestrians and Bicycles

Based on the analysis results, the pedestrian/bicycle LOS at all the signalized intersections along the Pine Hills Road corridor are observed at LOS D or better during each of the analysis periods.

Because there are no pedestrian refuge areas at the unsignalized study intersection, the pedestrian/bicycle LOS at all the unsignalized stop locations operate at LOS F for pedestrians and bicycles crossing Pine Hills Road. The absence of pedestrian refuge areas at these locations result in pedestrians/bicyclists having to cross the five-lane section in one stage, versus the two-stages made possible with a mid-block crossing location.

In terms of the Mid-Block (MB) crossings, **Table 4.6** shows the LOS during the AM and PM peak periods at the existing mid-block crosswalks and other locations along Pine Hills Road in the study area. Pedestrian LOS (based on FDOT Quality/LOS Handbook methodology) at unsignalized crossings (including mid-block crossings) is determined by the major street traffic volumes.

Table 4.6: Pedestrian and Bicycle Traffic Volumes Crossing Pine Hills Road LOS at Mid-block Crossing Locations

MB #	Pedestrian/Bicycle Crossing Location	Peak Direction Traffic Volumes		Pedestrian LOS (1)		Bicycle LOS (1)	
		AM	PM	AM	PM	AM	PM
54	Existing Crosswalk 100 feet North of Alhambra Dr	1,300	1,154	F	F	F	F
55	Survey Location 275 feet North of Sunray Dr (No Crosswalk)	1,266	1,146	F	F	F	F
56	Existing Crosswalk 400 feet North of Balboa Dr	1,339	1,460	F	F	F	F
57	Survey Location 200 feet North of Hernandes Dr (No Crosswalk)	1,221	1,356	F	F	F	F
58	Existing Crosswalk 440 feet North of Indialantic Dr	1,163	1,265	F	F	F	F
59	Existing Crosswalk 165 feet North of Figwood Ln	1,152	1,293	F	F	F	F
60	Survey Location 500 feet North of Silver Star Rd (No Crosswalk)	1,211	1,382	F	F	F	F
61	Existing Crosswalk 100 feet North of El Trio Way	1,395	1,461	F	F	F	F
62	Existing Crosswalk 145 feet North of Pipes O the Glen Way	1,174	1,357	F	F	F	F
63	Survey Location 335 feet North of Fir Dr (No Crosswalk)	989	1,129	E	F	D	F
64	Survey Location 530 feet West of Silver Star Rd (No Crosswalk)	1,513	1,824	F	F	F	F

Figure 4.10 illustrate automobile LOS for the AM, mid-day, school (signalized intersections only) and PM peak hours. More details on LOS for automobiles and pedestrian and bicycles are included in *Technical Memorandum No. 3—Existing Conditions*.

Figure 4.10: Automobile Level of Service

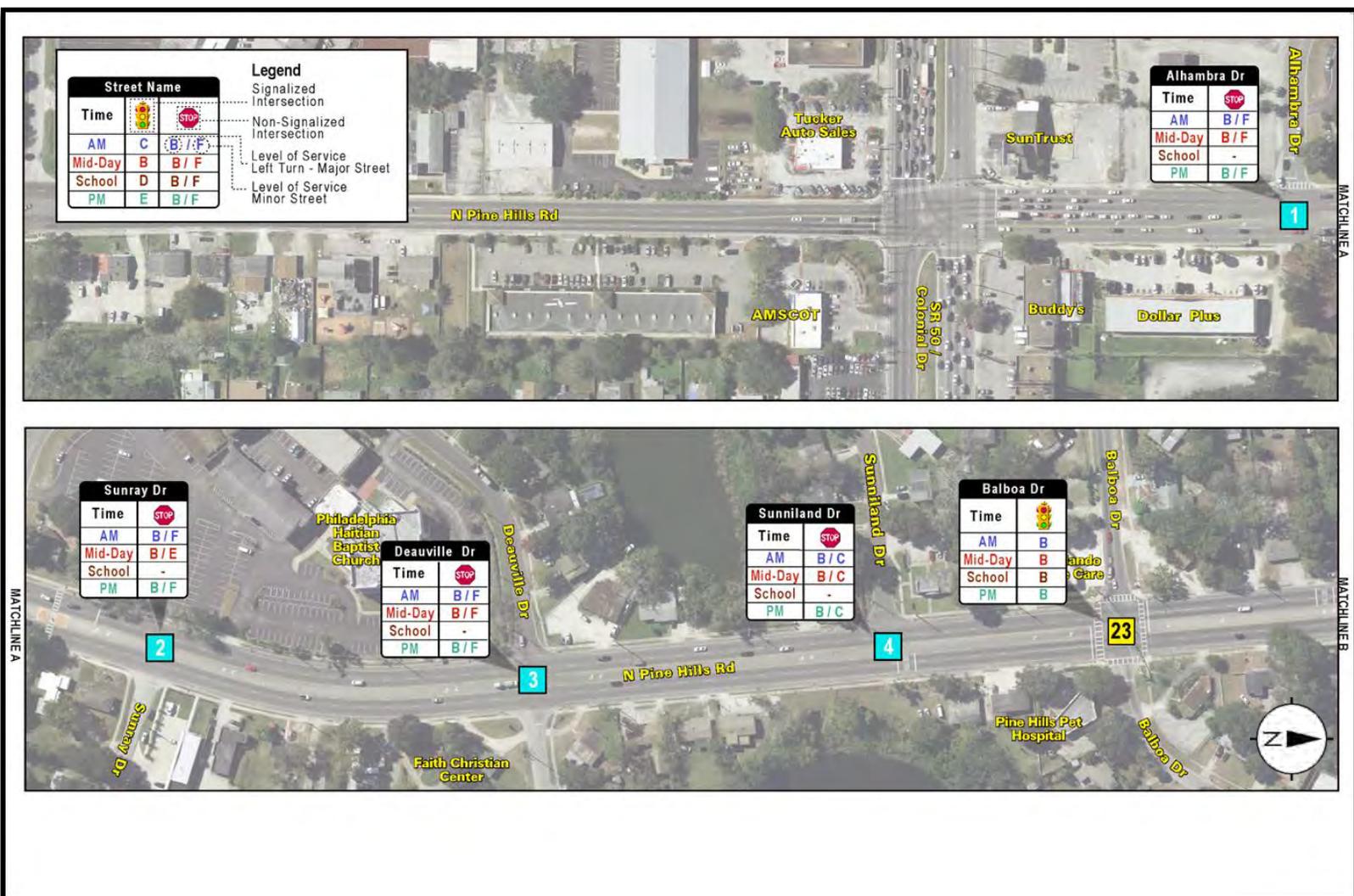


Figure 4.10 (continued): Automobile Level of Service

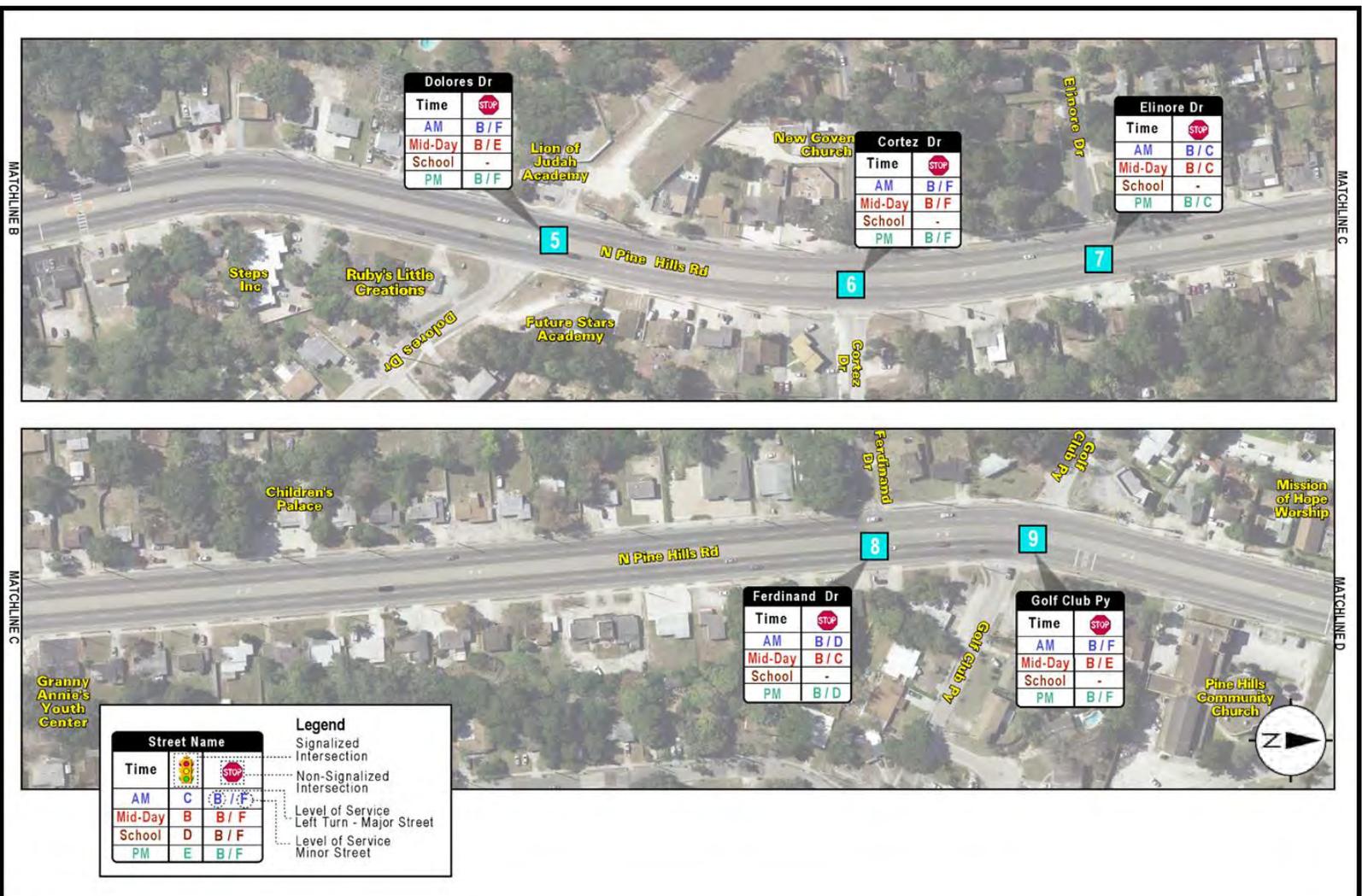
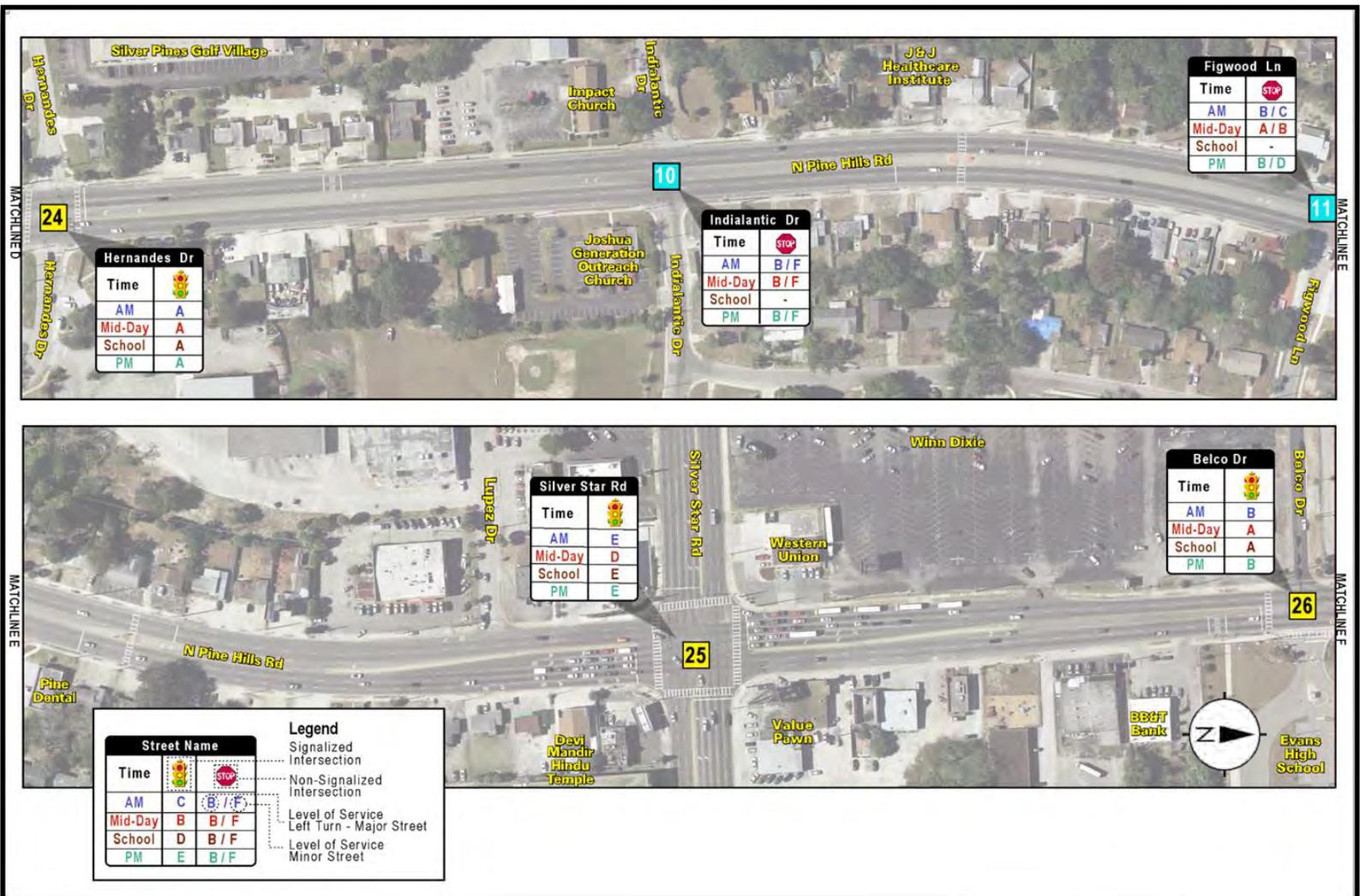


