ORANGE COUNTY GOVERNMENT FLORIDA

Interoffice Memorandum

AGENDA ITEM

January 30, 2018

TO: Mayor Teresa Jacobs
-AND-
Board of County Commissioners

FROM: Jon V. Weiss, P. E., Director
Community, Environmental and Development Services Department

CONTACT PERSON: **Renzo Nastasi, AICP, Manager**
Transportation Planning Division
(407) 836-8072

SUBJECT: February 20, 2018 – Work Session
Pine Hills Road Pedestrian/Bicycle Safety Study

The Transportation Planning Division has completed the Pine Hills Road Pedestrian/Bicycle Safety Study. The scope of the study extended from SR 50 (Colonial Drive) to Bonnie Brae Circle. This study is part of the Mayor's "Walk-Ride-Thrive" initiative that focuses on creating an environment where local residents, businesses and visitors are able to enjoy safe pedestrian and biking options. The study identified cost-feasible operational enhancements to balance the safety and mobility needs of all mode users along Pine Hills Road, taking into consideration such factors as traffic calming measures, access management and pedestrian/bicycle safety.

The operational and safety enhancements recommended under the Preferred Alternative are consistent with Transportation Element Policies T1.1.3, T3.3.5, T3.3.6, T3.4.8 and relevant implementing policies. These policies address the implementation of the County's adopted 2030 Long Range Transportation Plan through the completion of similar studies and projects.

The backup documentation for this item has been delivered under separate cover. It may also be accessed online as part of the e-Agenda by clicking here.

The complete study is also available under the Roadway Project section of the county's Traffic and Transportation webpage:

http://orangecountyfl.net/TrafficTransportation/PineHillsPedestrianBicycleSafetyStudy.aspx

This item is for informational purposes only; no action is required by Board. A public hearing regarding the study will be scheduled in the coming months.

RN/am

c: Mark V. Massaro, P.E., Director, Public Works Department

ORANGE COUNTY GOVERNMENT FLORIDA

MEMORANDUM

January 11, 2018

TO: **Mayor Teresa Jacobs**
-AND-
Board of County Commissioners

FROM: **JaJa Wade, Chairman**
Planning and Zoning Commission (PZC) /Local Planning Agency (LPA) Members

SUBJ: **Pine Hills Road Pedestrian/Bicycle Safety Study**

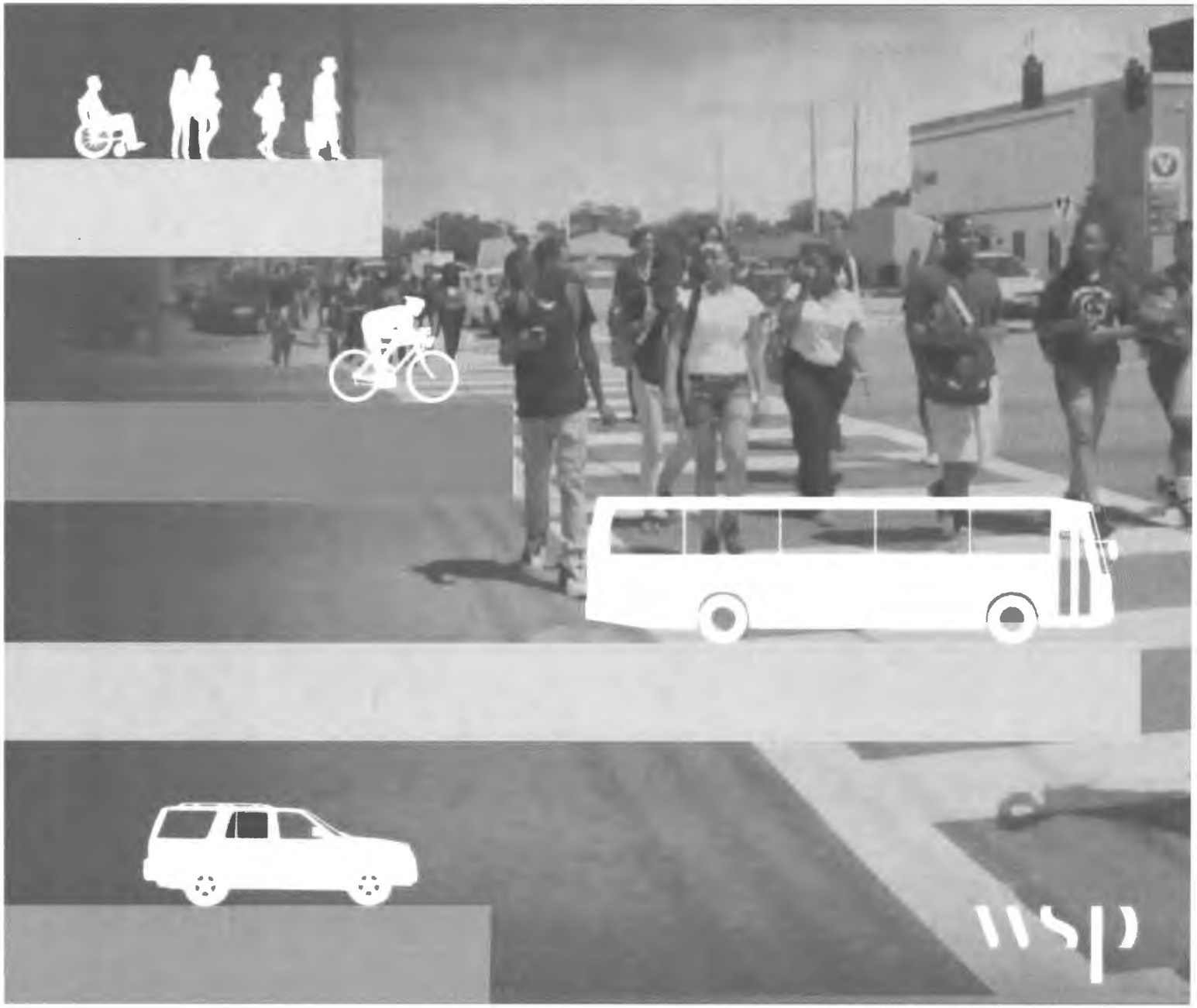
On December 21, 2017 the Local Planning Agency (LPA) held a public hearing regarding the Pine Hills Road Pedestrian/Bicycle Safety Study. This study pertains to improvements on Pine Hills Road (SR 50 (Colonial Drive) to Bonnie Brae Circle). The study identified cost-feasible operational enhancements to balance the safety and mobility needs of all mode users along Pine Hills Road, taking into consideration such factors as traffic calming measures, access management and pedestrian/bicycle safety. The LPA approved the findings of the study and found them consistent with the Comprehensive plan.

cc: Local Planning Agency
Jon V. Weiss, P.E., Director, CEDS Department
Mark V. Massaro, P.E., Director, Public Works Department
Renzo Nastasi, AICP, Manager, Public Works Transportation Planning Division
Raymond L. Williams, P.E., Manager, Public Works Engineering Division

Pine Hills Road Pedestrian/Bicycle Safety Study

Final Report

Technical Memorandum No. 7



ORANGE COUNTY GOVERNMENT FLORIDA

ORANGE COUNTY WALK • RIDE • THRIVE!

INVEST Our HOME for Life

Many Cultures, One Bright Future PINE HILLS NEIGHBORHOOD IMPROVEMENT DISTRICT

On behalf of Orange County Mayor Teresa Jacobs, District 2 Commissioner Bryan Nelson and District 6 Commissioner Victoria P. Siplin, Orange County is pleased to present this Technical Memorandum for Safety Improvement Strategies as part of the Pine Hills Road Pedestrian/Bicycle Safety Study. The study limits are from Colonial Drive (State Road (SR) 50) to Bonnie Brae Circle, a distance of approximately 3.6 miles.

This Pine Hills Road corridor has been identified as a high crash corridor for pedestrian and bicycle crashes. In addition, there are a variety of land uses along the corridor including multiple schools, residential, retail and office land uses, as well as heavily-used transit routes, which result in a truly multi-modal corridor.

The Pine Hills Road Pedestrian/Bicycle Safety Study is a comprehensive review of the Pine Hills Road corridor which will investigate various measures to provide a safe integration of walkers and bicyclists with other modes of transportation. This study is a result of Mayor Jacobs' "Walk-Ride-Thrive!" and "INVEST in Our Home for Life" initiatives to make Orange County roads safer for all pedestrians and bicyclists.

Honorable Teresa Jacobs
Orange County Mayor

Bryan Nelson
Orange County District 2 Commissioner

Victoria P. Siplin
Orange County District 6 Commissioner

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1. Introduction

1.1 Overview

Orange County is taking a proactive approach to address pedestrian and bicycle safety on its roadways. As a result, Mayor Teresa Jacobs has proposed several initiatives, including "Walk-Ride-Thrive!" and "INVEST in Our Home for Life", to make Orange County roads safer for pedestrians and bicyclists. In addition to these initiatives, Mayor Jacobs is one of 120 nationwide mayors who have signed an online pledge to participate in the "U.S. Department of Transportation's Mayors' Challenge for Safer People, Safer Streets." The common goal of these initiatives is to make roads throughout the County more pedestrian and bicycle friendly by incorporating safe and convenient walking and biking facilities in transportation projects.

Orange County's current efforts to improve pedestrian safety include the Orange County Community Traffic Safety Team and a Student-Pedestrian Safety Committee with Orange County Public Schools. The County has established a budget of $2 million to fund designated pedestrian safety and related improvements. An additional $3.5 million is available to fund sidewalk repairs, regular Road Safety Audit projects, school safety audits, and many other projects.[1]

The "Walk-Ride-Thrive!" initiative expands on these efforts by enhancing the County's coordination, capital planning and codes, including changes to the Comprehensive Plan and Code, and a new Pedestrian Bicycle Safety Action Plan and Complete Streets policy.

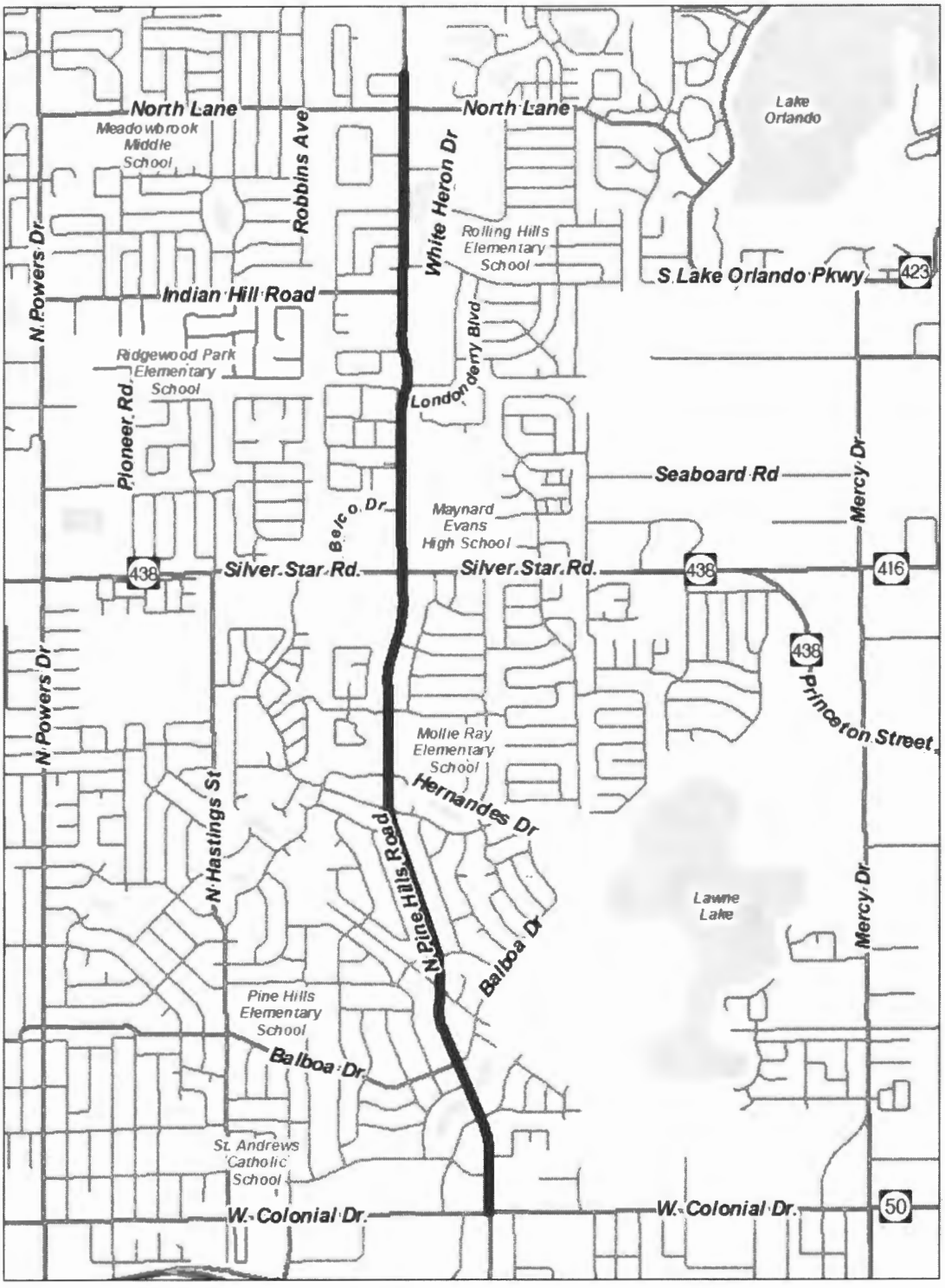
The County has created a separate "INVEST in Our Home for Life" initiative apart from the above funding that will provide an additional $15 million for pedestrian safety improvements at intersections and other selected locations which will address sidewalks, crosswalks, signals, turn lanes, updated signage, and other necessary improvements.