Figure 4.10 (continued): Automobile Level of Service



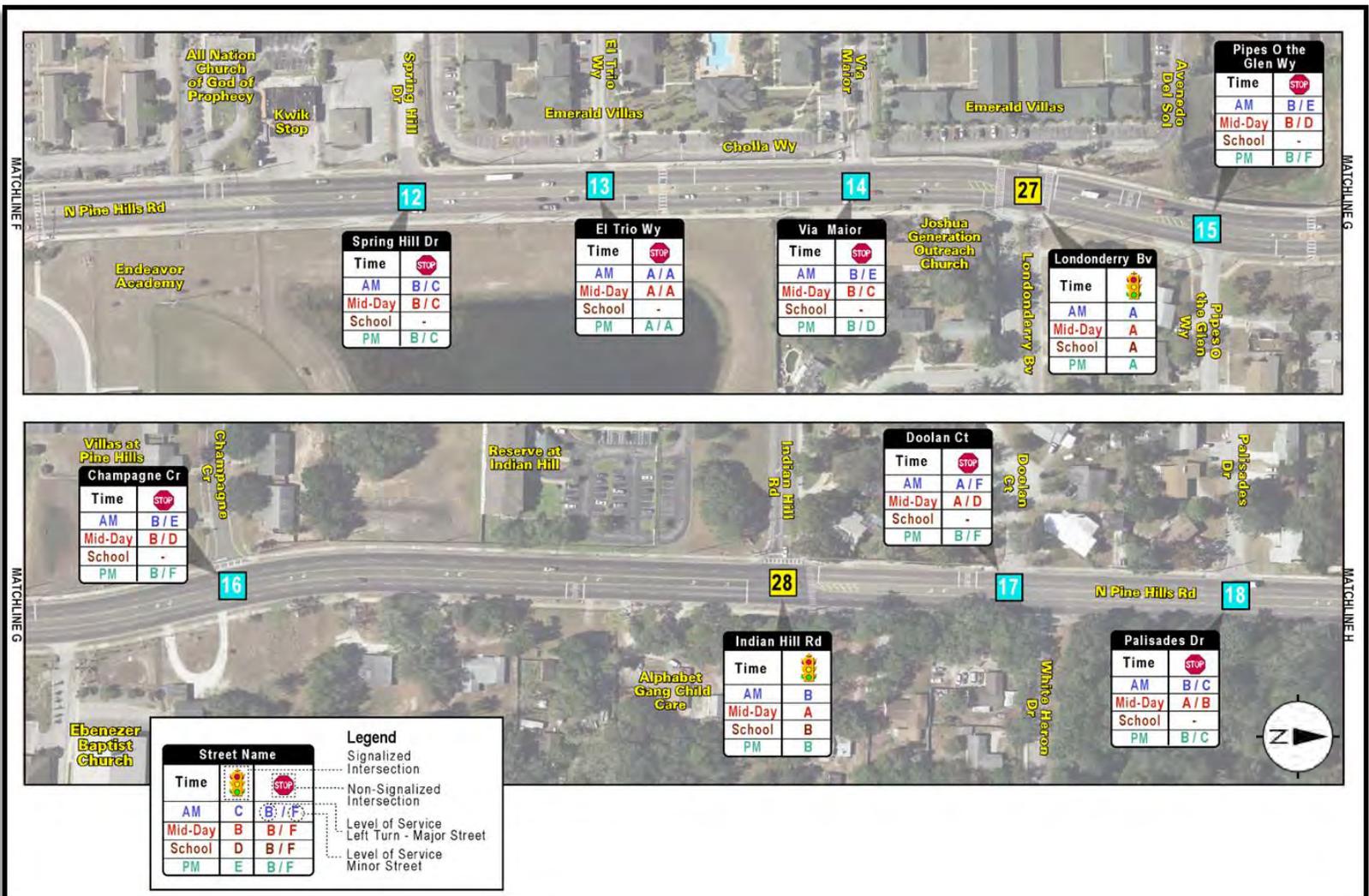
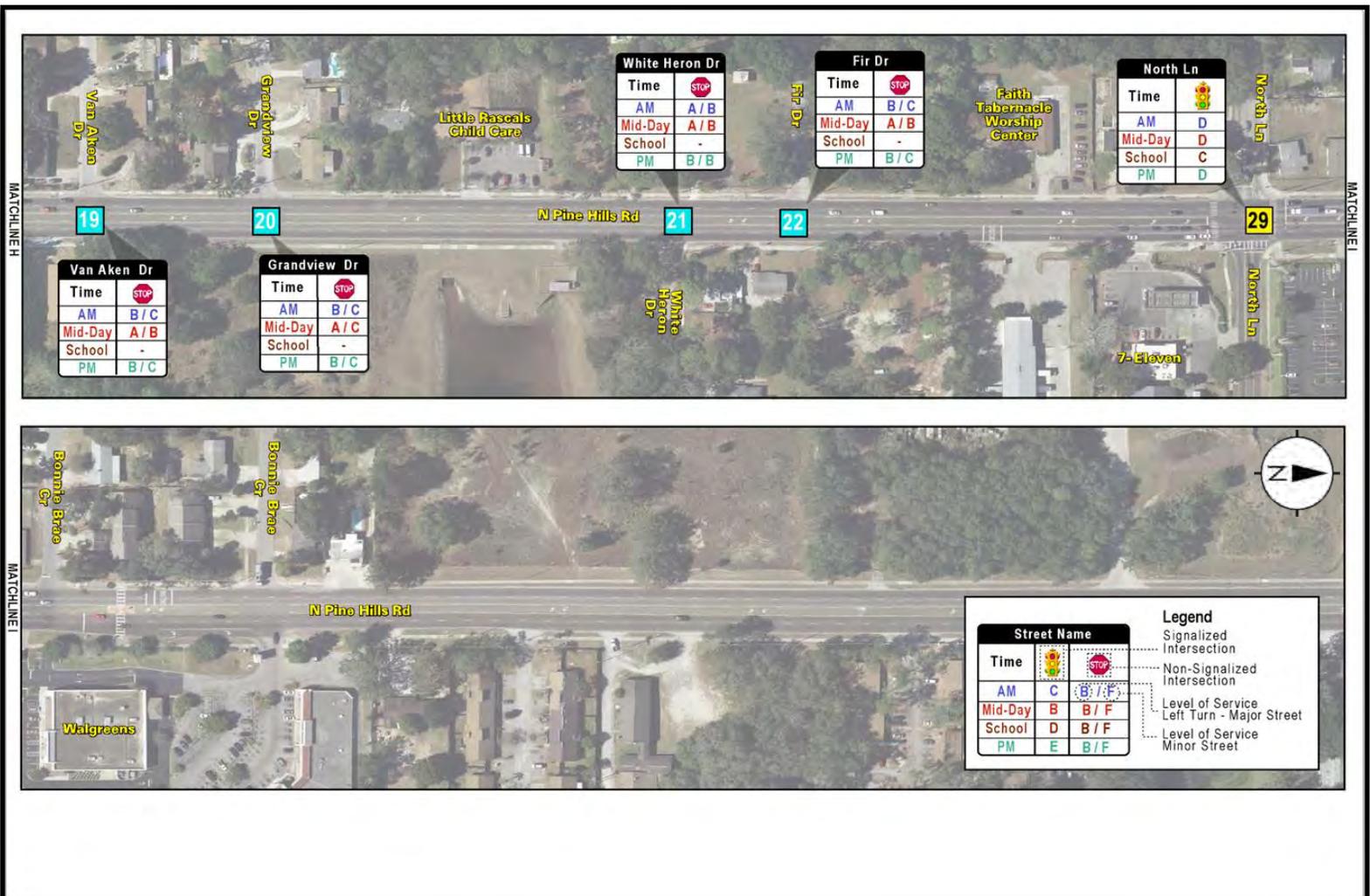


Figure 4.10 (continued): Automobile Level of Service

Figure 4.10 (continued): Automobile Level of Service



4.6.4 Existing Conditions Crash Experience Summary

The conclusions reached by this study regarding the crash experience in the Pine Hills Road corridor are noted below.

- Approximately 45 percent of the pedestrian/bicycle crashes occurred at dusk or under dark conditions. The luminosity study found that with the wide spacing of existing luminaires and aging high pressure sodium lamps, lighting levels do not meet FDOT standards. Based on these conditions and relatively high night-time crashes, new lighting is recommended for Pine Hills Road south of Silver Star Road since the County already has plans for upgrading the lighting north of this road. LED fixtures should be considered since they would provide long term operational and maintenance cost benefits.
- Almost 45 percent of the pedestrian/bicycle crashes occurred in between intersections along Pine Hills Road. For the most part, these crashes were not found to be focused at specific locations along Pine Hills Road, but were widely dispersed along the corridor. The Gap Analysis Study also found that only one gap was available for pedestrians attempting to fully cross the entire roadway at one time during the hours studied. Consequently, these findings suggest the following approach:
 - Convert the two-way left turn lane to a raised median which would dramatically increase the number of available gaps to as much as 120 in a two-hour period. Based on the FDOT Median Handbook, a raised median has been shown to be effective in reducing crash experience.
 - The Spot Speed Study indicated the 85th percentile speed was in the range of 47-48 mph which is higher than the posted speed limit of 40 mph. To reduce operating speeds and provide more gaps for pedestrian crossings, 11-foot travel lanes are recommended which will help shorten the crossing distances for pedestrians.
 - The alignment of Pine Hills Road has a number of horizontal curves which may impair the ability of motorists to detect pedestrians crossing Pine Hills Road. To improve the visibility at mid-block crossings or at unsignalized intersections, the use of RRFB's or HAWK signals should be considered at selected mid-block crossings to alert motorists of pedestrians crossing the roadway.³
- The Pine Hills Road/Silver Star intersection incurred 18 crashes over a three-year period and had the highest crash history in the study area. Observations taken during the course of the study indicated heavy southwest to northeast (and vice versa) pedestrian and student movements. Suggestions to encourage pedestrians to use the existing signals at this intersection would include the following measures, subject to FDOT approvals.
 - Employ a signal phase that once actuated, given acceptable impacts to automobile traffic, would provide an all-red sequence that would allow pedestrians to move across or diagonally through the intersection which could encourage pedestrian usage. This phasing has been analyzed and found that long delays are likely to occur and FDOT has indicated concerns over this practice. Consequently, this initiative has been dropped from further consideration.

³ If there is not adequate sight distance because of curves, mid-block crossings should not be installed regardless of RRFB or HAWK signals.

- Reconstruct the curb returns at the northeast and southwest quadrants by increasing the turning radii, thereby reducing the width of the acceleration lane and the crossing distance.
- Almost one-third (24) of the crashes involved persons less than 18 years of age. There were 30 crashes (41 percent) involving dart/dash movements across roadways. These data suggest that an educational program may be helpful to reinforce safe crossing behavior and movements.

4.7 Access Management

Pine Hills Road serves many different types of abutting land uses and the existing two-way left turn lane can create numerous conflict points for vehicles, pedestrians, and bicyclists. While necessary to provide access to abutting land uses, there are instances where the inclusion of raised medians can reduce conflict points which would improve safety based on FDOT studies.

Two different access management classes are proposed for Pine Hills Road. South of Belco Drive, Pine Hills Road is characterized by numerous side streets and small businesses that have been converted from original residential properties fronting Pine Hills Road to commercial usages.

For this section of Pine Hills Road, Class 7 meeting FDOT Access Class Spacing Standards (see **Table 4.7** below) is proposed since it provides greater control of access than the current undivided roadway, yet it would be the least restrictive and would continue to provide a high level of access to properties.

To the north of Belco Drive, Class 5 is proposed since there are fewer businesses that front Pine Hills Road through this area and thus a higher level of controlled access can be prescribed.

Table 4.7: FDOT Access Class Spacing Standards

FDOT Access Management Class	Median	Minimum Median Opening Spacing (feet)		Minimum Signal Spacing (feet)	Minimum Connection Spacing (feet)
		Full	Directional		
Class 1 ¹	Restrictive	-	-	-	5,280 (CBD) – 31,680 (Rural)
Class 2	Restrictive with Service Roads	2,640	1,320	2,640	1,320 / 660 ²
Class 3	Restrictive	2,640	1,320	2,640	660 / 440 ²
Class 4	Non-Restrictive			2,640	660 / 440 ²
Class 5	Restrictive	2,640 / 1,320 ²	660	2,640 / 1,320 ²	440 / 245 ²
Class 6	Non-Restrictive			1,320	440 / 245 ²
Class 7	Both Median Types	660	330	1,320	125

Source: Section 14-97.003, Florida Administrative Code

(<http://www.fdot.gov/planning/systems/programs/sm/accman/pdfs/1497.pdf>)

¹ Access Class 1, for limited access facilities, only applies to interchange spacing, not median or signal spacing.

² Greater than 45 MPH posted speed / Less than or equal to 45 MPH posted speed

The proposed access management plan would provide a raised median throughout the length of the study corridor which is illustrated on **Figures 4.11 and 4.12**. These improvements would reduce the number of conflict points along the corridor with a corresponding reduction in crashes.

Figure 4.11: Proposed Typical Section: Colonial Drive to Silver Star Road

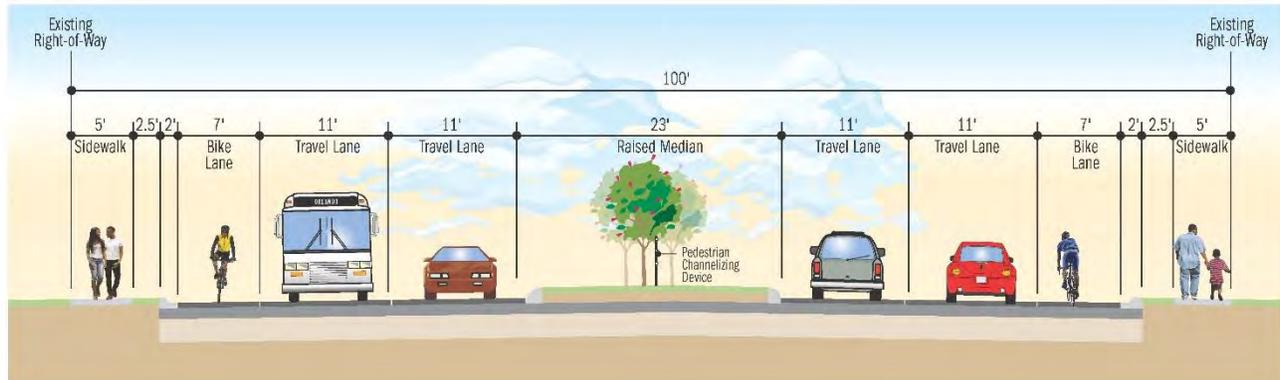
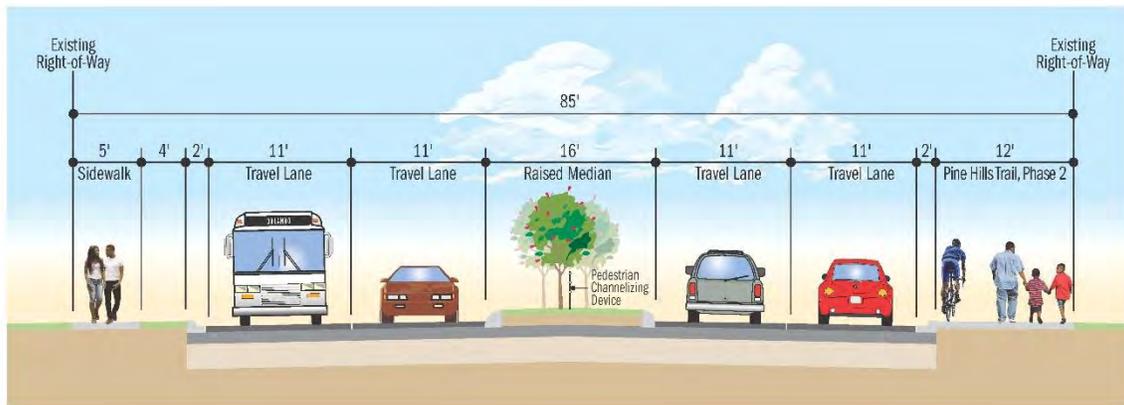


Figure 4.12: Proposed Typical Section: Silver Star Road to Bonnie Brae Circle



The proposed access management plan is described below for Pine Hills Road.

South Segment – Colonial Drive to Belco Drive

- All signalized intersections (Colonial Drive, Balboa Drive, Hernandes Drive, Silver Star Road and Belco Drive) will receive full openings since signals are already in place at these locations and their installations have likely been justified by previous engineering studies substantiating higher traffic usage and demands. In addition, since the County has recently approved signal installations at Dolores Drive and at Indialantic Drive, these intersections will also receive full openings. Additional full openings are proposed at Deauville Drive, Elinor Drive, Ferdinand Drive and Figwood Lane because of the relatively heavy traffic demands at these intersections and the need to provide access to local neighborhoods.
- A directional opening has been provided at Alhambra Drive to provide for local traffic movements, especially to the businesses located between Colonial Drive and Alhambra Drive.
- Intersections that will be provided with only right in, right out access include Sunray Drive, Sunniland Drive, Cortez Drive, Golf Club Parkway and Lupez Drive. While these intersections will still have access in the form of right in, right out movements only, they could not be provided full or directional access due to Access Management guidelines. Traffic demands at these locations are also relatively light.

North Segment – Belco Drive to North Lane

- For reasons similar to the south segment, full openings are proposed at all signalized intersections – Londonderry Boulevard, Indian Hill Drive and North Lane. Additional full openings are proposed at Champagne Circle and at Van Aken Drive to meet local traffic demands.
- Directional opening are proposed at Via Maior and White Heron Drive due to relatively high traffic counts and the need to serve adjacent neighborhoods.
- The remainder of the intersections in the north segment are proposed to have right in, right out operations. Generally, these streets have relatively low traffic volumes or do not meet the spacing guidelines.

To improve access to/from these locations, the nearby full and directional intersections would have flares or bulb outs constructed in the outside curbs to allow most vehicles to perform U-turn maneuvers. These improvements are needed in the north segment of this project since the width of Pine Hills Road is not sufficient to allow U-turns to be fully completed within the existing street section. Given the tight right-of-way north of Silver Star Road, it is likely that the flares and bulb outs will require minor right-of-way takes for these improvements.

Proposed plans containing access management recommendations can be found in **Figure 7.5**. A detailed analysis of the existing access management conditions and the proposed access management recommendations are available in *Technical Memorandum No. 4—Access Management Study* (see **Appendix D**).

5.0 Future Conditions

This report presents a description of the methodology used to determine the recommended traffic growth rates, development of future intersection AM and PM peak hour traffic volumes and evaluation of intersection multimodal traffic operations for the Pine Hills Road study corridor for the No Build and Build conditions. The analysis for this project is based on an opening year of 2020 and design year of 2040. The No-Build condition assumes that the corridor configuration remains unchanged through year 2040. The Build condition analyzes the corridor based on a raised median and other safety related improvements along much of the length of the study corridor. A detailed explanation of each of these safety improvements is provided in *Technical Memorandum No. 6—Safety Improvement Strategies Report* (see **Appendix F**).

5.1 Future Traffic Forecasts

This section presents the recommended growth rate used to derive future traffic volumes for the Pine Hills Road study corridor. The development of traffic projections for a study corridor requires the examination of historical growth and the proposed development levels within the corridor vicinity, as well as a basic understanding of local traffic circulation patterns and travel characteristics of the corridor. An initial set of growth rates were derived using the following:

- Opening year 2020 and design year 2040 model volumes from the latest adopted Orlando Urban Area Transportation Study (OUATS),
- Historical traffic counts (FDOT and Orange County) from 2005 through 2015 (within the study area)
- Population projections from the Bureau of Economic and Business Research (BEBR).

Based on the comparison of growth rates from these three sources, a recommended growth rate was determined and used to derive 2020 and 2040 turning movement volumes for the signalized study intersections. It should be noted that all growth rates referred to in this study are simple annual growth rates.

5.1.1 Model-Based Growth Rates

The year 2040 OUATS model was reviewed to verify if programmed improvements were included near the project limits, and scheduled for the next five-year period. Based on the review, it was determined that there are no funded improvements relating to road segment widening within the Pine Hills Road study area. The only programmed or planned improvements include:

- Orange County Trail System- Pine Hills Trail from Silver Star Road to Alhambra Drive: 2016-2018 (Completed),
- Orange County Trail System- Pine Hills Trail from Alhambra Drive to Clarcona-Ocoee Road: post 2018, and
- Pine Hills Road Lighting between Silver Star Road and North Lane.

Table 5.1 illustrates the model growth rates for Pine Hills Road. As shown in **Table 5.1**, the model based growth rates are less than 0.2% (0.13%). This reflects the general, built-out, land uses along the Pine Hills Road corridor. No significant redevelopment plans were identified either.

5.1.2 Historical Traffic Growth Rates

Based on the historic count information obtained from both FDOT and Orange County, a trends analysis was performed for the available count stations (2005 to 2015) on Pine Hills Road. Future growth trends were established by a least square linear regression of the historic counts. The FDOT historical trends based annual growth rate was less than 0.8% (0.72%) and the Orange County historical trends based annual growth rate was negative for two of the three stations and less than 0.9% for the remaining count station (0.40%) (**Table 5.1**).