Based on the Mayor's efforts, Pine Hills Road has been identified as a desired corridor to address pedestrian and bicycle safety. **Figure 1.1** illustrates the project corridor study limits. This corridor is located within Orange County Commissioners Bryan Nelson and Victoria P. Siplin districts and has been identified as a roadway with a significant number of pedestrian and bicycle crashes. In addition, there are a variety of land uses along the corridor including multiple institutional, residential, retail, religious, and office uses. The Pine Hills Pedestrian/Bicycle Safety Study is a comprehensive review of the Pine Hills Road corridor with the objective to identify various improvements which can address and provide a safer integration of walking and riding bicycles with other modes of transportation.

The study includes detailed data collection, analysis and understanding of existing conditions, public outreach, potential safety measures, cost estimates, benefit cost analysis, and recommendations regarding proposed safety improvements.

[1] http://www.orangecountyfl.net/TrafficTransportation/WalkRideThrive.aspx#.Vs3GsE32boo

Figure 1.1: Project Study Corridor



2. Study Purpose and Scope

2.1 Purpose

The purpose of this study is to develop alternatives and strategies that identify solutions to address the mobility needs of the users along this corridor, and to provide for the safe integration of both the walking and bicycle riding public with other modes of transportation. The Pine Hills Road Study Area extends from Colonial Drive (SR 50) to Bonnie Brae Circle, a distance of approximately 3.6 miles.

One of the study goals is to place special emphasis at the Silver Star Road (SR 438) and Pine Hills Road intersection, consistent with the goals of the Pine Hills Road Neighborhood Improvement District (PHNID), by creating a safe, efficient, and attractive pedestrian gateway and associated amenities at this intersection. Besides the focus at this intersection, the study also will collect data and public input throughout the project limits to identify barriers and obsolete infrastructure, analyze the data collected, develop transportation safety countermeasures and enhancements, and estimate the cost and potential implementation schedule of these measures in the study report.

2.2 Introduction to the Study Corridor

The Pine Hills Road corridor is a 3.6-mile corridor, bounded by Colonial Drive on the south and ending at Bonnie Brae Circle on the north. Pine Hills Road is classified as a Minor Arterial and is owned and maintained by Orange County (CR 431). The posted speed limit on the corridor is 40 miles per hour (mph).

Through the study area, Pine Hills Road is generally a five-lane arterial with two travel lanes in each direction separated by a two-way left turn lane (TWLTL) along much of the corridor. Raised medians are also present at several pedestrian mid-block crossings. There are 15 pedestrian crossing locations across Pine Hills Road at eight signalized intersections and seven mid-block locations. Along the corridor, there are continuous sidewalks along both sides of Pine Hills Road.

The remainder of this document will provide additional details regarding the public involvement program, existing data collection including crash history, future traffic demands, and development of potential safety measures, cost estimates, and benefit cost analyses.

3. Public Involvement

This chapter outlines the public involvement process over the course of this study, including the Public Involvement Program, agency meetings and community workshops. The Public Involvement Plan (PIP) is detailed in *Technical Memorandum No. 1—Public Involvement* and a complete compilation of the public involvement activities are contained in **Appendix A.**

3.1 The Public Involvement Program

The Public Involvement Plan for the Pine Hills Road Pedestrian/Bicycle Safety Study included the following program elements:

- Identification of key stakeholders, including elected officials, internal County stakeholders, civic groups, neighborhood/homeowner associations, transportation agencies, Orange County School Board, the business community and affected property owners;
- Identification of key dates and locations for public meetings;
- Identification of public outreach methods, with particular attention to low-income, elderly, minority and disabled persons. Bilingual staff aided during community meetings;
- Contact information for key stakeholders and the Study Team; and
- Timelines for completing, reviewing, and distributing the public outreach materials and public notices.

3.2 Public Meetings

The following outreach efforts were employed during the project to notify key stakeholders and the affected public of the study and to solicit public input into the process.

3.2.1 Agency Coordination and Small Group Meetings and Public Opinion Survey

Agency Coordination Meetings

An initial meeting was held on January 26, 2017 with the following local, regional and state organizations combined – FDOT District Five, Bike/Walk Central Florida, LYNX, Orange County Utilities Department, Orange County School Board and the St. Johns River Water Management District (SJRWMD).

A follow-up meeting with the above agencies was held on May 11, 2017 to inform them of the study progress and solicit their input.

Small Group Meetings

The County and members of the Study attended other related public/community meetings. These small group meetings were scheduled directly with the requesting parties and are summarized and included as part of the Public Involvement documentation (see **Appendix A**).

Public Opinion Survey

To help ensure a comprehensive public outreach process, a Public Opinion Survey was conducted in conjunction with CBW #1 to obtain public feedback on viable safety countermeasures. The survey, developed through the Survey Monkey website, was electronically distributed to residents and stakeholders by email. The survey was also available on the study website, and hard copies, along with a collection box, were available at key locations along the corridor. The survey contained questions to prompt individuals on their ideas for safety

improvements. Input was also solicited on such issues as gateway features, landscaping, and Pine Hills Neighborhood Improvement District (PHNID) objectives.

The Public Opinion Survey was open for six (6) weeks (March to April) prior to the first community meeting to obtain initial public feedback on travel needs and preferences and two (2) weeks following the first community meeting to receive feedback on potential safety measures that may be advanced into final recommendations. The results of the Public Opinion Survey can be found as **Appendix A.**

3.2.2 Community Workshops

During the study, two Consensus Building Workshops (CBWs) were held to present the study findings, safety improvement alternatives, and study recommendations to key stakeholders and the public. Additionally, comment cards were provided so that attendees could submit their input in writing. A public review and comment period was established for the receipt of comments from citizens. The County prepared written responses to the person(s) or group(s) who posed the question or comment. A copy of all comments, questions and responses was documented in the study file located at the Transportation Planning Division.

Meeting participants had an opportunity to provide feedback on the proposed pedestrian safety countermeasures and recommendations. During each of the two workshops, displays featured various safety treatments, information from data collection efforts, potential safety countermeasures and access management alternatives.

- CBW #1
  - This workshop was conducted June 08, 2017 following the completion of the data collection and analysis activities.
  - The purpose was to present the findings of data collection and the evaluation of barriers and challenges and engage the public to obtain their feedback on strategies for potential pedestrian safety improvements.
  - Feedback received through the Public Opinion Survey was also presented.

- CBW #2:
  - This workshop was conducted on August 24, 2017.
  - The purpose was to present the Safety Improvement Plan Alternatives and Benefit-Cost evaluations, and obtain public feedback on ranking and recommendations prior to the presentation of the improvement alternatives to the Orange County Local Planning Agency (LPA) and Orange County Board of County Commissioners.

The public community meeting minutes, sign-in sheets and summaries of comment cards were posted to the study website as they became available.

- LPA Meetings
  - The LPA Workshop is scheduled for September 21, 2017
  - The LPA Hearing is scheduled for October 19, 2017

- Board of County Commissioners (BCC) Meetings
  - The BCC Workshop is scheduled for December 12, 2017
  - The BCC Hearing is scheduled for January, 2018

4. Existing Conditions

4.1 Summary of Transportation Plans

A review of various transportation plans was performed to identify planned improvements throughout the study area. The results of the review are included in a separate *Technical Memorandum No. 2—Evaluation of Existing Studies*. To summarize, the following studies are applicable to this project:

- Orange County Capital Improvement Program (CIP) and Long Range Transportation Plan (LRTP)
  - Pine Hills Trail (Alhambra Drive to Silver Star Road)
  - Roadway Lighting Improvements (Silver Star Road to North Lane)
- Orange County Walk-Ride-Thrive! Program (WRT!)
- Orange County Multi Modal Corridor Plan
  - Identified Livability Corridor (Colonial Drive to Silver Star Road)
- Orange County ADA Transition Plan
- Orange County Development Projects
  - Silver Pines (120 Multi-Family Units at Silver Star Road/Pine Hills Road)
  - Pine Hills SuperStop (Belco Drive)
- LYNX Transit Development Plan (TDP)
  - Pine Hills SuperStop (Belco Drive)
- MetroPlan Orlando Transportation Improvement Program (TIP)
  - TSM&O Improvements (Silver Star Road/Pine Hills Road intersection)
- Pine Hills Neighborhood Improvement District 2015-2045 Improvement Plan
- American Planning Association Community Planning Assistance Team (CPAT) Report
  - Town Center Master Plan

4.2 Land Use

Existing and future land use patterns along the Pine Hills Road corridor are very important to consider when evaluating current and future pedestrian and bicyclist safety. The highest share of existing land uses within the Pine Hills Road study area are residential and institutional, though most land uses with frontage on Pine Hills Road are either institutional or commercial. Along the corridor, there are small businesses directly adjacent to Pine Hills Road, with neighborhoods behind and extending to the east and west of the corridor. There are several schools and major churches that contribute to the pedestrian and bicycle activity along the Pine Hills Road corridor including:

- Schools
  - Mollie E. Ray Elementary, on Hernandes Drive to the east of Pine Hills Road
  - Pine Hills Elementary, on Balboa Drive to the west of Pine Hills Road
  - Rolling Hills Elementary, on Donovan Street to the east of Pine Hills Road
  - Ridgewood Park Elementary, on Pioneer Road to the west of Pine Hills Road
  - Meadowbrook Middle School, on North Lane to the west of Pine Hills Road
  - Maynard Evans High School, on Pine Hills Road north of Silver Star Road
  - Robinswood Middle School, on Vernon Street west of Pine Hills Road
  - St. Andrews Catholic School, on N. Hastings Street west of Pine Hills Road

- Churches
  - Ebenezer Baptist Church, on Pine Hills Road at Pipes O the Glen Way
  - All Nation Church of God, on Pine Hills Road at Spring Hill Drive

- Joshua Generation Outreach Church, on Pine Hills Road at Indialantic Drive
- Mission of Hope Worship Center, on Pine Hills Road at Hernandes Drive
- New Covenant Church of Jesus Christ, on Pine Hills Road at Cortez Drive
- Faith Christian Center, on Pine Hills Road at Deauville Drive
- Pine Hills Community Church, on Pine Hills Road at Hernandes Drive
- Eglise Baptiste Haitienne Philadelphie, on Pine Hills Road at Deauville Drive
- Devi Mandir Hindu Temple, on Pine Hills Road, south of Silver Star Road