5.1.3 Population Projections

Population projection data obtained from BEBR published by the University of Florida were also used for comparison purposes. The BEBR population projections are not indicative of growth in the Pine Hills Road corridor as they include regions having sufficient undeveloped tracts to grow very quickly, including Horizon West and other western beltway areas. The Pine Hills Road corridor is mature with little undeveloped land remaining. No major re-development plans were identified for areas within the study corridor. This roadway is not a prominent cut-through corridor that will increase due to shifting of traffic. The surrounding roadways in the corridor have similar land use characteristics as Pine Hills Road. The medium population Orange County wide estimate obtained from BEBR reported an annual growth rate of 2.09% per year (**Table 5.1**), but are not indicative of the expected growth for the Pine Hills Road corridor.

Table 5.1: Growth Rate Comparison

Source	Segment	Growth/Year	Method	Average by Source
FDOT	Colonial Drive to Balboa Drive	0.00%	Historic Trend	0.72%
FDOT	Balboa Drive to Silver Star Road	2.16%	Historic Trend	
FDOT	Silver Star Road to Bonnie Brae Circle	0.00%	Historic Trend	
Orange County	Colonial Drive to Balboa Drive	0.88%	Historic Trend	-0.40%
Orange County	Balboa Drive to Silver Star Road	-0.61%	Historic Trend	
Orange County	North Lane to Bonnie Brae Circle	-1.47%	Historic Trend	
OUATS	Colonial Drive to Balboa Drive	-0.03%	Model Growth	0.13%
OUATS	Balboa Drive to Silver Star Road	0.14%	Model Growth	
OUATS	Silver Star Road to Indian Hill Road	0.21%	Model Growth	
OUATS	Indian Hill Road to North Lane	0.21%	Model Growth	
Average of all source above:		0.15%		
BEBR	Medium Projection - Orange County	2.09%	Pop. Projection	2.09%

5.1.4 Recommended Growth Rate

The growth rates obtained from the above three sources, combined with the existing and expected land uses along the study corridor were reviewed to derive the recommended growth rate for the study area. The model based growth rates were less than 0.2%, the growth rates from historical traffic counts were negative (-0.4%), implying an insignificant change (decrease or no change) in traffic volumes in the last 10 years. The growth rate from the population estimates (low) is 2%, but includes regions growing very quickly, such as Horizon West and other western beltway areas. As a result of the assessment of the growth rates developed from the different sources and input from Orange County staff, an annual growth rate of 1% was deemed to be reasonable and appropriate.

5.1.5 Intersection Design Hour Volume Development

Based on a review of the growth rate evaluation summary and concurrence from Orange County staff, a growth rate of 1.0% per year was used to derive the intersection AM and PM peak hour volumes for the No Build Alternative for the Opening Year (2020) and Design Year (2040). The base (existing year, 2017) volumes served as the basis to apply the 1.0% per year growth to produce the future year 2020 and 2040 study intersection turning movement volumes.

Based on the proposed access management plan for the study corridor, the No Build Alternative peak hour volumes were reassigned to derive the peak hour volumes for the Build (Raised Median) alternative. The re-assignment of the turning movement volumes for the Build Alternative reflected the restriction to turns at certain intersections resulting from the installation of median improvements. In addition, an alternative was included in the analysis, which involved a minor variation to the Build Alternative Raised Median by providing a northbound to westbound directional median opening at the Via Maior intersection. The proposed access management plan (Raised Median) is provided in **Figure 7.5** and **Appendix D**.

5.2 Operational Analysis Results

The opening year (2020) and design year (2040) operational analyses were conducted to determine the LOS for the signalized study area intersections (including intersections with proposed signal improvements), for both the No Build and Build Alternatives. Per the scope, only signalized intersections were evaluated. For the No Build analysis, the unsignalized intersections of Pine Hills Road and Delores Drive, and Pine Hills Road and Indialantic Drive) were included because both are proposed to be signalized in the near future. The LOS for the signalized study area intersections were determined using the procedures as outlined in the Highway Capacity Manual (HCM 2010) using Synchro Software (Version 9.0) for signalized intersections.

In addition to the LOS for the automobile mode, the LOS for bicycle and pedestrian modes was also evaluated at the signalized intersections. As noted in *Technical Memorandum No. 3—Existing Conditions*, six-foot wide dedicated bicycle facilities exist along Pine Hills Road between SR 50 and Figwood Lane within the project limits for the No Build and Build Alternatives.

5.2.1 Automobile Operational LOS

A summary of the automobile operational LOS results for the No Build and Build Alternatives AM and PM peak hours is available in **Table 5.2** of this report. The Opening Year 2020 LOS results are summarized as follows:

- With the exception of the Silver Star Road and Pine Hills Road intersection, all the other signalized intersections are projected to operate at LOS D or better under the No Build Alternative. The Silver Star Road and Pine Hills Road intersection is projected to continue to operate at LOS E under the No Build Alternative, similar to existing conditions, in Opening Year 2020.
- The Build Alternative results were similar to the No Build results. With the exception of the Silver Star Road and Pine Hills Road intersection, all the other signalized intersections are projected to operate at LOS D or better under the Build Alternative. The Silver Star Road and Pine Hills Road intersection is projected to continue to operate at LOS E under the Build Alternative, again similar to existing conditions, in Opening Year 2020.
- Under this alternative, the Build Alternative median treatment for the Pine Hills Road at Via Maior intersection will be changed from no opening to a directional opening allowing northbound to westbound traffic movements under Stop control for the minor street.

The Design Year 2040 operational analysis results are similar to the Opening Year 2020 intersection LOS results, as summarized below:

- With the exception of the Silver Star Road and Pine Hills Road intersection and the North Lane and Pine Hills Road intersection, all the other signalized intersections are projected to operate at LOS D or better under the No Build Alternative for 2040. The Silver Star Road and Pine Hills Road intersection is projected to operate at LOS F under the No Build Alternative and the North Lane and Pine Hills Road intersection is projected to operate at LOS E in Design Year 2040.
- For the Build Alternative, with the exception of the Silver Star Road and Pine Hills Road intersection and the North Lane and Pine Hills Road intersection, all the other signalized intersections are projected to operate at LOS D or better for 2040. The Silver Star Road and Pine Hills Road intersection is projected to operate at LOS F under the Build Alternative and the North Lane and Pine Hills Road intersection is projected to operate at LOS E in Design Year 2040.

Table 5.2: Automobile No Build and Build Alternatives LOS

AM Peak Hour											
#	Intersection	Control Type	Opening Year 2020				Design Year 2040				
			No Build		Build		No Build		Build		
			Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	
5	Dolores Drive	Stop*	12.7/114.2	B/F	N/A	N/A	14.8/340.8	B/F	N/A	N/A	
5	Dolores Drive	Signal	N/A	N/A	3.3	A	N/A	N/A	3.8	A	
10	Indialantic Drive	Signal	12.4	B	12.4	B	14.6	B	14.7	B	
23	Balboa Drive	Signal	15.2	B	15.3	B	19.2	B	19.5	B	
24	Hernandes Drive	Signal	5.9	A	5.9	A	6.7	A	6.6	A	
25	Silver Star Road	Signal	59.9	E	60.7	E	64.6	E	68.5	E	
26	Belco Drive	Signal	19.5	B	20.1	C	27.3	B	33.4	C	
27	Londonderry Boulevard	Signal	6.8	A	6.7	A	7.8	A	7.8	A	
28	Indian Hill Road	Signal	15.1	B	15.1	B	18.9	B	19.2	B	
PM Peak Hour											
#	Intersection	Control Type	Opening Year 2020				Design Year 2040				
			No Build		Build		No Build		Build		
			Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	
5	Dolores Drive	Stop*	14.5/173.4	B/F	N/A	N/A	17.8/646.4	C/F	N/A	N/A	
5	Dolores Drive	Signal	N/A	N/A	4.7	A	N/A	N/A	7.2	A	
10	Indialantic Drive	Signal	14.3	B	14.5	B	18.1	B	18.8	B	
23	Balboa Drive	Signal	19.4	B	19.5	B	25.4	B	26.5	C	
24	Hernandes Drive	Signal	8.3	A	8.4	A	10.0	B	10.3	B	
25	Silver Star Road	Signal	71.8	E	72.1	E	97.4	F	99.3	F	
26	Belco Drive	Signal	10.2	B	11.0	B	12.1	B	13.1	B	
27	Londonderry Boulevard	Signal	4.9	A	4.9	A	6.1	A	6.3	A	
28	Indian Hill Road	Signal	13.9	B	14.0	B	18.8	B	19.4	B	
29	North Lane	Signal	41.0	D	41.0	D	55.1	E	56.0	E	

(1) Automobile delay and LOS based on Synchro 9 and HCM 2010

* Unsignalized Intersection Analysis. Reported for Worst Condition Delay for the Major Street Left/Minor Street Movements.

A summary of the automobile operational LOS results for the Build Alternative 1 AM and PM peak hours are shown in **Table 5.3** for years 2020 and 2040, respectively. The operational LOS results are summarized as follows:

- For the No-Build Alternative, the Pine Hills Road and El Trio Way intersection will continue to operate at an acceptable LOS C or better for both the Opening Year 2020 and the Design Year 2040. It should be noted that this intersection is closed and the results would change if the intersection was open. However, the results include U-turns that would utilize the Build Alternative 1 directional median configuration.
- For the No-Build Alternative, the Pine Hills Road and Via Major intersection is projected to operate at LOS F for the minor street movements for both the Opening Year 2020 and the Design Year 2040.
- For the Build Alternative, the Pine Hills Road and El Trio Way intersection is projected to continue to operate at an acceptable LOS C or better for both the Opening Year 2020 and the Design Year 2040. Again, it should be noted that his intersection is closed and the results would change if the intersection was open and the results include U-turns that would utilize the Build Alternative 1 directional median configuration.
- For the Build Alternative, the Pine Hills Road and Via Major intersection is projected to operate at an acceptable LOS E or better for both the Opening Year 2020 and the Design Year 2040.

The Synchro reports for the future conditions are included as in *Technical Memorandum No. 5—Future Travel Demand Report* (see **Appendix E**).

Table 5.3: Automobile Build Alternatives

AM Peak Hour											
#	Intersection	Control Type	Opening Year 2020				Design Year 2040				
			No Build		Build		No Build		Build		
			Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	
13	El Trio Way	Stop	13.8/0.0	B/A	15.1/0.0	C/A	16.4/0.0	C/A	13.8/0.0	B/A	
14	Via Maior	Stop	16.1/51.0	C/F	16.2/23.6	C/C	21.4/140.4	C/F	21.7/37.2	C/E	
PM Peak Hour											
#	Intersection	Control Type	Opening Year 2020				Design Year 2040				
			No Build		Build		No Build		Build		
			Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	
13	El Trio Way	Stop	12.7/0.0	B/A	13.4/0.0	B/A	14.8/0.0	B/A	16.0/0.0	C/A	
14	Via Maior	Stop	13.6/30.3	B/D	13.7/17.7	B/C	16.7/902.6	C/F	16.9/22.7	C/C	

(1) Automobile delay and LOS based on Synchro 9 Unsignalized Intersection Analysis.

* Unsignalized Intersection Analysis. Reported for Worst Condition Delay for the Major Street Left/Minor Street Movements.

5.2.2 Pedestrian/Bicycle Operational LOS

A summary of the peak hour LOS results for pedestrian and bicycle modes are shown in **Table 5.4** and **Table 5.5** for the opening year 2020 and 2040 No-Build and Build alternatives. Based on the No-Build Alternative analysis results, the pedestrian/bicycle modes at all but one (1) of the study signalized intersections are anticipated to operate at LOS D or better, for both Opening Year (2020) and Design Year (2040). Under the No-Build condition, the unsignalized intersection of Pine Hills Road and Delores will experience a LOS F condition for northbound and southbound pedestrians (no analysis procedure is provided in the HCM for bicycles under unsignalized analysis) during the AM and PM peak periods.