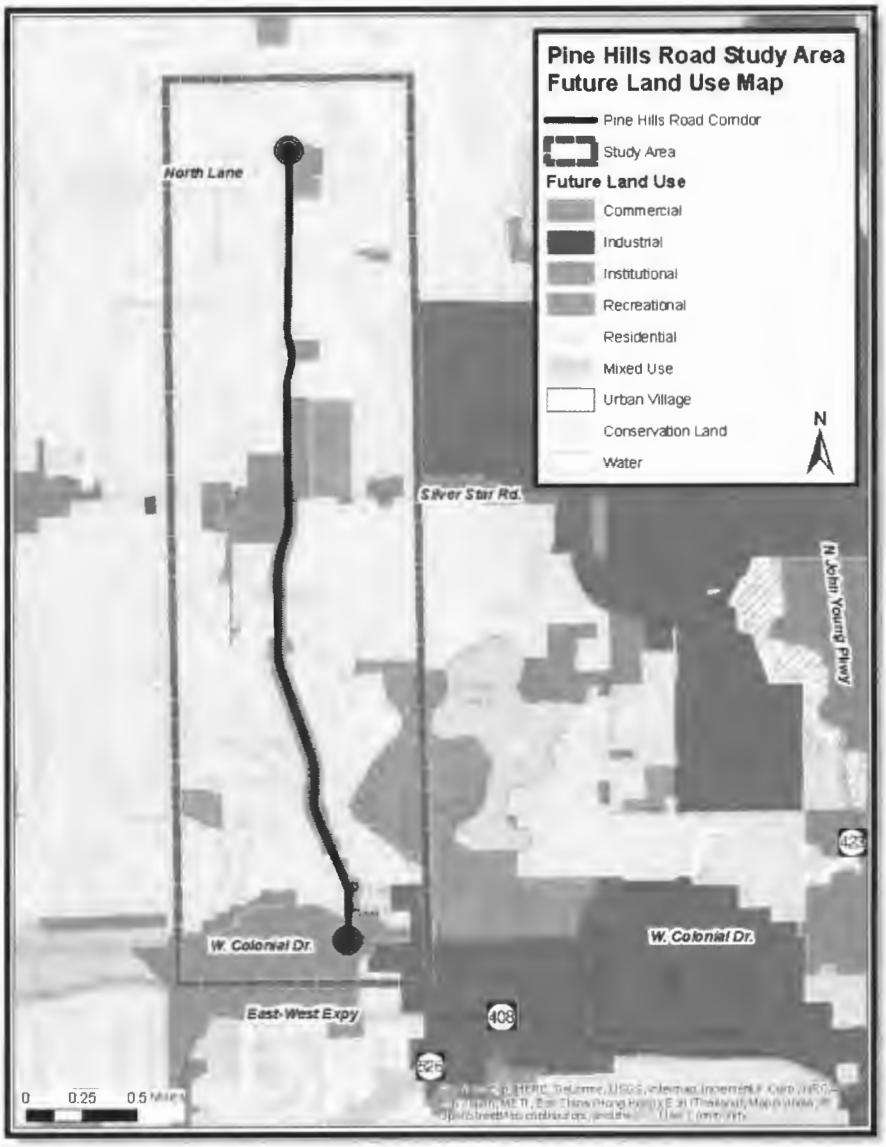
The Future Land Use (FLU) designations assigned to the study area are generally consistent with the existing land uses (displayed in **Figure 4.1**). The FLU pattern remains generally residential, with some commercial and institutional land uses along Pine Hills Road.

The Pine Hills Neighborhood Improvement District (PHNID) working together with the American Planning Association formed a Community Planning Assistance Team (CPAT) which created a report that envisioned various planning opportunities for Pine Hills Road including the potential for a future town center at the Silver Star Road intersection. This report was used as the basis for the Gateway Study (see Section 8.2) of this report.

4.3 Existing Transportation Infrastructure

This chapter includes an evaluation of the transportation infrastructure conditions within the corridor. The existing physical features were collected through field inspection, aerial photography, data provided by Orange County and previous plans/studies. This information is intended to identify current roadway design issues and aid in identifying study area roadway segments and intersections requiring closer examination as part of the future recommendations for the corridor.

Figure 4.1: Future Land Use



The following topics are covered below:

- Roadway Characteristics
- Right-of-Way
- Typical Section
- Intersection Geometry
- Bicycle/Pedestrian Infrastructure
- Signage, Markings, Design & Posted Speed, Traffic Volumes, & School Zones
- Spot Speed Study
- Lighting
- Transit Service and Infrastructure
- Safety and Crash Analysis

4.3.1 Roadway Characteristics

Pine Hills Road is classified as a Minor Arterial and is owned and maintained by Orange County (CR 431). The posted speed limit on the corridor is 40 miles per hour (mph). There are 15 pedestrian crossing locations across Pine Hills Road at eight signalized intersections and seven mid-block locations. Along the corridor, there are continuous sidewalks along both sides of Pine Hills Road.

The features of the corridor facilities are displayed in **Figure 4.2**, which were gathered through field inspection, aerial photography, Orange County data, and previous plans. The information is intended to identify current roadway design issues and aid in identifying study area roadway segments and intersections requiring closer examination as part of future recommendations for the corridor.

As can be seen in **Figure 4.2**, most of the Pine Hills Road frontage contains properties with single or multiple driveways directly accessing the roadway. This situation results in a high number of driveways serving low volumes of inbound and outbound traffic.

Figure 4.2: Corridor Characteristics

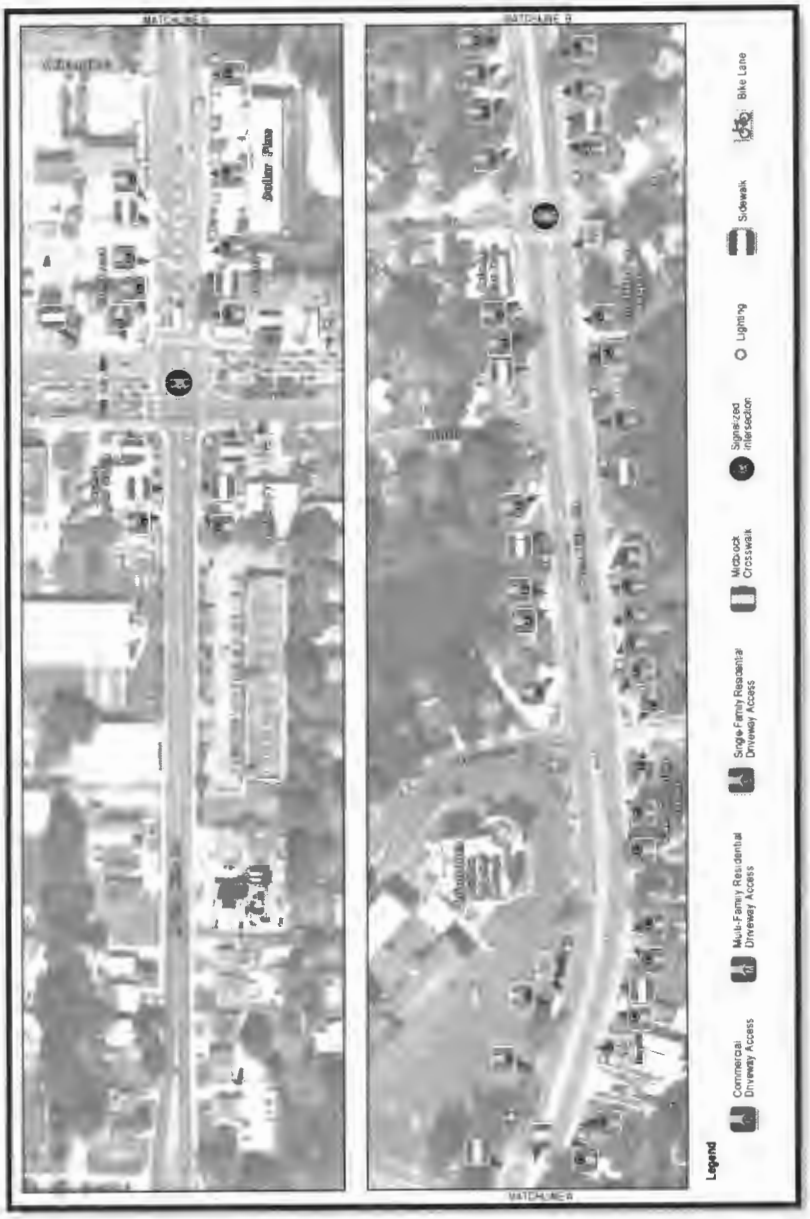


Figure 4.2 (continued): Corridor Characteristics

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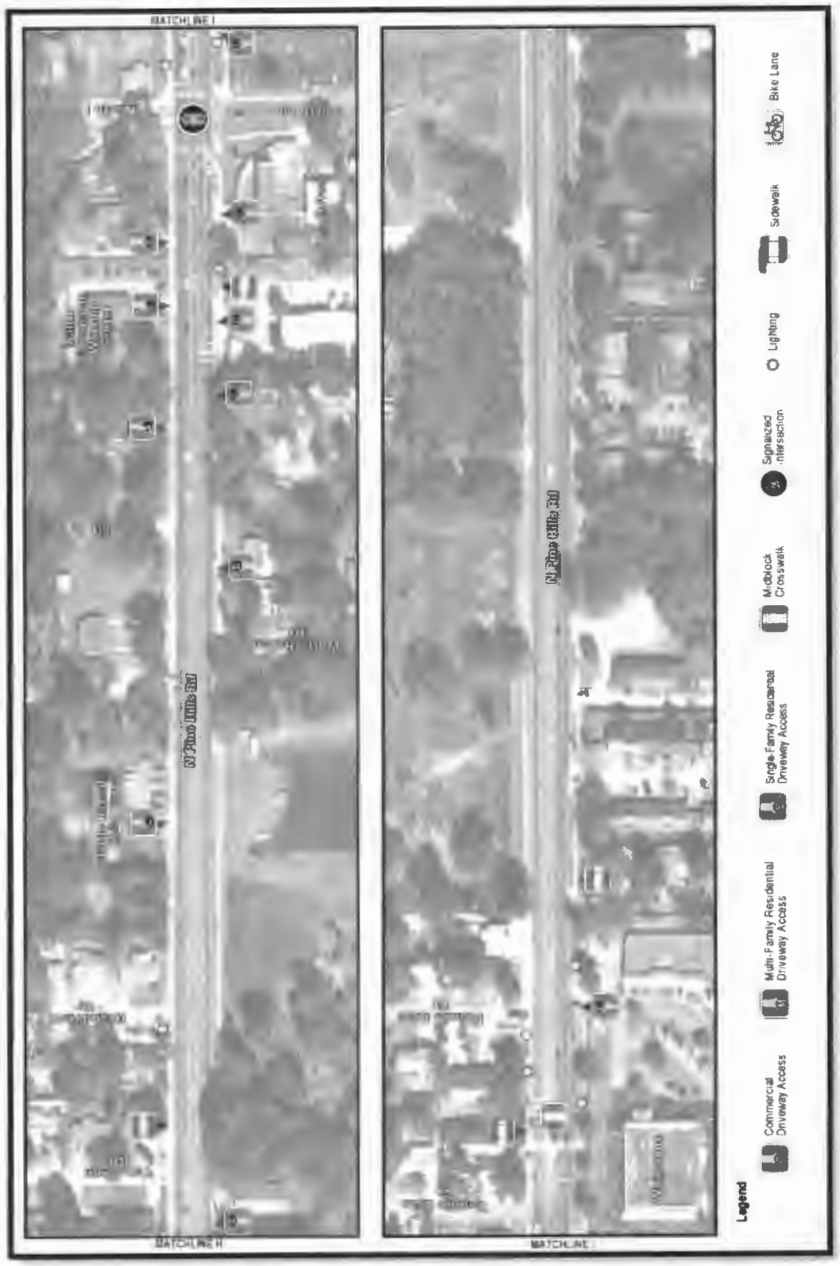


4.3.2 Typical Sections

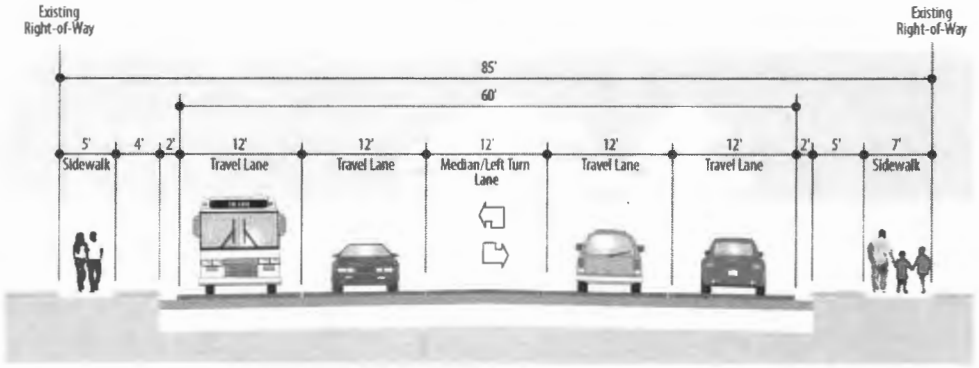
There are two typical sections along the study area corridor consisting of Pine Hills Road north of Silver Star Road (SR 438) and Pine Hills Road south of Silver Star Road (SR 438).

- **Pine Hills Road (North of Silver Star Road)** - the typical section consists of four 12-foot travel lanes (two in each direction), a 12-foot two-way left turn lane, 2-foot curb and gutters, 4 to 5-foot grass buffer strips, a 5-foot sidewalk on the west side of the roadway, and a 7-foot sidewalk on the east side of the roadway.

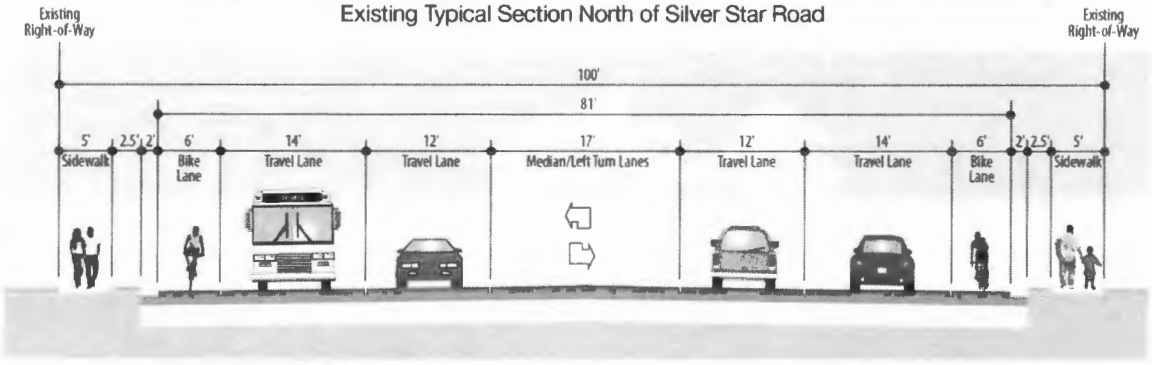
- **Pine Hills Road (South of Silver Star Road)** - the typical section consists of four 12 to 14-foot travel lanes (two in each direction), a 17-foot two-way left turn lane, 6-foot bicycle lanes, 2-foot curb and gutters, 2.5-foot grass buffer strips, and 5-foot sidewalks on both sides of the roadway.

The roadway right-of-way (ROW) information was obtained using available property appraisal parcel data. The ROW varies along the corridor ranges from 85 north of Silver Star Road to 100 feet south of Silver Star Road. No additional right-of-way is expected to be needed south of Silver Star Road, although the proposed access management changes north of Silver Star Road may precipitate the need for minor right-of-way takes to address flares and curb bulb-outs needed to accommodate U-turn movements. **Figure 4.3** illustrates the existing typical sections for Pine Hills Road.

Figure 4.3: Typical Sections



Existing Typical Section North of Silver Star Road



Existing Typical Section South of Silver Star Road

4.3.3 Intersection Geometry

Figure 4.4 illustrates the intersection geometries for the following signalized and non-signalized intersections:

- Colonial Drive (SR 50) (signalized)*
- Alhambra Drive
- Sunray Drive
- Deauville Drive
- Sunniland Drive
- Balboa Drive (signalized)
- Dolores Drive (planned signals) **
- Cortez Drive
- Elinore Drive
- Ferdinard Drive
- Golf Club Parkway
- Hernandes Drive (signalized)
- Indialantic Drive (planned signals) **
- Figwood Lane
- Silver Star Road (SR 438) (signalized)
- Belco Drive (signalized)
- Spring Hill Drive
- El Trio Way
- Via Maior
- Londonderry Blvd (signalized)
- Pipes O the Glen Way
- Champagne Circle
- Indian Hill Road (signalized)
- White Heron Drive
- Palisades Drive
- Van Aken Drive
- Grandview Drive
- Fir Drive
- North Lane (signalized)
- Bonnie Brae Circle

* *It should be noted that characteristics were collected and included in the study for the signalized intersection of Colonial Drive (SR 50) and Pine Hills Road. These characteristics included lane geometry, signage, sidewalks and bicycle lanes. Per the scope of the study identified by Orange County, existing traffic counts and analysis were not included for the intersection of Colonial Drive (SR 50) and Pine Hills Road.*

** *New signal improvements are planned at the intersections of Pine Hills Road at Dolores Drive and at Indialantic Drive.*

Left turn lanes (on Pine Hills Road) are provided at the signalized intersections as well as the northbound approach of the unsignalized intersection of Alhambra Drive. The remaining unsignalized intersections utilize the center lane of the undivided five-lane section for left turn movements.

Orange County is responsible for the operation and maintenance of all eight traffic signals within the study area. In addition, new signal improvements are planned at Pine Hills Road at Indialantic Drive. Signals have recently been installed at Dolores Drive which will accommodate the proposed extension of the Pine Hills Trail Spur to Barnett Park.