Based on the Build Alternative analysis results, the pedestrian/bicycle modes at all of the study signalized intersections are anticipated to operate at LOS D or better, for both opening (2020) and design year (2040). The results are summarized as follows:

- 2020 Opening Year Results
 - Based on the No Build analysis results, the pedestrian/bicycle modes at all but one (Dolores Drive) of the study signalized intersections are anticipated to operate at LOS D or better, for both Opening Year (2020) and Design Year (2040).
- 2040 Design Year Results
 - Based on the No Build analysis, the intersection of Silver Star Road will experience LOS E for southbound bicycles during the AM period and LOS E for northbound bicycles during the PM peak period.

Table 5.4: Pedestrian Intersection LOS

AM Peak Hour																		
#	Intersection	Control Type	Opening Year 2020								Design Year 2040							
			No Build LOS				Build LOS				No Build LOS				Build LOS			
			EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
5	Dolores Drive	Stop	B	B	F	F	N/A	N/A	N/A	N/A	B	B	F	F	A	A	C	C
5	Dolores Drive	Signal	N/A	N/A	N/A	N/A	A	A	C	C	N/A	N/A	N/A	N/A	A	A	C	C
10	Indialantic Drive	Signal	A	A	C	C	A	A	C	C	A	A	C	C	A	A	C	C
23	Balboa Drive	Signal	A	A	C	C	A	A	C	C	A	A	C	C	A	A	C	C
24	Hernandes Drive	Signal	A	A	C	C	A	A	C	C	A	A	C	C	A	A	C	C
25	Silver Star Road	Signal	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
26	Belco Drive	Signal	A	A	C	C	A	A	C	C	A	A	C	C	A	A	C	C
27	Londonderry Blvd	Signal	N/A	B	C	C	N/A	B	C	C	N/A	B	C	C	N/A	B	C	C
28	Indian Hill Road	Signal	B	N/A	C	B	B	N/A	C	C	B	N/A	C	C	B	N/A	C	C
29	North Lane	Signal	B	B	C	B	B	B	C	B	B	B	C	C	B	B	C	C
PM Peak Hour																		
#	Intersection	Control Type	Opening Year 2020								Design Year 2040							
			No Build LOS				Build LOS				No Build LOS				Build LOS			
			EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
5	Dolores Drive	Stop	B	B	F	F	N/A	N/A	N/A	N/A	B	B	F	F	A	A	C	C
5	Dolores Drive	Signal	N/A	N/A	N/A	N/A	A	A	C	C	N/A	N/A	N/A	N/A	A	A	C	C
10	Indialantic Drive	Signal	A	A	C	C	A	A	C	C	A	A	C	C	A	A	C	C
23	Balboa Drive	Signal	A	A	C	C	B	A	C	C	B	A	C	C	B	A	C	C
24	Hernandes Drive	Signal	A	B	C	C	B	B	C	C	B	B	C	C	B	B	C	C
25	Silver Star Road	Signal	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
26	Belco Drive	Signal	A	A	C	C	A	A	C	C	A	A	C	C	A	A	C	C
27	Londonderry Blvd	Signal	N/A	B	C	C	N/A	B	C	C	N/A	B	C	C	N/A	B	C	C
28	Indian Hill Road	Signal	B	N/A	C	C	B	N/A	C	C	B	N/A	C	C	B	N/A	C	C
29	North Lane	Signal	B	B	C	C	B	B	C	B	B	B	C	C	B	B	C	C

Table 5.5: Bicycle Intersection LOS

AM Peak Hour																		
#	Intersection	Control Type	Opening Year 2020								Design Year 2040							
			No Build LOS				Build LOS				No Build LOS				Build LOS			
			EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
5	Dolores Drive	Signal	N/A	N/A	N/A	N/A	B	B	C	C	N/A	N/A	N/A	N/A	B	B	C	C
10	Indialantic Drive	Signal	B	B	B	C	B	B	C	C	B	B	C	C	B	B	C	C
23	Balboa Drive	Signal	C	B	B	C	C	B	B	C	C	B	C	C	C	B	C	C
24	Hernandes Drive	Signal	B	B	C	C	B	B	C	C	B	B	C	C	B	B	C	C
25	Silver Star Road	Signal	D	C	D	D	D	C	D	D	D	D	D	E	D	D	D	E
26	Belco Drive	Signal	C	B	C	C	C	B	C	C	C	B	C	C	C	B	C	C
27	Londonderry Blvd	Signal	N/A	C	C	D	N/A	C	C	D	N/A	C	C	D	N/A	C	C	D
28	Indian Hill Road	Signal	C	N/A	C	C	C	N/A	C	C	C	N/A	C	C	C	N/A	C	C
29	North Lane	Signal	C	C	B	B	C	C	C	B	C	C	C	C	C	C	C	C
PM Peak Hour																		
#	Intersection	Control Type	Opening Year 2020								Design Year 2040							
			No Build LOS				Build LOS				No Build LOS				Build LOS			
			EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
5	Dolores Drive	Signal	N/A	N/A	N/A	N/A	B	B	C	C	N/A	N/A	N/A	N/A	B	B	D	C
10	Indialantic Drive	Signal	B	B	C	C	B	B	C	C	B	B	C	C	B	B	C	C
23	Balboa Drive	Signal	C	B	C	C	C	B	C	C	C	B	C	C	C	B	D	C
24	Hernandes Drive	Signal	B	B	C	C	B	B	C	C	B	C	D	C	B	C	D	C
25	Silver Star Road	Signal	C	D	D	D	C	D	D	D	D	D	E	D	D	E	E	D
26	Belco Drive	Signal	C	B	C	C	C	B	C	C	C	B	C	C	C	B	C	C
27	Londonderry Blvd	Signal	N/A	B	C	D	N/A	B	D	C	N/A	C	D	D	N/A	C	C	D
28	Indian Hill Road	Signal	C	N/A	D	C	C	N/A	D	C	C	N/A	D	C	C	N/A	D	C
29	North Lane	Signal	C	C	C	B	C	C	C	B	C	D	C	C	C	D	C	C

5.3 Future Conditions Conclusions

Based on the multimodal operational analysis of the study intersections, it is anticipated that under the proposed Build Alternative access modifications, all the study signalized intersections except Silver Star Road and North Lane will operate at LOS D or better by 2040. This outcome is similar to the results for the No Build Alternative. The proposed Build Alternative access modifications will not adversely impact the traffic operations of any mode (auto, pedestrian or bicycle modes) under future conditions (2020 and 2040). For the non-motorized modes, the No Build Alternative indicates that Delores Drive will operate at LOS F for bicycles during the AM and PM peak hours.

The signalized intersection delays would be slightly higher under the Build Alternative compared to the No Build Alternative, but would not result in a change in the LOS conditions. Moreover, LOS conditions at the unsignalized intersection would generally remain the same or were improved under the Build Alternative (compared to the No Build Alternative) because of the left turn movements restricted at many of the side streets/driveways along the corridor. For the non-motorized modes, the No Build and Build Alternatives would have similar results under the future conditions.

6.0 Issues and Opportunities

The following potential safety measures have been proposed to address crash history along Pine Hills Road and improve pedestrian and bicycle safety along this roadway. These measures are not only expected to reduce pedestrian and bicycle crashes, but they can also result in corollary benefits by reducing vehicular crashes thereby achieving overall safety improvements for the corridor.

6.1 Lighting

The Pine Hills Road corridor experienced a high incidence of crashes at night and the luminosity survey indicated the existing lighting does not meet FDOT standards. Accordingly, lighting improvements are proposed consisting of new LED fixtures to increase the visibility of pedestrians and bicyclists as they travel along the Pine Hills Road corridor. Improved lighting can also improve visibility for vehicular traffic as well. As a side benefit, lighting can provide pedestrians and bicyclists with a greater sense of security.

6.2 Raised Medians

The access management plan developed under this study recommends replacing the current five-lane undivided roadway with a four-lane section with a raised median. Raised medians can improve safety by reducing the number of potential conflict points at driveways and intersections. In addition, raised medians provide the opportunity for refuge at mid-block crossings or intersections, thereby giving pedestrians and bicyclists a safe place to rest as they cross the street and wait for gaps in traffic.

6.3 Landscaping

In addition to providing aesthetic improvements along the corridor and creating a sense of place, landscaping can serve to guide pedestrian and bicycle movements to designated crosswalks or intersections to improve safety. Orange County currently provides standard, low maintenance landscaping on their projects which includes sod and small trees that do not require irrigation.

As an option, enhanced landscaping consisting of scrubs and ground cover can also be provided to reinforce pedestrian crossings at designated or desirable locations while providing a higher level of aesthetics. However, the cost of materials, installation and maintenance costs are typically higher with this option.

6.4 Pedestrian Channelizing Devices

Pedestrian channelization devices can be installed within a raised median that can serve to guide pedestrian and bicycle movements to designated crosswalks. Pedestrian channelization devices are recommended to be installed in accordance with FDOT Standard Index D804.

6.5 Lane Width Reductions

The installation of raised medians will require the width of the travel lanes to be reduced in order to avoid reconstructing the existing outside curbs. One benefit of decreasing the width of travel lanes is the crossing distances for pedestrians will be shortened as well.

6.6 Pedestrian Signals

The implementation of pedestrian crossing signals, such as Rectangular Rapid Flashing Beacons (RRFB's) or High intensity Activated crossWalk (HAWK), encourages pedestrians/bicyclists to use the crosswalk instead of attempting to cross at other non-designated locations. In addition,

RRFB's or HAWK's can increase motorist awareness of pedestrian/bicyclist movements at marked crosswalks.

6.7 Transit Stop Improvements

By relocating transit stops or shelters close to marked crosswalks or intersections, pedestrians/bicyclists are more incentivized to cross at marked locations, thereby improving safety. A summary of the recommendations for existing bus station improvements is shown in **Table 6.1**.

6.8 Silver Star Road / Pine Hills Road Intersection Improvements

The curb returns at the Silver Star Road/Pine Hills Road intersection will be reconstructed where possible to provide for shorter crossing distances for pedestrians. In addition, the crosswalks will be rebuilt and widened to a minimum of 10 feet with high intensity pavement markings.

6.9 Multi-Use Path

Multi-use paths can improve safety by providing an opportunity for safe pedestrian or bicycle travel in a separate area away from vehicular traffic. Multi-use paths are particularly beneficial when bicycle lanes are not present on the roadway and can also accommodate children or some bicyclists that may not be comfortable riding on the roadway.

6.10 Pedestrian / Bicyclist Education Programs

Pedestrian/bicyclist education programs provide greater awareness and understanding to residents about how to walk and ride safely in their community. A number of crashes had "Dart/Dash" (pedestrians darting or dashing across the roadway) movements as a contributing factor, and education programs especially for children can potentially reinforce better crossing behavior. The "Walk-Ride-Thrive!" program is planning an educational event at the Pine Hills Boys & Girls Club during FDOT Mobility Week.