Figure 4.4: Intersection Geometry

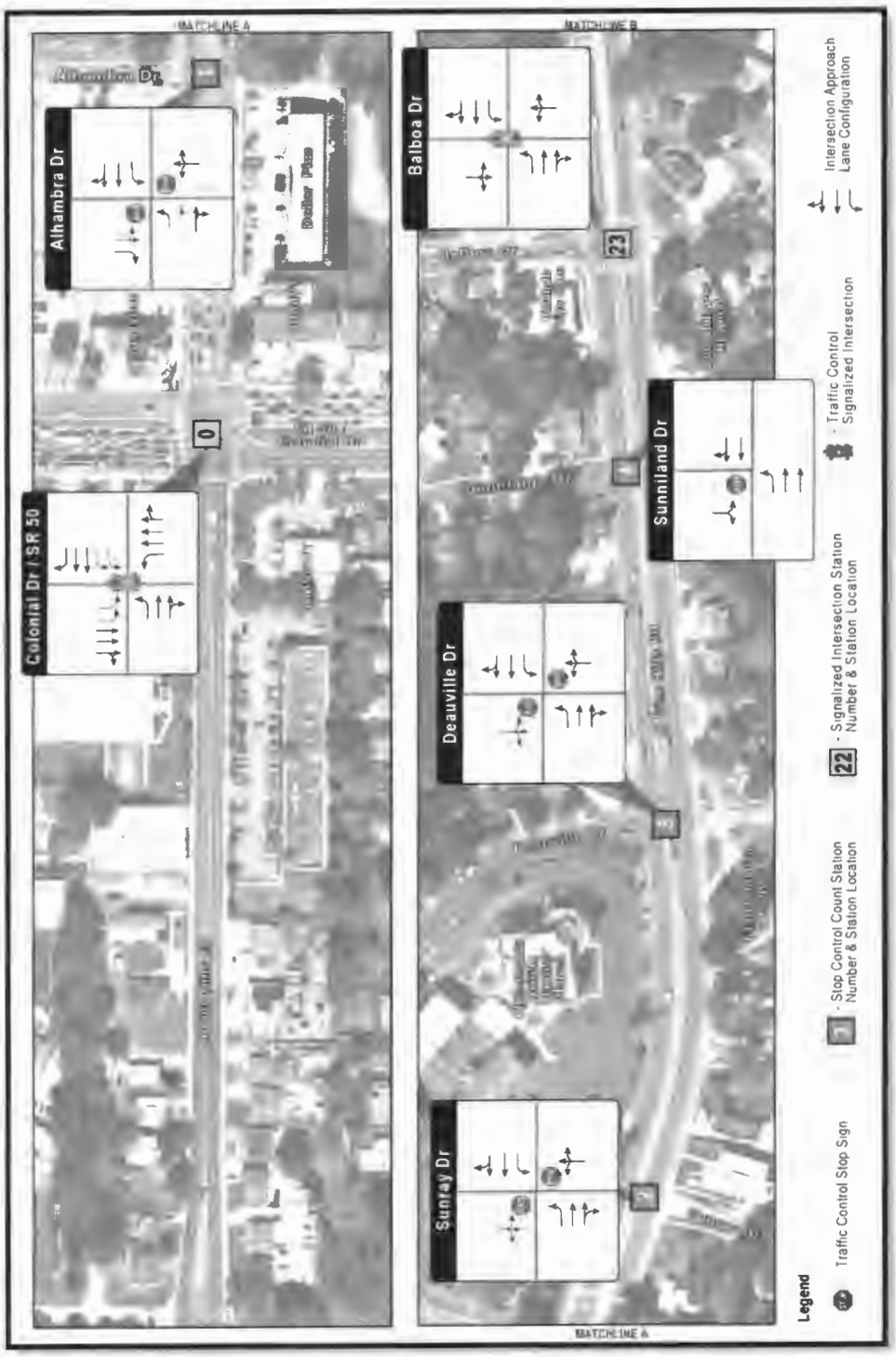


Figure 4.4 (continued): Intersection Geometry

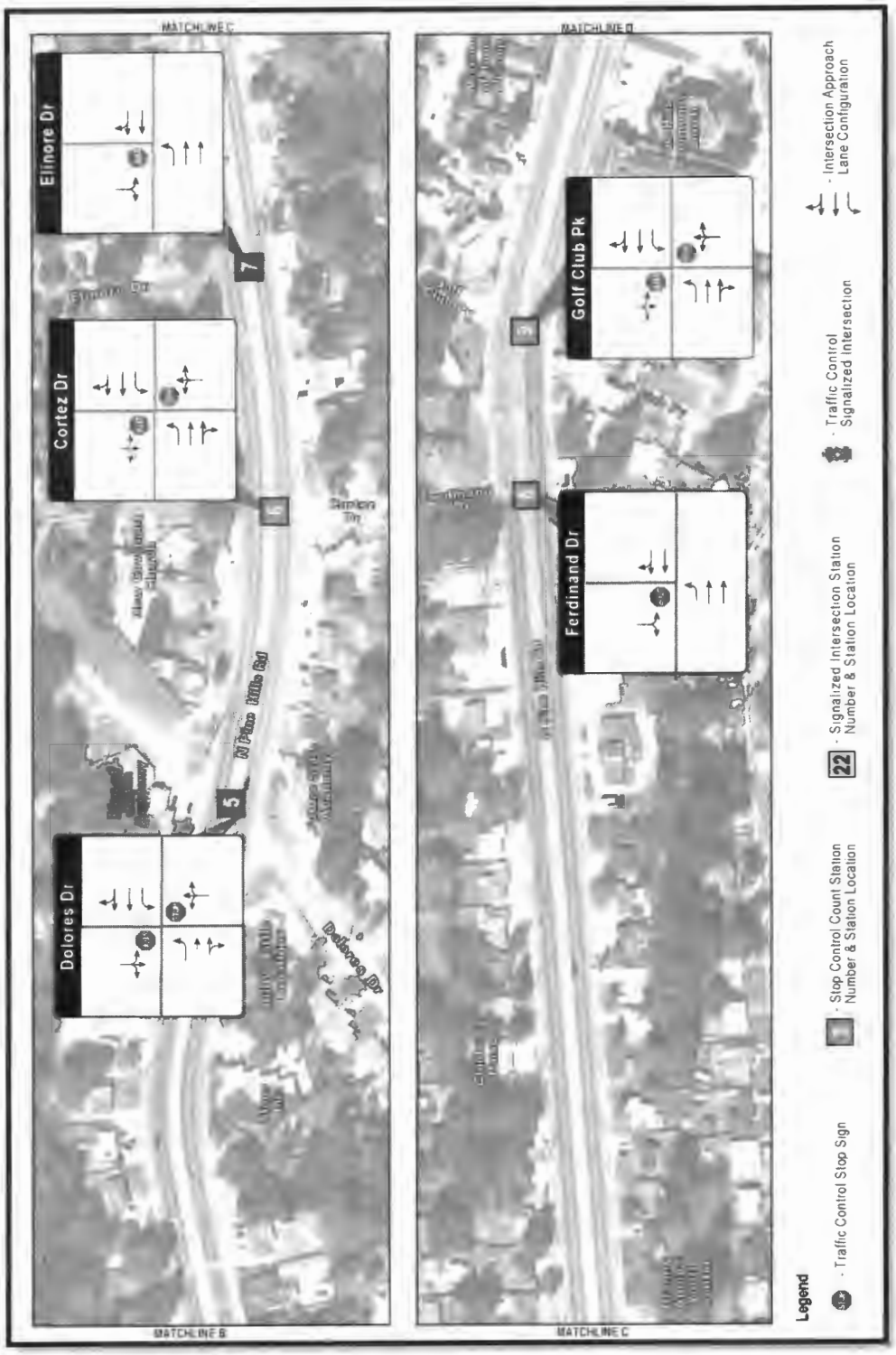


Figure 4.4 (continued): Intersection Geometry

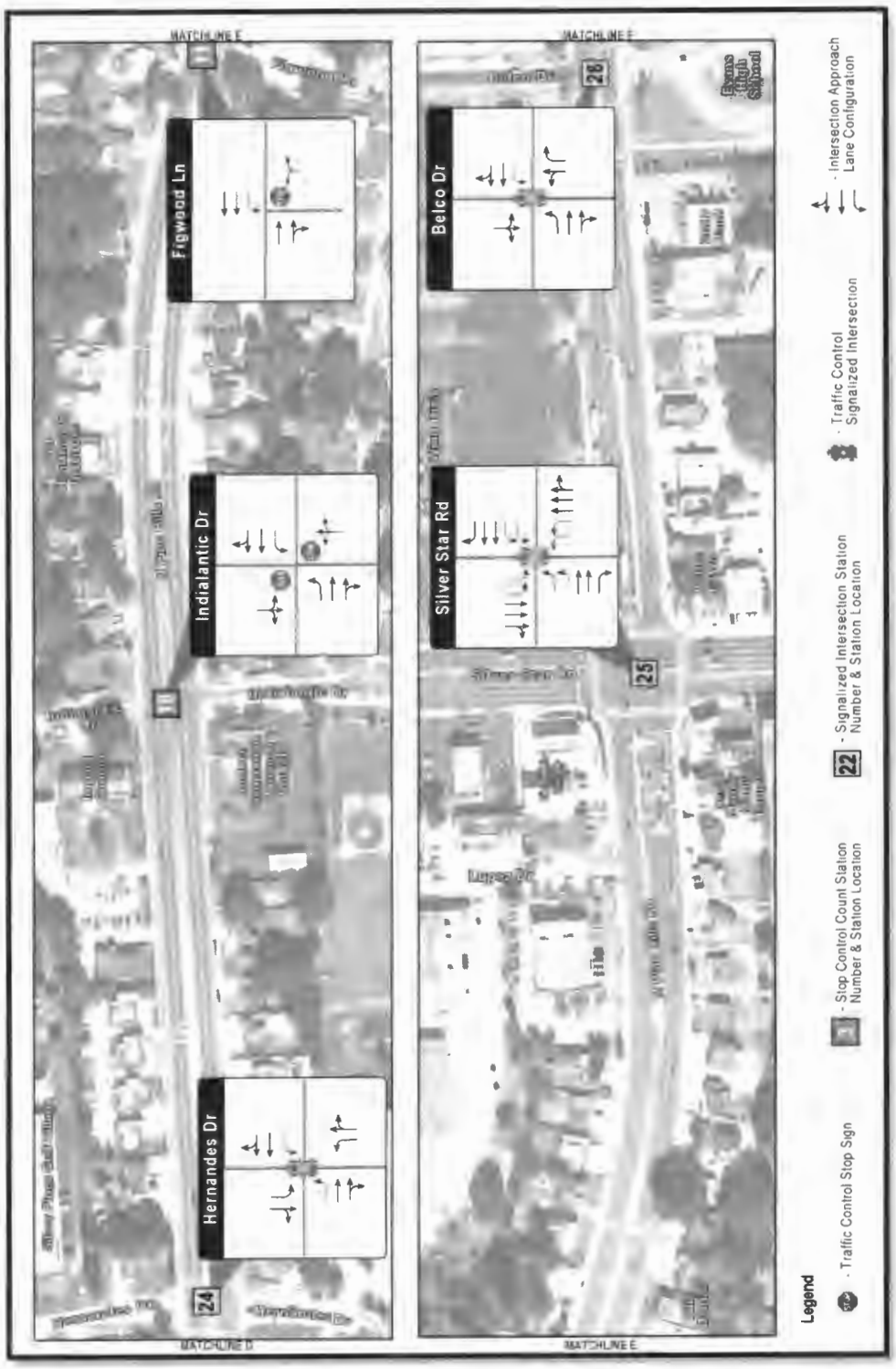


Figure 4.4 (continued): Intersection Geometry

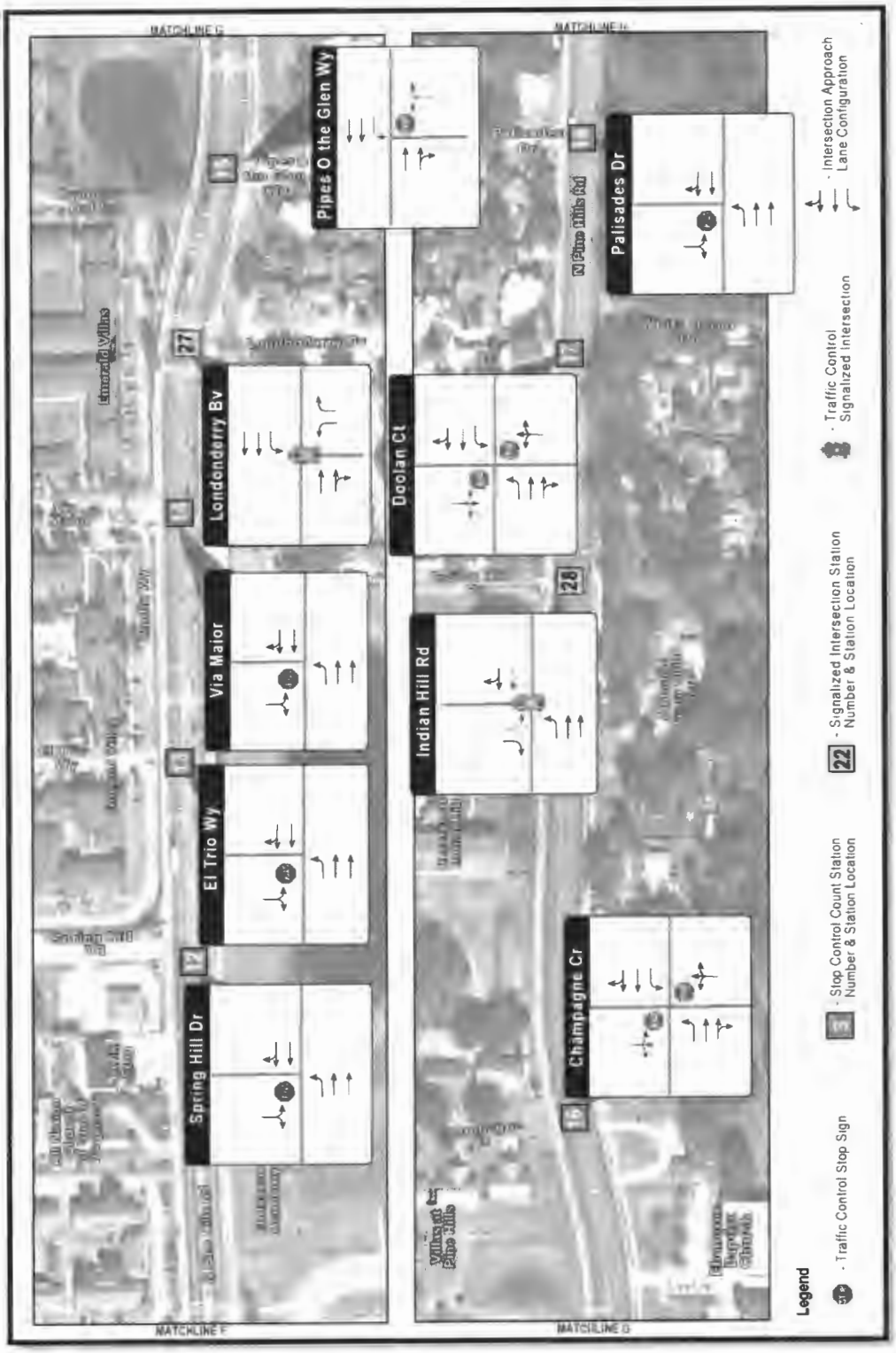
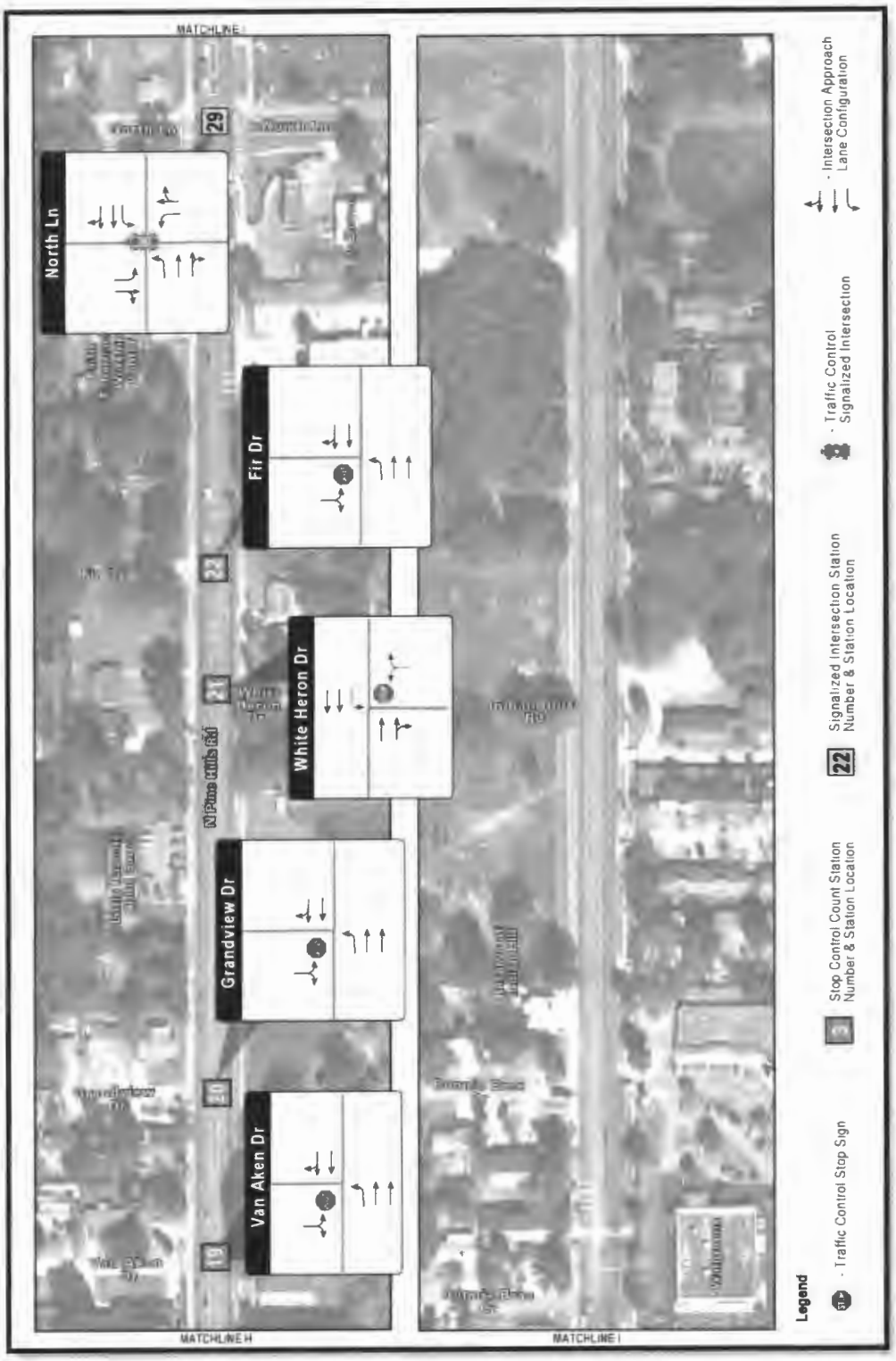


Figure 4.4 (continued): Intersection Geometry



4.3.4 Pedestrian and Bicycle Infrastructure

This section provides the location, interconnectivity and continuity of sidewalks/crosswalks, bicycle trails/facilities (e.g. Pine Hills Trail), and crossings at and away from intersections and in relation to the transit network (include any multi-use paths). The pedestrian and bicycle infrastructure details are included in *Technical Memorandum No. 3 – Existing Conditions*.