Table 6.1: Recommendations for Bus Stop Improvements

No.	Location	Approximate Distance to Nearest Crosswalk across Pine Hills Road (ft)	Boardings & Alightings	Recommendation	Distance to Crosswalk After	Install Amenities	Cost
Northbound Direction							
1	N of Colonial Drive	200	81/51	Keep	200	Shelter	\$18,000
2	S of Deauville Drive	700	7/10	Relocate - Consolidate with Stop 3 - move to N. of Sunniland Drive	260		
3	N of Balboa Drive	170	6/14	Remove - consolidate with Stop #2	170		
4	N of Dolores Drive	830	12/37	Keep	140		
5	N of Elinore Drive	2,300	0/0	Remove – serves Link 301 only	--		
6*	S of Ferdinand Drive	1,390	1/7	Remove	40		
7	S of Hernandes Drive	100	6/36	Keep	100		
8	N of Indialantic Drive	300	2/29	Keep	50		
9	S of Figwood Lane	220	6/36	Relocate stop to far side of Figwood – relocate mid-block crossing	85		
10	N of Belco Drive	200	46/64	Keep	200	Shelter	\$18,000
11	S of Via Maior	230	4/24	Relocate - Consolidate with stop #12 to Londonderry Blvd	50		
12	N of Pipes O the Glen Way	50	12/17	Remove - consolidate with stop #11	50		
13	S of Indian Hill Road	90	0/0	Consolidate with Stop 14 – move to far side of Indian Hills Rd with cross walk	60		
14	N of Van Aken Drive	890	0/1	Remove - consolidate with stop 13	60		
15	S of White Heron Drive	870	0/0	Remove - consolidate with stop 16	10		
16	S of North Lane	10	0/2	Keep – consolidate with stop 15	10		
Southbound Direction							
17	N of Alhambra Drive	40	7/81	Keep	40		
18	S of Deauville Drive	690	7/6	Relocate shelter - consolidate with stop 19 – add mid-block	50		
19	N of Sunniland Drive	250	14/7	Consolidate with Stop 18 – add mid-block	50		
20	S of Dolores Drive	720	29/9	Keep	50	Bicycle Rack	\$1,000*
21*	N of Elinore Drive	1,590	21/5	Consolidate with Stop 22	10		
22	S of Ferdinand Drive	1,350	4/3	Remove - consolidate with Stop 21	10		

Table 6.1 (continued): Recommendations for Bus Stop Improvements

No.	Location	Approximate Distance to Nearest Crosswalk across Pine Hills Road (ft)	Boardings & Alightings	Recommendation	Distance to Crosswalk After	Install Amenities	Cost	
23*	S of Hernandes Drive	280	44/11	Keep	60	Shelter	\$18,000	
24*	S of Indialantic Drive	590	37/4	Keep	50	Shelter	\$18,000	
25	S of Figwood Lane	310	10/1	Remove - consolidate with Stop 26	60			
26	S of Lupez Drive	260	84/6	Consolidate with Stop 25 relocate mid-block crossing	60		**	
27	S of Belco Drive	190	49/14	Consolidate with Stop 28 – relocate to N. Belco (future transit station)	70		**	
28	N of Belco Drive	70	16/19	Keep	70			
29	N of El Trio Way	100	10/1	Relocate north to Londonderry	50			
30	S of Pipes O the Glen Way	160	6/3	Remove - consolidate with Stop 29	50			
31	S of Indian Hill Road	110	18/2	Keep	110			
32	N of Van Aken Drive	730	14/4	Remove – consolidate with Stop 31	--			
33	N of Fir Drive	560	13/3	Relocate to south of North Lane	120			
	Relocate Stop					New Shelters	4	\$72,000***
	Remove Stop					New Bicycle Racks	1	\$1,000
	Consolidate & Move Stop					Total Cost		\$73,000

* Existing shelter at location. U-style bicycle rack could serve Pine Hills Trail Crossing.

** Location is not suitable for a shelter or bench due to ROW constraints.

*** Amenities include LYNX standard shelter, bench, and trash can.

7.0 Candidate Improvement Strategies

7.1 Overview of Improvement Strategies

This section analyzes two alternatives considered for the Pine Hills Road corridor as described below:

- No Build Alternative – a “do nothing” approach where only limited changes will be made to the existing roadway section consisting only those that are currently programmed. Under this alternative, the current crash history can be expected to continue.
- Build Alternative – includes various safety measures such as a raised median consistent with access management changes, dedicated left turn lanes, multi-use path, landscaping and other improvements.

7.1.1 No Build Alternative

The No Build Alternative reflects the continuation of existing pedestrian, bicycle, traffic, and transit operations along Pine Hills Road through 2040 with little changes other than programmed transportation infrastructure and service improvements as identified in *Technical Memorandum No. 2—The Evaluation of Existing Plans and Studies*. One such planned program are new lighting improvements between Silver Star Road and North Lane. For the most part, the No Build Alternative will closely reflect the existing physical configuration of Pine Hills Road, as illustrated in the typical sections displayed in **Figures 7.1** and **7.2**.

Figure 7.1: No Build Alternative Typical Section: Colonial Drive to Silver Star Road

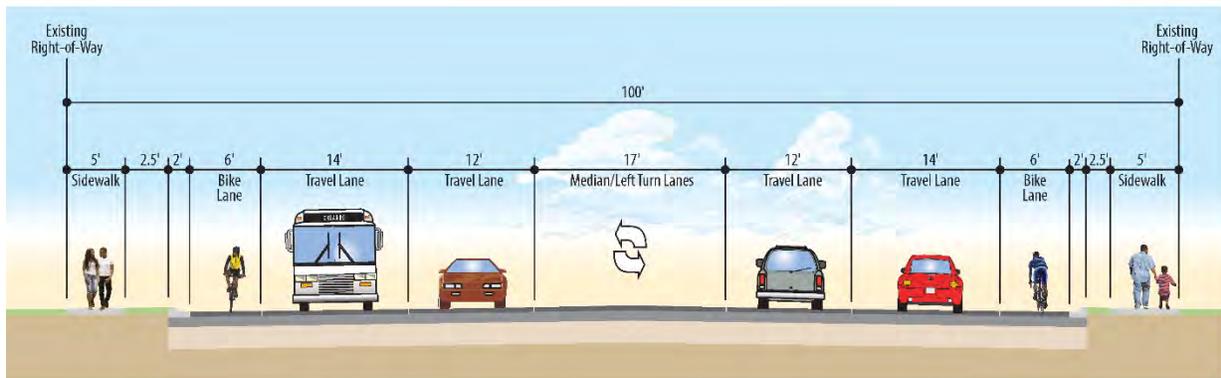
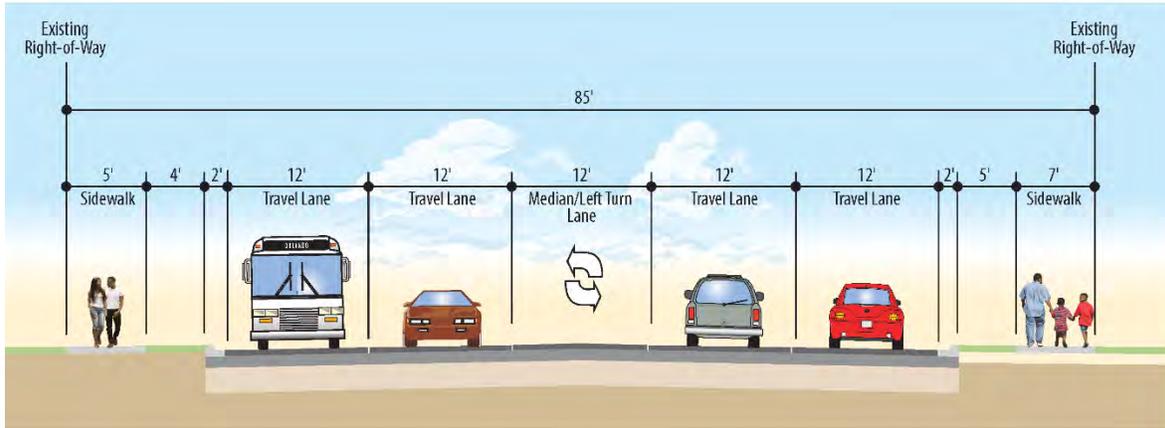


Figure 7.2: No Build Alternative Typical Section: Silver Star Road to Bonnie Brae Circle



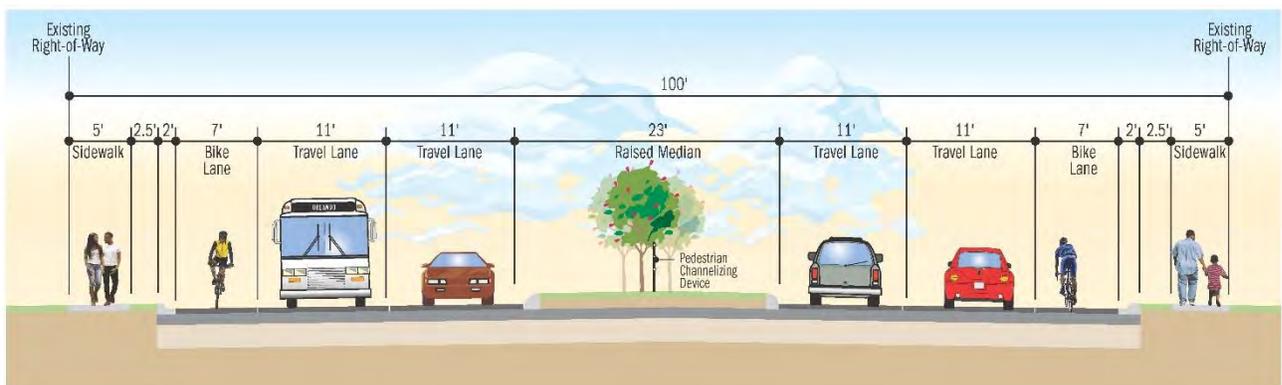
7.1.2 Build Alternatives

The Build Alternative(s) incorporates the application of several safety measures along the Pine Hills Road corridor as well as the Pine Hills Road/Silver Star Road intersection (further detailed in **Section 8.2** and **Appendix E**).

An access management review (see *Technical Memorandum No. 4 – Access Management*) was performed which recommended a raised median could be expected to likely reduce potential conflict points with a corresponding reduction in crashes and improvement in both pedestrian and vehicular safety. The above report also identified appropriate intersection treatments along the Pine Hills Trail corridor. These median improvements and intersection treatments form the basis of the Build Alternative and are summarized further in the following paragraphs and shown as Build Alternative, Raised Median in **Figures 7.3** and **7.4**.

7.1.2.1 Phase 1: Colonial Drive to Silver Star Road

Figure 7.3: Proposed Build Typical Section: Colonial Drive to Silver Star Road

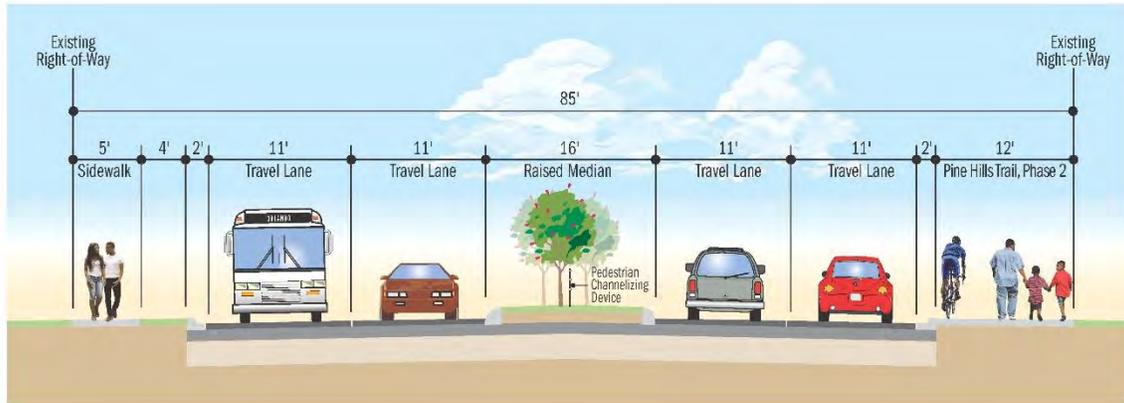


South Segment – Colonial Drive (SR 50) to Silver Star Road (SR 438)

- Provide following intersection improvements:
 - Alhambra Drive - Provide directional median opening
 - Deauville Drive – Provide full median opening
 - Balboa Drive – Provide full median opening
 - Dolores Drive – Provide full median opening with new traffic signals for the Pine Hills Trail Spur
 - Add pedestrian crosswalks on north and south legs
 - Elinore Drive - Provide full median opening
 - Mid-Block Location between Elinor Drive and Ferdinand Drive – Provide full median opening
 - Ferdinand Drive - Provide full median opening
 - Hernandes Drive – Provide full median opening
 - Indialantic Drive – Provide full median opening with new traffic signals
 - Add pedestrian crosswalks on all four legs
 - Figwood Lane – Provide full median opening
 - Silver Star Road – Reconstruct curb returns and add high intensity crosswalks
- Construct a 23-foot raised median with landscaping, including 11-foot left turn lanes at selected locations
- Reduce outside lane widths through median improvements and restriping from 14-foot lanes to 11-foot lanes
- Reduce inside lane widths through median improvements and restriping from 12-foot lanes to 11-foot lanes
- Transit Stop Changes:
 - Remove Stop #3, 5, 22, and 25.
 - Relocate Stops #2 and 18.
 - Consolidate and Move Stops #19 and 26.
- Provide upgraded lighting improvements, decreasing the distance between light pole and changing the lamp fixtures to LED lamps, from Colonial Drive to Silver Star Road
- Gateway Improvement features at the intersection of Pine Hills Road and Silver Star Road
 - Enhanced crosswalk markings
 - Curb reconstruction
 - Sign tower
 - Low wall
 - Wayfinding signage
 - New mast arm signals

7.1.2.2 Phase 2: Silver Star Road to Bonnie Brae Circle

Figure 7.4: Proposed Build Typical Section: Silver Star Road to Bonnie Brae Circle



North Segment – Silver Star Road (SR 438) to Bonnie Brae Circle

- Provide following intersection improvements:
 - Belco Drive – Provide full median opening
 - Via Maior – Provide directional median opening
 - Londonderry Boulevard – Provide full median opening
 - Champagne Circle – Provide full median opening
 - Indian Hill Road – Provide full median opening
 - Van Aken Drive - Provide full median opening
 - White Heron Drive - Provide directional median opening
 - North Lane - Provide full median opening
- Construct a 16-foot raised median with standard landscaping, including 11-foot left turn lanes with a traffic separator where indicated
- Reduce lane widths through restriping from 12-foot lanes to 11-foot lanes
- To accommodate U-turn movements north of Silver Star Road, additional roadway width will be needed to accommodate turning vehicles. This extra width will be achieved by reconstructing the outside curbs through the use of flares or bulb-outs which may require additional right-of-way
- Construct a new 12-foot shared use path on the east side of Pine Hills Road from Belco Drive to Bonnie Brae Circle
- Transit Stop Changes:
 - Remove Stop #12, 14, 15, 30, and 32.
 - Relocate Stops #9, 11, 29, and 33.
 - Consolidate and Move Stops #13 and 27.

Figure 7.5: Build Alternative, Raised Median



Figure 7.5 (continued) : Build Alternative, Raised Median



Figure 7.5 (continued) : Build Alternative, Raised Median

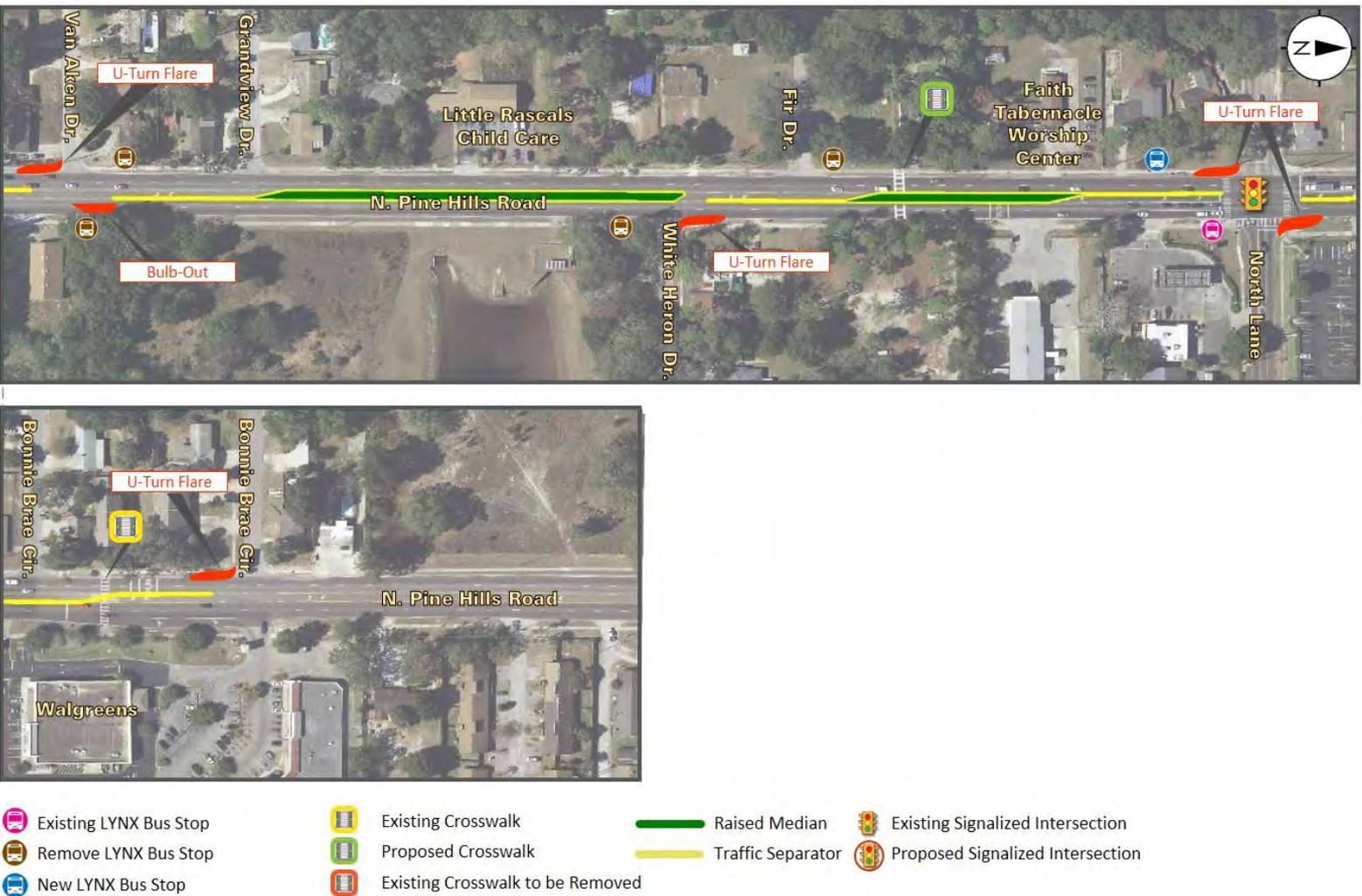


Figure 7.5 (continued) : Build Alternative, Raised Median



- Existing LYNX Bus Stop
- Remove LYNX Bus Stop
- New LYNX Bus Stop
- Existing Crosswalk
- Proposed Crosswalk
- Existing Crosswalk to be Removed
- Raised Median
- Traffic Separator
- Existing Signalized Intersection
- Proposed Signalized Intersection

Figure 7.5 (continued) : Build Alternative, Raised Median



7.2 Screening of Candidate Recommendations

This chapter screens the No Build and Build Alternatives on how well they meet the project purpose and objectives – “to make Pine Hills Road safer for pedestrians and bicyclists.” This project has the following objectives:

- Create a roadway environment for users of all ages and abilities
- Provide safe access for pedestrians/bicyclists to cross Pine Hills Road
- Provide safe access to and from schools, religious institutions, businesses, and residential areas – for all modes of travel

The screening of the No Build and Build Alternatives is summarized in **Table 7.1** which indicates how well these alternatives subjectively meet the project purpose and objectives.

Table 7.1: Build / No Build Summary Matrix

Evaluation Criteria (Project Purpose and Objectives)	Alternative	
	No Build Alternative	Build Alternative
Objective #1 - Create a roadway environment for users of all ages and abilities	Low	High
Objective #2 – Provide safe and more convenient access for pedestrians and bicyclists to cross Pine Hills Road	Low	High
Objective #3 – Provide safe access to and from schools, religious institutions, businesses, and residential areas for all modes of travel	Low	High

7.2.1 No Build Alternative

The No Build Alternative is not expected to result in substantial improvement of pedestrian and bicycle safety along the Pine Hills Road Corridor since only a few safety improvements are planned such as roadway lighting from Silver Star Road to Bonnie Brae Circle. The No Build Alternative is also not expected to substantially increase the safety and convenience for pedestrians and bicyclists to cross Pine Hills Road, nor is it expected to advance safe pedestrian and bicycle access to schools, religious institutions, businesses and residential areas along Pine Hills Road.

7.2.2 Build Alternative

The Build Alternative is projected to result in substantial improvement of pedestrian and bicycle safety along the Pine Hills Road corridor through the use of various safety measures including access management initiatives such as providing a raised median, narrower travel lanes, multi-use path, landscaping and other pedestrian safety improvements as outlined earlier in this report. The final determination will be made during final design.

7.3 Preliminary Cost Estimates

This chapter summarizes the methodology and assumptions used in preparing the preliminary cost estimate for various safety improvements identified under this study which are summarized in **Table 7.2**. The cost estimates are based on planning quantities and FDOT unit prices (2017) which should be reviewed and further refined during final design. In addition, the preliminary cost

estimates have been further adjusted for the following additional expenses and their assumed percentages:

- Mobilization: 5% of subtotal cost
- Maintenance of Traffic: 5% of subtotal cost
- Contingency: 20% of subtotal cost

The above contingency estimate also provides for design and CEI costs. Listed in **Table 7.2** is a summary of the proposed safety improvements and costs for the Build Phases. Preliminary cost estimates for the two primary Build Phases shown on **Table 7.2** are included in **Appendix F** along with individual cost estimates of each safety improvement. Since the cost estimates are based on planning level quantities, certain assumptions were necessary to determine the cost estimates. Some of the relevant assumptions are listed below:

- Construction of the 16-foot and 23-foot raised medians assume an excavation depth of six inches to remove the existing roadway surface and place the curbing.
- Reduced lane width assumes that the existing pavement will be milled and resurfaced, which will allow new pavement markings to be placed. Milling depth is assumed to be two inches.
- Multi-use path quantities assume the existing concrete sidewalk will be removed and a new 12-foot wide multi-use path will be constructed with four inches of concrete.
- Standard landscaping is consistent with Orange County's construction program which typically includes sod with crepe myrtles (or equivalent) without irrigation.
- Enhanced landscaping will have a higher level of landscaping including a high use of scrubs and ground cover.
- Pedestrian channelizing devices will be provided meeting FDOT Standard Index D804. Actual limits of the pedestrian channelizing devices will be determined during final design.
- To accommodate U-turn movements north of Silver Star Road where the existing roadway is relatively narrow, the outside curbs will be reconstructed to create a wider roadway using flares or bulb-outs to provide additional width to accommodate turning vehicles.