Bicycle Lanes

An inventory of bicycle lanes was completed for the corridor utilizing the latest Google Earth aerial photography and field visits. South of Figwood Lane, existing bicycle lanes are generally 6 feet wide, adjacent to the outside vehicular travel lanes, and delineated with pavement markings along both northbound and southbound Pine Hills Road. North of Figwood Lane, no bicycle lanes are present, and bicyclists either ride in the outside vehicle travel lane or on the adjacent sidewalks.

Pedestrian Facilities

Pedestrian facilities along the corridor consist of sidewalks, crosswalks, and trails. Similar to the bicycle lane inventory, an inventory of pedestrian facilities was completed for the study area utilizing the latest Google Earth aerial photography and field visits.

Sidewalks

There are continuous sidewalks on both sides of the roadway, over the entire limits of the Pine Hills Road study area. The sidewalk width along the corridor is typically five feet in width. North of Belco Drive along the east side of Pine Hills Road, the sidewalk width is seven feet. The sidewalks are shaded by trees in several locations along the corridor; however, the majority of the sidewalks are without shade. Street furniture is limited to transit infrastructure. No other sidewalk amenities and enhancements were identified along the corridor. Sidewalks are generally in fair condition along the corridor although there are various obstructions that may impede pedestrian movements in some areas such as overgrown landscaping of adjacent properties, utility poles, and road signs which effectively narrow the sidewalk width.

Crosswalks

There are 24 intersections with some type of pedestrian crossings within the corridor - 15 pedestrian crossing locations are *across* Pine Hills Road at 8 signalized intersections and seven mid-block locations, and nine pedestrian crossings are along Pine Hills Road at unsignalized intersection approaches to Pine Hills Road (**Table 4.1**). At those 24 intersections, there are a total of 47 crosswalk legs (23 across Pine Hills Road, 24 along Pine Hills Road).

Detailed information about the pedestrian crosswalks along Pine Hills Road is provided in **Table 4.1**, including crosswalk location, traffic control, crosswalk type, warning type, maximum crossing distance, median/refuge island width, marking patterns, number of legs, and general condition. As indicated in **Table 4.1**, the distance between pedestrian crosswalks *across* Pine Hills Road varies from approximately 241 feet to 3,871 feet, averaging 1,059 feet (0.20 mile). The longest distance without either a pedestrian crossing or a mid-block crosswalk is 3,871 feet (0.73 mile), between the mid-block crossing north of Balboa Drive and the signalized crossing at Hernandes Drive. This high average spacing between pedestrian crosswalks along Pine Hills Road is one of the factors that

may encourage pedestrians or bicyclists to cross the road outside of a marked crosswalk.

For a number of unsignalized intersections, the minor street approach did not have any crosswalks marked. These intersections are listed below:

- Sunray Drive
- Deauville Drive
- Sunniland Drive
- Spring Hill Drive
- White Heron Drive
- Palisades Drive
- Van Aken Drive
- Grandview Drive
- Fir Drive
- Bonnie Brae Circle

Two locations (Balboa Drive and the crossing north of Indialantic Drive) with ladder markings were identified as not meeting FDOT criteria for special emphasis markings since the gaps between markings did not meet standards.

Table 4.1: Crosswalk Locations along Pine Hills Road

#	Crosswalk Location (along Pine Hills Road)	Type	Across or Along Pine Hills Road	Crossing Type	Maximum Crossing Distance (ft.)	Distance to Previous E-W Crosswalk (ft.)	Distance to Nearest LYNX Bus Stop (ft.)	Median/ Refuge Island (width in ft.)	Marking Patterns and Legs	General Conditions
1	Colonial Drive (SR 50)	Signalized Intersection	Both	Pedestrian	134	0	185	None	Continental (4)	Fair
2	Alhambra Drive	Stop-Controlled Intersection	Along	None	56	N/A	115	None	Ladder (1-W)	Good
3	109 ft. N of Alhambra Drive	Uncontrolled Midblock Crossing	Across	Pedestrian	80	566	30	Raised (12)	Ladder	Fair
4	Balboa Drive	Signalized Intersection	Both	School	89	1,567	160	None	Ladder (4)	Good
5	405 ft. N of Balboa Drive	Uncontrolled Midblock Crossing	Across	Pedestrian	84	371	220	Raised (12)	Ladder	Fair
6	Dolores Drive	Stop-Controlled Intersection	Along	None	79	N/A	130	None	Continental (1–E)	Fair
7	Cortez Drive	Stop-Controlled Intersection	Along	None	54	N/A	330	None	Continental (1–E)	Worn
8	Elinore Drive	Stop-Controlled Intersection	Along	None	54	N/A	45	None	Transverse (1-W)	Worn
9	Ferdinand Drive	Stop-Controlled Intersection	Along	None	58	N/A	585	None	Transverse (1-W)	Worn
10	Golf Club Parkway	Stop-Controlled Intersection	Along	None	67	N/A	360	None	Continental (1-E) Transverse (1-W)	Worn
11	Hernandes Drive	Signalized Intersection	Both	School	88	3,871	110	None	Continental (2-N/S) Ladder (2-E/W)	Good (N/S), Fair (E/W)
12	Indialantic Drive	Stop-Controlled Intersection	Along	None	56	N/A	100	None	Continental (1-E) Transverse (1-W)	Worn
13	440 ft. N of Indialantic Drive	Uncontrolled Midblock Crossing	Across	Pedestrian	80	1,310	300	Raised (12)	Ladder	Fair
14	Figwood Lane	Stop-Controlled Intersection	Along	None	54	N/A	20	None	Continental (1-E)	Fair
15	160 ft. N of Figwood Lane	Uncontrolled Midblock Crossing	Across	Pedestrian	82	716	230	Raised (12)	Ladder	Fair
16	Silver Star Road (SR 438)	Signalized Intersection	Both	Pedestrian	124	780	500	None	Ladder (4)	Good
17	Belco Drive	Signalized Intersection	Both	School	82	787	10	None	Ladder (4)	Good (N/S), Fair (E), Worn (W)
18	375 ft. N of Belco Drive	Uncontrolled Midblock Crossing	Across	Pedestrian	60	917	100	Raised (12)	Ladder	Fair
19	Londonderry Blvd.	Signalized Intersection	Both	School	77	495	230	None	Ladder (3)	Fair
20	136 ft. N of Pines O' The Glen Way	Uncontrolled Midblock Crossing	Across	Pedestrian	62	388	50	Raised (12)	Ladder	Fair
21	Champagne Circle	Stop-Controlled Intersection	Along	None	60	N/A	475	None	Transverse (1-W)	Good
22	Indian Hill Road	Signalized Intersection	Both	School	64	1,338	85	None	Ladder (1-W) Continental (1-N)	Good

23	North Lane	Signalized Intersection	Both	School	73	2,541	10	None	Ladder (1-E) Continental (3-N/W/S)	Good
24	Bonnie Brae Circle	Uncontrolled Midblock Crossing	Across	Pedestrian	67	241	350	Raised (12)	Ladder	Fair
	Color represents "Signalized Intersection"									
	Color represents "Uncontrolled Midblock Crossing"									

Trails

In addition to sidewalks, bicycle lanes, and crosswalks, existing and planned regional trails that cross through the study area were also inventoried. Trails are multi-use paths that are used by runners, bicyclists and other non-motorized users.

As part of the Orange County Trails Master Plan, the Pine Hills Trail is being constructed west of Pine Hills Road from Colonial Drive to Silver Star Road (Phase 1), as shown in **Figure 4.5**. The second phase of the Pine Hills Trail will complete the 8.2 miles long trail north of Silver Star Road at a later date. The County is currently considering routing the trail improvements along Pine Hills Road north of Silver Star Road and rebuilding the existing sidewalk to accommodate a multiuse path.

The trail primarily utilizes an existing Duke Energy power-line corridor in its alignment from Colonial Drive (SR 50) for Phase 1. In addition to the connection to the Seminole Wekiva Trail and Seminole County's trail system, the intersection of Clarcona Ocoee Road provides a link west to the West Orange Trail (WOT) and Lake County's trail system.

A future spur from the Pine Hills Trail is proposed to extend easterly along Dolores Drive which will connect to Barnett Park. There are no existing crosswalks across Pine Hills Road at Dolores Drive for the proposed Pine Hills Trail spur, though there is an existing north-south crosswalk across Dolores Drive. A signal at Pine Hills Trail and Dolores Drive is anticipated to be installed as part of the trail spur.

Figure 4.5: Pine Hills Trail

Source: Orange County Trails Master Plan, page 9 (2012).

4.3.5 Vehicle Gap Size Study

As part of the existing conditions analysis, a vehicle gap size study was conducted to determine the size and the number of gaps in the vehicular traffic stream for pedestrians crossing Pine Hills Road. For pedestrians to utilize mid-block crossings or attempt to cross Pine Hills Road at

undesignated locations, a certain vehicle gap size should be available. Vehicle gap studies were conducted at two (2) locations along Pine Hills Road during the AM and PM peak hours. The gap size study concluded that there were adequate gaps in the traffic stream to accommodate pedestrian crossings over Pine Hills Road. Under the full pavement width crossing scenario, the number of adequate gaps greater than 14 seconds are reduced, and significantly lower than the pedestrian crossing demand. The 14 seconds represents the minimum time needed to cross the full pavement width of Pine Hills Road. Details of the gap size analysis are included in *Technical Memorandum No. 3—Existing Conditions*.

4.3.6 Signage, Markings, Posted Speed, Traffic Volumes, and School Zones

The pedestrian, bicycle, and school crossing signage along the corridor is illustrated in **Figures 4.6 and 4.7**. There are 15 marked pedestrian crosswalks across Pine Hills Road. A summary of the signage along the corridor includes the following:

- Seven crosswalk legs at mid-block crosswalks
- Twenty-nine crosswalk legs at signalized intersections
- Six crosswalks signed with school crossing signs
- Thirteen crosswalks signed with pedestrian crossing signs
- No pedestrian warning signs at or ahead of the Colonial Drive (SR 50) intersection or the Silver Star Road (SR 438) intersection.

Most of the school pedestrian crosswalk warning signs (MUTCD Type S1-1 and W11-2, respectively) are supplemented by downward diagonal arrow plaques (MUTCD Type W16-7) and have advance school and pedestrian crosswalk warning signs which are supplemented with "Ahead" (MUTCD Type W-15-9p) plaques. It was noted that the W16-7 signs were missing for the north leg crosswalk at Londonderry Boulevard.

In addition, crosswalks are present at Balboa Drive, Hernandes Drive, Belco Drive (Evans High School access), Londonderry Boulevard, Indian Hill Road, and North Lane to support nearby schools. All of these crossings have advance school pavement markings and school ahead signs, However, there are no designated school zones along Pine Hills Road with reduced speed limits.

Schools that exist along or in the vicinity of Pine Hills Road include:

- Mollie E. Ray Elementary, Hernandes Drive to the east of Pine Hills Road
- Pine Hills Elementary, Balboa Drive to the west of Pine Hills Road
- Rolling Hills Elementary, Donovan Street to the east of Pine Hills Road
- Ridgewood Park Elementary, Pioneer Road to the west of Pine Hills Road
- Meadowbrook Middle School, North Lane to the west of Pine Hills Road
- Maynard Evans High School, Pine Hills Road north of Silver Star Road (SR 438)
- Robinswood Middle School, Vernon Street west of Pine Hills Road
- St. Andrews Catholic School, N. Hastings Street west of Pine Hills Road

Details of the signage along the corridor are included in *Technical Memorandum No. 3—Existing Conditions*.

4.3.7 Spot Speed Study

The posted speed limit is 40 mph for the entire corridor. To analyze existing travel speeds along the corridor, spot speed studies were performed to collect speed data. Spot speed studies were conducted for a 24-hour period at three different locations along the Pine Hills Road corridor:

south of Indian Hill Road, and north and south of Balboa Drive. The locations were selected based upon crash history, sections where drivers would not be constrained from speeding, areas prime for pedestrians and bicyclists crossing mid-block, and the lack of an adjacent traffic signal that could result in platooning of vehicles.