Table 7.2: Proposed Safety Improvements and Preliminary Cost Estimates

Phase No.	Description of Improvement	Estimated Costs
<p>Phase 1 – South Segment Colonial Drive to Silver Star Road</p>	<ul style="list-style-type: none"> ▪ Construct 23' raised median, including 11' left turn lane and separator ▪ Reduce lane widths (restriping after milling & resurfacing) ▪ Construct pedestrian channelizing devices in median ▪ Remove LYNX bus stops #3, 5, 22 and 25. ▪ Relocate LYNX bus stops #2, 18 and 23 ▪ Consolidate and move LYNX bus stops #19 and 26. ▪ Milling & resurfacing ▪ Standard Landscaping ▪ Silver Star Road Intersection Improvements ▪ Install One RRFB or HAWK signal ▪ Install roadway lighting improvements from Colonial Drive to Silver Star Road ▪ Gateway Improvement Features 	<p>\$3.75 million</p>
<p>Phase 2 – North Segment Silver Star Road to Bonnie Brae Circle</p>	<ul style="list-style-type: none"> ▪ Construct 16' raised median, including 11' left turn lane and separator at designated locations ▪ Reduce lane widths (restriping after milling & resurfacing) ▪ Construct pedestrian channelizing devices in median ▪ Construct 12' shared use path from Belco Drive to Bonnie Brae Circle ▪ Remove LYNX bus stops #12, 14, 15, 30 and 32. ▪ Relocate LYNX bus stops #9, 11, 29 and 33. ▪ Consolidate and move LYNX bus stops #13 and 27. ▪ Add U-turn flares at Belco Drive (SW and NE), Londonderry (NE), Champagne Circle (SW), Indian Hill Road (SW), Van Aken Drive (SW), White Heron Drive (NE), North Lane (SW and NE), Bonnie Brae Circle (SW) ▪ Add bulb-outs at Londonderry (SW), Champagne Circle (NE), Indian Hill Road (NE), and Van Aken Drive (NE), ▪ Milling & resurfacing ▪ Standard Landscaping ▪ Install One RRFB or HAWK signal 	<p>\$2.05 million</p>

7.4 Benefit / Cost Analysis

This chapter provides an overview of the benefit and cost analyses for the recommended safety measures on this project. Benefits are derived from anticipated reductions in crash experience, while costs are measured in terms of construction and maintenance expenses, with both quantified in dollars over the design life of the safety improvements.

The methodology employed by this report is consistent with the process and guidelines used by the Florida Department of Transportation (FDOT) in their Plans Preparation Manual (PPM). A discount (interest) ratio of 4% was used as suggested in the PPM.

For the purposes of this study, the historical crashes were used to calculate the benefit to cost ratio for the proposed safety improvements. This ratio consists of the estimated annual reduction in crash costs (benefits) divided by the estimated annual increase in combined construction and maintenance expenses (costs). The annualized calculations will show whether the projected expenditure of funds for the crash benefit will exceed the direct cost for the improvement.

The benefit/cost methodology uses the Highway Safety Improvement Program Guideline (HSIPG) cost per crash by facility type as shown in Table 23.6.1 of the FDOT's PPM to estimate the benefit to society, while the cost to society is estimated by the expected cost of right of way, construction and maintenance. Based on the information provided in the PPM, an average cost per crash (for Florida between 2010 and 2014) for a 4-5 lane urban divided roadway facility was \$119,072.

7.4.1 Construction Cost Estimates

Estimated costs for each safety measure and benefit cost ratios have been calculated for the two Build Alternative phases as noted in **Table 7.3**. Additional information regarding estimated costs for the safety improvements, benefit/cost calculations, and CMF/CRF data can be found in **Appendix F**.

By quantifying the benefits of each measure in terms of cost savings from crash reductions, a benefit to cost ratio (B/C) can be developed by applying the estimated costs of each proposed safety improvement. This benefit/cost ratio can then provide a logical rationale for comparing various safety measures and prioritizing the improvements.

A listing of various safety measures, estimated costs, and benefit/cost ratios have been prepared for three primary build options as displayed in **Table 7.3**.

7.4.2 Benefits

This section contains the process of quantifying countermeasure benefits in terms of the annual cost savings associated with the expected reduction of pedestrian and bicycle involved crashes along the study corridor, if the proposed safety countermeasure improvements are constructed.

Crash Reduction Factors (CRFs) were derived from FDOT's database and applied to various safety measures associated with this study. Where FDOT CRF's were not available, one of two alternatives were used to develop CRF's:

1. FHWA Crash Modification Factors (CMF) appropriate for the improvement were identified and converted to CRFs.
2. CRFs were developed based upon the alternative studies or corridor specific conditions.

The crash analysis was conducted to emulate FDOT's "CRASH" software format. Therefore, the CRFs used for this study were taken directly from FDOT's table of CRF's which is included in the detailed calculations and supporting data collected in **Appendix F-3**. The CRF's employed by this study are listed below and a more detailed breakdown of this methodology is included in **Appendix F-3**.

Table 7.3: Estimated Construction Costs and Benefit Cost Ratios for Recommended Safety Improvements

Phase No.	Safety Improvement (s)	Estimated Construction Costs (Current Dollars)	Benefit / Cost Ratio
1	Colonial Drive to North of Silver Star Road		
	- Raised Median, Reduced Travel Lanes	\$ 1,438,545	11.84
	- Standard Landscaping	\$ 148,493	12.81
	- Enhanced Landscaping*	\$ 178,706	11.64
	- Silver Star Intersection	\$ 188,937	7.61
	- Pedestrian Channelizing Devices	\$ 50,515	13.79
	- Changes to LYNX Stops	\$ 19,825	19.11
	- RRFB	\$ 48,281	3.28
	- HAWK*	\$ 91,435	1.90
	- Pedestrian Education	\$ -	
	- Lighting (Colonial Drive to Silver Star Road)	\$ 1,082,369	4.12
	- Gateway Improvements (Landscape, Hardscape)	\$ 396,993	4.31
	- New Signals at Silver Star Road	\$ 372,357	66.25
	- TOTAL (With Standard Landscaping)*	\$ 3,746,315	
2	North of Silver Star Road to Bonnie Brae Circle		
	- Raised Median, Reduced Travel Lanes	\$ 1,402,275	7.19
	- Standard Landscaping	\$ 64,253	6.88
	- Enhanced Landscaping*	\$ 77,643	8.10
	- Reconstruct/Widen Sidewalk	\$ 492,986	15.34
	- Pedestrian Channelizing Devices	\$ 31,559	8.10
	- Changes to LYNX Stops	\$ 5,915	64.04
	- RRFB	\$ 48,281	3.28
	- HAWK*	\$ 91,435	1.90
	- Pedestrian Education	\$ -	
	- TOTAL (With Standard Landscaping)*	\$ 2,045,269	

* Enhanced Landscaping, HAWK costs are not included in Phase 1 and 2.

8.0 Recommended Improvement Strategies

8.1 Recommended Strategy and Implementation Plan

Based on a combination of evaluations, comparisons, cost estimates and benefit/cost analyses, the recommended course of action to improve pedestrian and bicycle safety along the corridor is the Build Alternative.

Orange County currently has approximately \$2.0 million set aside for improvements in the Pine Hills Road corridor. However, it is recommended that all of the safety improvements as outlined in this study be undertaken at a cost of \$5.8 million. Depending on funding, the County may wish to implement the identified Phase 1 improvements from Colonial Drive to Silver Star Road initially. Work on the segment north of Silver Star Road would closely follow depending on funding and the acquisition of right-of-way needed for the flares and or bulb out improvements.

In addition, we would also recommend that lighting improvements be implemented concurrently with Phase 1 since this work covers the same segment from Colonial Drive to Silver Star Road and the installation costs for the lighting are addressed by the power company rather than the County.

8.2 Gateway Study

As part of the Pine Hills Road Pedestrian and Bicycle Safety Study, a separate study was undertaken at the Pine Hills Road and Silver Star Road Intersection to identify potential gateway opportunities. The study team coordinated with Orange County, FDOT District 5, PHNID, the Pine Hills Community Council, and Maynard Evans High School.

A site visit of the intersection revealed that the right-of-way is constrained and there is a profusion of “visual clutter”. This intersection also experiences a high volume of pedestrians, particularly when Evans High School is dismissed. To prevent adding to the “visual clutter”, representatives from the Pine Hills Neighborhood Improvement District recommended that banners or flags not be included in the overall gateway improvements. In the initial public meeting and in two subsequent meetings with Orange County, there was also considerable discussion about channeling pedestrian movements and/or making the sidewalks wider.

To accommodate wider sidewalks, portions of the two acceleration lanes along Pine Hills Road would be reduced to increase the sidewalk landing areas on the northeast and southwest corners of the Pine Hills/Silver Star Road intersection. Walls and fencing to direct pedestrian flow were not possible given the setbacks required by FDOT safety requirements and the existing right-of-way constraints. Note, these improvements would require approvals from FDOT.

For this study, all of the proposed improvements are planned to be within the public right-of-way, including the gateway signage. Each corner of the Pine Hills/Silver Star Road intersection would have a low wall and signage tower. The tower design allows for the maximum signage area in the minimum footprint. The acrylic tower will allow light and colors to accent the intersection at night and define the gateway.

The letters on the wall and tower would be inscribed into the base material to reduce venerable attachment points. Proposed pedestrian improvements include wide crosswalks to accommodate heavy pedestrian activity at peak times. Decorative mast arms are proposed to reduce the “visual

clutter” created by the existing span wire signals and other above ground utilities. Based on the gateway signage, a companion sign prototype was designed as part of a vehicular-scale wayfinding system.

With no open space within the rights-of-way for landscaping, street trees in tree grates are planned to provide much needed shade along the sidewalks. The plant pallet was based on Florida-Friendly plants that are known to survive without an irrigation system after establishment. The Pine Hills Neighborhood Improvement District currently maintains the landscaping in the medians on Silver Star Road and Orange County intends to request similar assistance with maintenance of the additional landscaping proposed in the Pine Hills Road Pedestrian/Bicycle Safety Study.

Numerous goals and objectives found in Neighborhood Improvement Plan (prepared by the Pine Hills Neighborhood Improvement District) were met by these proposed gateway improvements:

- Create a sense of place through the use of new architectural and landscape design features
- Redevelop blighted properties and require streetscaping
- Promote measures to slow traffic and address heavy pedestrian demands
- Provide measures that increase pedestrian safety through the use of crosswalks, pedestrian channelizing devices, and vegetated barriers.

Many of the goals proposed in the Community Planning Assistance Team (CPAT) Town Center Report (produced jointly by the American Planning Association and the PHNID) were also met by these proposed gateway improvements. The communities’ unique tag line: “Many Cultures, One Bright Future” and the colorful community logo were incorporated in the gateway and wayfinding signage.

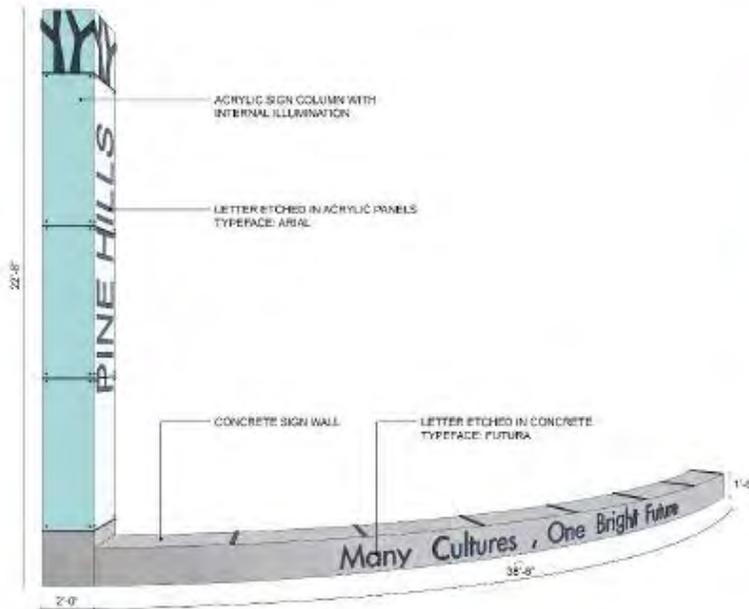
The Opinion of Construction Cost for the gateway improvements covers features proposed at the Pine Hills/Silver Star Road intersection as well as additional landscaping in proposed medians along Silver Star Road. The results of the Gateway Study including costs are included in **Appendix F**. The proposed gateway improvements are also recommended to be implemented as part of Phase 1 improvements.

Figure 8.1: Proposed Gateway Improvements



SIGN ELEVATION

GATEWAY SIGN



VEHICULAR SIGN