The studies were performed utilizing MetroCount tube counters and analyzed using the methods prescribed in the Manual on Uniform Traffic Studies (MUTS) and the FDOT Manual on Speed Zoning for Highways, Roads and Streets. Several statistical measures are used to determine the basis for establishing the regulatory speed limit on a roadway, including the following:

- 85th Percentile Speed: The speed at which 85% of the free-flowing vehicles are traveling along the road.
- 50th Percentile Speed or Mean Speed: The speed at which 50% of the free-flowing vehicles are traveling along the road.
- Pace: A 10-mph range that includes the highest number of vehicles observed. For this study, the pace is 35-45 miles per hour

Generally, the 85th percentile speed and the 10 miles per hour (mph) pace represent the speed range recorded by the highest number of vehicles along the corridor, which can serve as the basis for setting the posted speed limit on a road segment.

The 85th percentile speed data revealed that northbound and southbound traffic travel above the posted speed limit at all of the studied locations. The 50th percentile speed indicates the speed at which 50% of the traffic is traveling at. The pace is the 10-mph range which contains the most vehicles and for this project, has a range of 35 mph and 45 mph. Overall, the speed data indicate that much of the traffic along Pine Hills Road are traveling at or near the posted speed limit.

Table 4.2 contains the details of the spot speed study. Further information of the spot speed study along the corridor are included in *Technical Memorandum No. 3—Existing Conditions*.

Table 4.2: Spot Speed Study

LOC ID	Location (Posted Speed)	Direction	85th Percentile Speed	50th Percentile Speed	Pace
65	Pine Hills Rd South of Indian Hills Road (40 mph)	NB	47.12	41.63	35 - 45
		SB	47.46	41.95	35 - 45
		Combined	47.31	41.79	35 - 45
66	Pine Hills Rd South of Balboa Drive Crosswalk (40 mph)	NB	47.3	39.81	35 - 45
		SB	46.95	39.00	35 - 45
		Combined	47.13	59.47	35 - 45
67	Pine Hills Rd North of Balboa Drive Crosswalk (40 mph)	NB	46.61	41.50	35 - 45
		SB	49.77	44.00	40 - 50
		Combined	48.24	42.33	35 - 45

4.3.8 Lighting

Street lighting and pedestrian lighting were evaluated along the corridor. Conventional High Pressure Sodium (HPS) street lighting is present along both sides of Pine Hills Road throughout the project. Lighting at all the signalized intersection crosswalks do not meet FDOT standards. Only four of the northbound stops and seven of the southbound transit stops were found to have sufficient lighting conditions. It should be noted that 27 stops had no lighting. The Accessing Transit Design Handbook for Florida Bus Passenger Facilities states that "when lighting at the stop is not provided by the transit agency at night, local stops without shelter should be located within 30 feet of overhead light source." Based on this requirement, there are 15 transit stops that exceed 30 feet to the nearest overhead light source.

Details of the lighting study and luminosity measurements are included in *Technical Memorandum No. 3—Existing Conditions.*

4.4 Transit Service and Infrastructure

Transit service in the study are is provided by the Central Florida Regional Transportation Authority (LYNX), which provides transit service to Orange, Seminole, and Osceola counties. The following sections summarize information about LYNX, transit service, ridership and infrastructure along the study corridor.

Overview of LYNX

LYNX's service area covers more than 2,500 square miles extending through Orange, Seminole and Osceola Counties and serving over 1.8 million residents. LYNX also offers shuttle service to special events; commuter assistance with vanpools and carpools; special door-to-door transportation for customers who cannot use the regular bus service; and special fares for students, physically and mentally challenged customers and riders aged 65 and older. Throughout Orange, Seminole, Osceola, Lake, and Polk counties, there are 4,402 bus stops available from which 3,334 bus stops are located in Orange County. A total number of 1,108 Active Shelters are provided from which 771 shelters are located in Orange County.

4.4.1 Transit Service

There are four LYNX routes that serve Pine Hills Road between Colonial Drive (SR 50) and Bonnie Brae Drive, including Routes 49, 301, 302, and 613. There are other LYNX routes that intersect the study area but do not travel along Pine Hills Road, including Routes 9, 48, 105, 125, and 443. The following is a description of the four LYNX routes serving the study area:

- *Route 49 (Colonial Drive/Pine Hills)* – This route begins at LYNX Central Station, serving the Central Florida Fairgrounds, Pine Hills, Evans High School, Meadowbrook, North Lane, Rolling Hills, Silver Hills Center, and the Department of Children and Families.
- *Route 301 (Pine Hills/Animal Kingdom)* - This route begins at Walt Disney World's Animal Kingdom, serving several Disney hotels and theme parks, and serves Conroy/Vineland, Kirkman Road, Pine Hills Road, and Silver Star Road.
- *Route 302 (Rosemont/Magic Kingdom)* - This route begins at Walt Disney World's Magic Kingdom, serving several Disney hotels and theme parks, and serves Kirkman Road, Ivey Lane, Mercy Drive, Pine Hills Road, and Rosemont.
- *Route 613 (NeighborLink 613 – Pine Hills Neighborhood Link)* - This route is based out of the West Oaks Mall bus transfer area, and provides on-demand service within the Pine

Hills area (bordered by the West Oaks Mall, Silver Star Road, Pine Hills Road, and Colonial Drive (SR 50)).

LYNX service in the study area is provided on weekdays, Saturdays, and Sundays/Holidays. The earliest route begins at 4:30 AM and the latest route ends at 12:45 AM. Frequencies vary by route, time of day, and day of the week. There are 33 transit stops along Pine Hills Road to accommodate the LYNX routes servicing the area. The average daily ridership along the corridor is based on the latest four-month service period, from December 2015 to April 2016.

The average distance from an existing LYNX bus stop to a designated pedestrian crossing across Pine Hills Road (at a signalized intersection or mid-block crossing) is 495 feet. The shortest distance between a bus stop and a crossing is 10 feet (Stop #10 located just north of the Belco Drive intersection) and the longest distance between a bus stop and a crossing is 2,300 feet (Stop #6 located south of Ferdinand Drive).

There are four LYNX bus stops that are more than 1,000 feet from a designated pedestrian crossing across Pine Hills Road (Stops #5, #6, #21, and #22) that are all located within the segment of Pine Hills Road between Hernandes Drive and the mid-block crossing 405 feet north of Balboa Drive. The boarding and alighting information is an average daily estimate based on sampled ridership data during the last service period, which occurs three times per year. The LYNX stops are illustrated in **Figure 4.6** and the corridor ridership summary and features for each of the bus stops are listed in **Table 4.3.**

4.4.2 Transit Stop Infrastructure

A review was performed using current aerial footage and LYNX data to assess the bus stop infrastructure within the study area. Amenities for existing transit stops may include availability of landing pad, shelter, seating, and lighting.

Out of the 33 LYNX bus stops within the study area, only five stops have landing pads (15 percent), which provide a connection from the sidewalk to bus doors. Over half of the LYNX bus stops within the study area have seating (58 percent) and over half have lighting (52 percent).

There is only one stop, which has a landing pad, shelter, seating, and lighting. There are five stops that do not have any of the above infrastructure elements, and merely consist of a sign. Transit stop infrastructure data at the LYNX bus stops along the corridor are summarized and displayed in **Figure 4.4** on the next page.

Figure 4.6: Existing Bus Routes and Stops

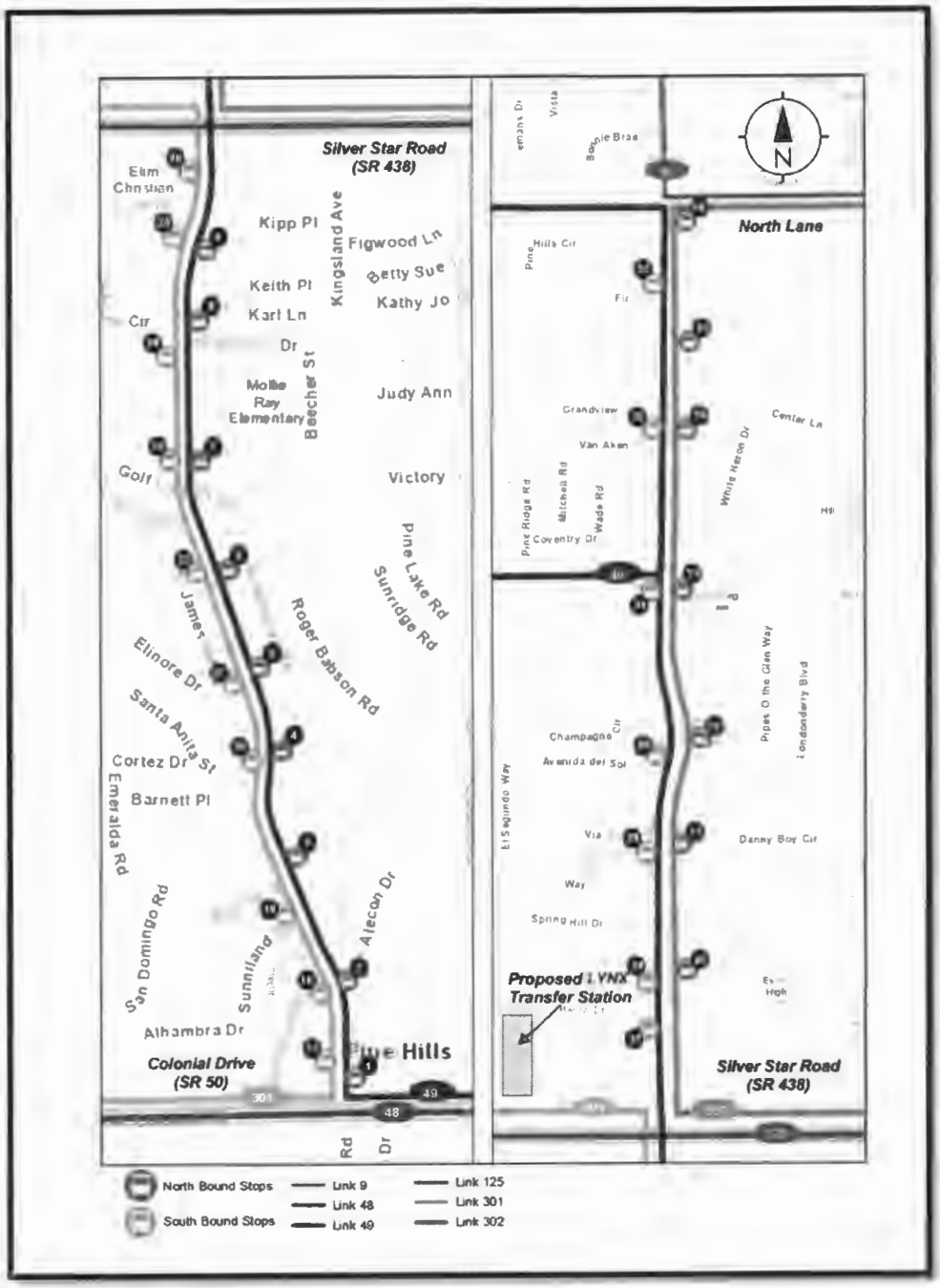
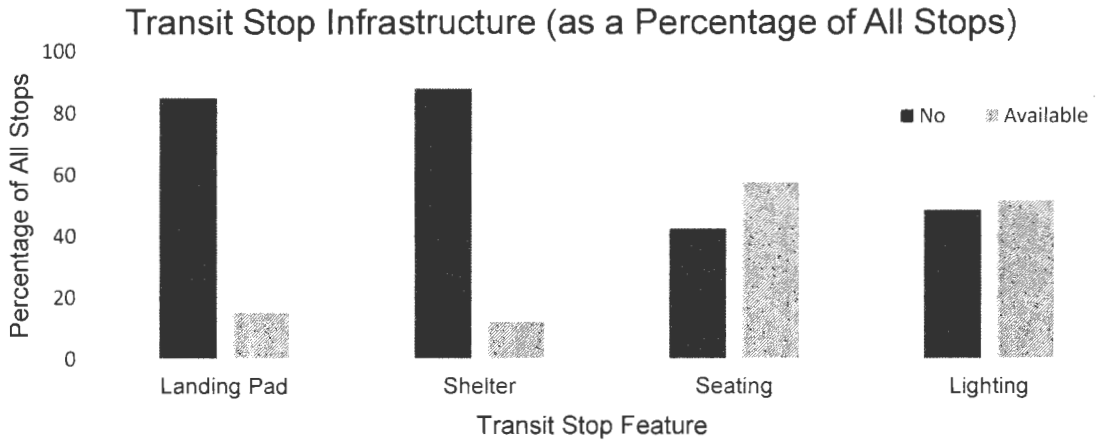


Table 4.3: LYNX Existing Bus Stop Ridership Summary

No.[2]	Location	LYNX Bus Stop ID	Avg. Daily On	Avg. Daily Off	Total	Routes	Shelter
Northbound Direction							
1	N of Colonial Drive	2065	81	51	132	49, 301	No
2	S of Deauville Drive	2066	7	10	17	49, 301	No
3	N of Balboa Drive	2758	6	14	20	49, 301	No
4	N of Dolores Drive	2759	12	37	49	49, 301	No
5	N of Elinore Drive	2760	0	0	0	49, 301	No
6	S of Ferdinand Drive	2761	1	7	8	49, 301	No
7	S of Hernandes Drive	2762	8	36	44	49, 301	No
8	N of Indialantic Drive	2763	2	29	31	49, 301	No
9	S of Figwood Lane	2764	6	86	92	49, 301	No
10	N of Belco Drive	2081	46	64	110	49, 302	No
11	S of Via Maior	2082	4	24	28	49, 302	No
12	N of Pipes O the Glen Way	2083	4	17	21	49, 302	No
13	S of Indian Hill Road	2765	0	0	0	49, 302	No
14	N of Van Aken Drive	2766	0	1	1	302	No
15	S of White Heron Drive	2767	0	0	0	302	No
16	S of North Lane	2768	0	2	2	302	Available
Southbound Direction							
17	N of Alhambra Drive	2113	7	61	68	49, 301	No
18	S of Deauville Drive	2112	7	6	13	49, 301	Available
19	N of Sunniland Drive	2111	14	7	21	49, 301	No
20	S of Dolores Drive	2920	29	9	38	49, 301	Available
21	N of Elinore Drive	6014	21	5	26	49, 301	No
22	S of Ferdinand Drive	2110	4	3	7	49, 301	No
23	S of Hernandes Drive	2109	44	11	55	49, 301	No
24	S of Indialantic Drive	2108	37	4	41	49, 301	No
25	S of Figwood Lane	2107	10	1	11	49, 301	No
26	S of Lupez Drive	2106	84	6	90	49, 301	No
27	S of Belco Drive	2105	49	14	63	49, 302	No
28	N of Belco Drive	9166	16	19	35	49, 302	Available
29	N of El Trio Way	2103	10	1	11	49, 302	No
30	S of Pipes O the Glen Way	2102	5	3	8	49, 302	No
31	S of Indian Hill Road	2101	18	2	20	49, 302	No
32	N of Van Aken Drive	2100	14	4	19	49, 302	No
33	N of Fir Drive	2099	13	3	16	49, 302	No

[2] *Refer to stop locations on Figure 4.6.*

Table 4.4: Transit Stop Infrastructure



4.5 Safety and Crash Analysis

A historical crash review was performed for the corridor to identify the pedestrian and bicycle crash patterns and hotspots within the corridor. To identify crash patterns along the corridor, crash data was obtained from the Orange County Traffic Engineering Division for crashes that involved only pedestrians or bicycles for the previous three years (January 1, 2014 to December 31, 2016) within 150 feet of the Pine Hills Road centerline. Two additional fatal pedestrian crashes that occurred in 2017 are included in the analysis. This tends to show a higher percentage of fatalities and pedestrian crashes, as only fatal crashes were considered, and for a non-specific period outside the three-year period analyzed.

Crash diagrams indicating the locations of crashes are shown in **Figure 4.7** (along with the 2017 fatalities).

4.5.1 Sight Line Analysis

In addition to crash diagrams, the crash data compiled for driveways and intersections within the Pine Hills Road study limits were reviewed to identify high accident pedestrian locations. Based on the crash data reviewed, a threshold of at least two or more crashes occurring within a given area were considered to be a high accident location. At these locations, the visibility of pedestrians and bicycles was evaluated from the perspective of motorists being able to detect pedestrian or bicycle activities. The locations were examined for potential sight-line obstructions and the results are shown of this assessment are shown in **Appendix B.**

Figure 4.7: Past Crash Locations and Types

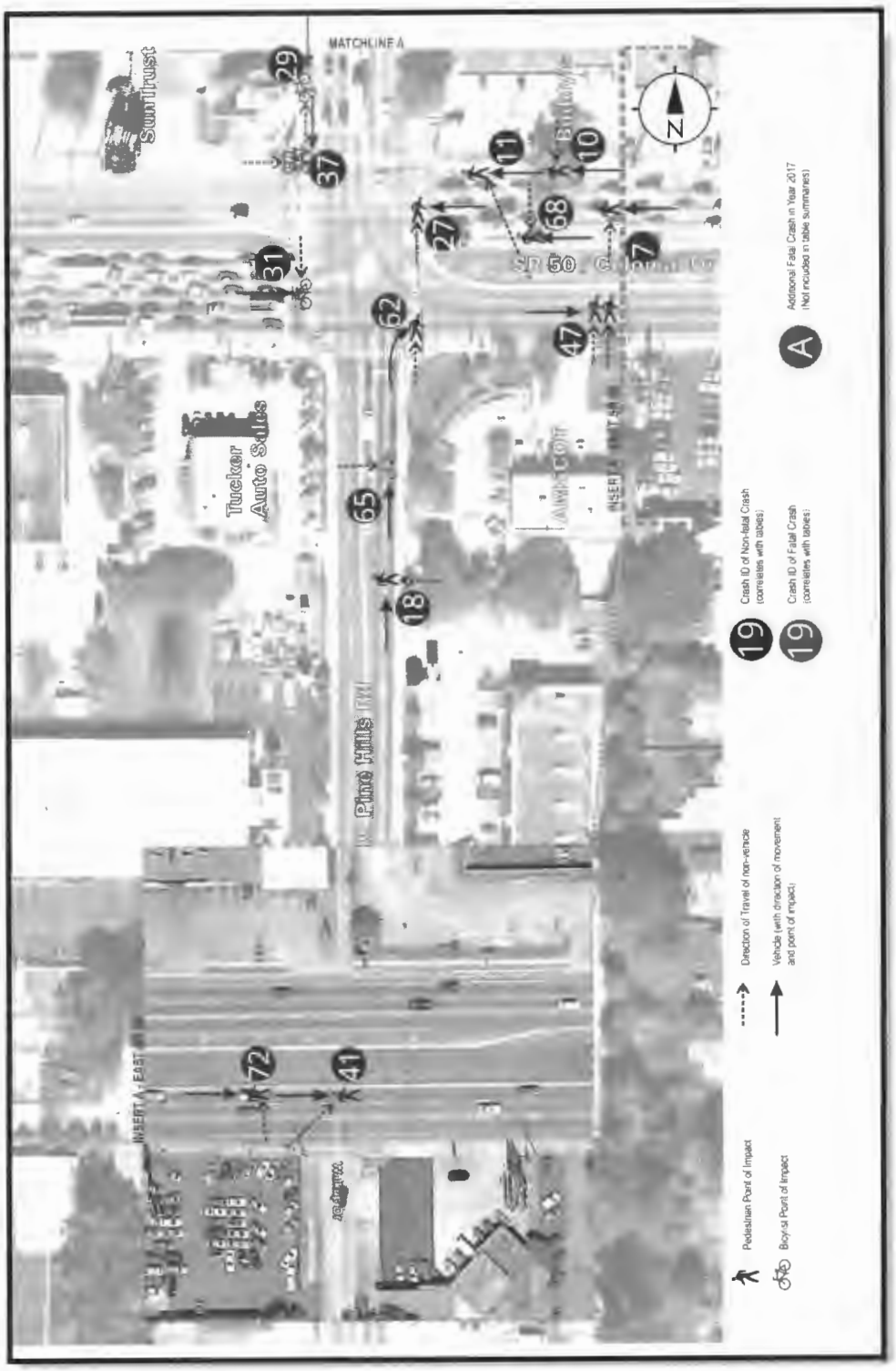


Figure 4.7 (continued): Past Crash Locations and Types

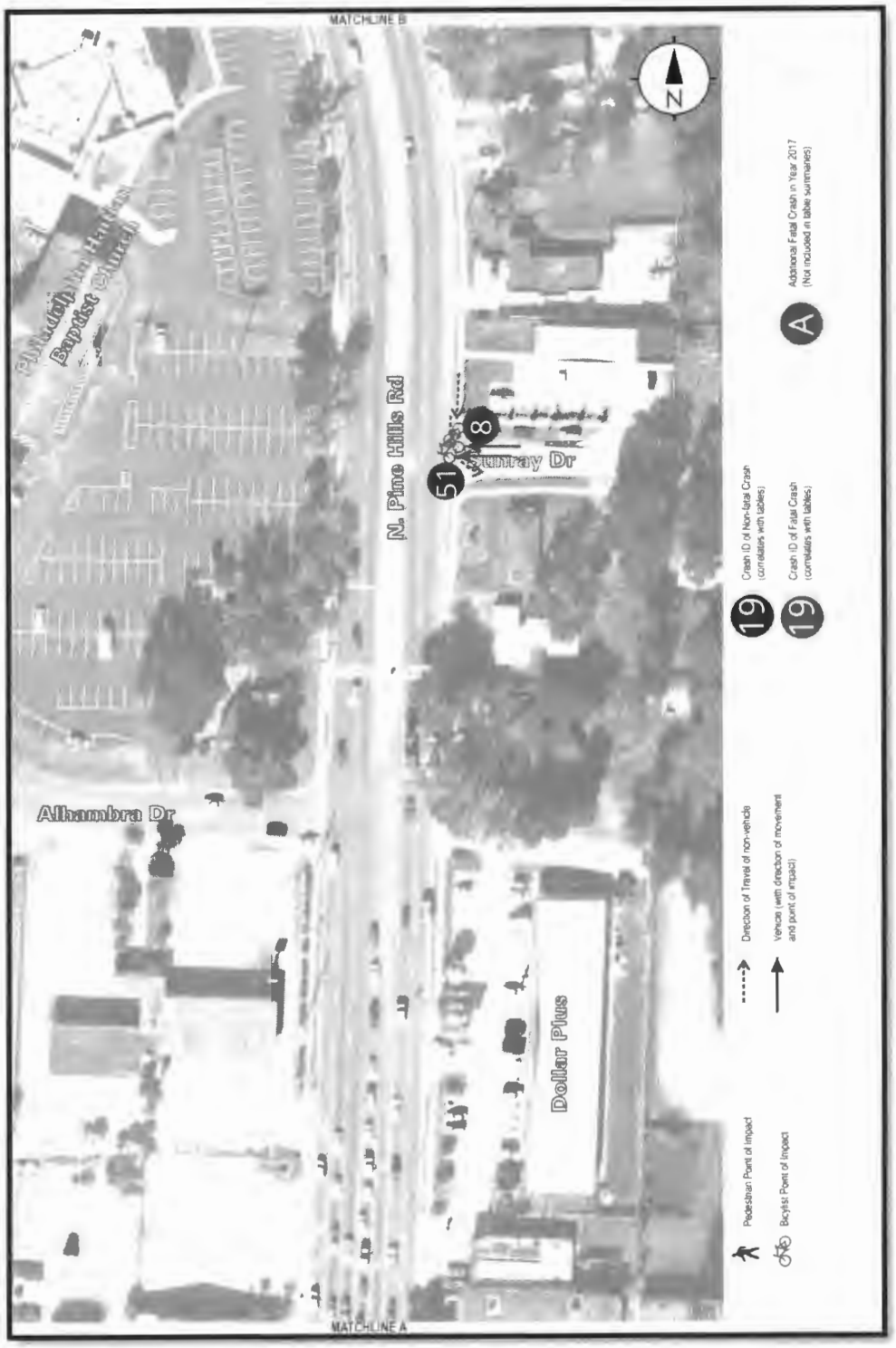


Figure 4.7 (continued): Past Crash Locations and Types

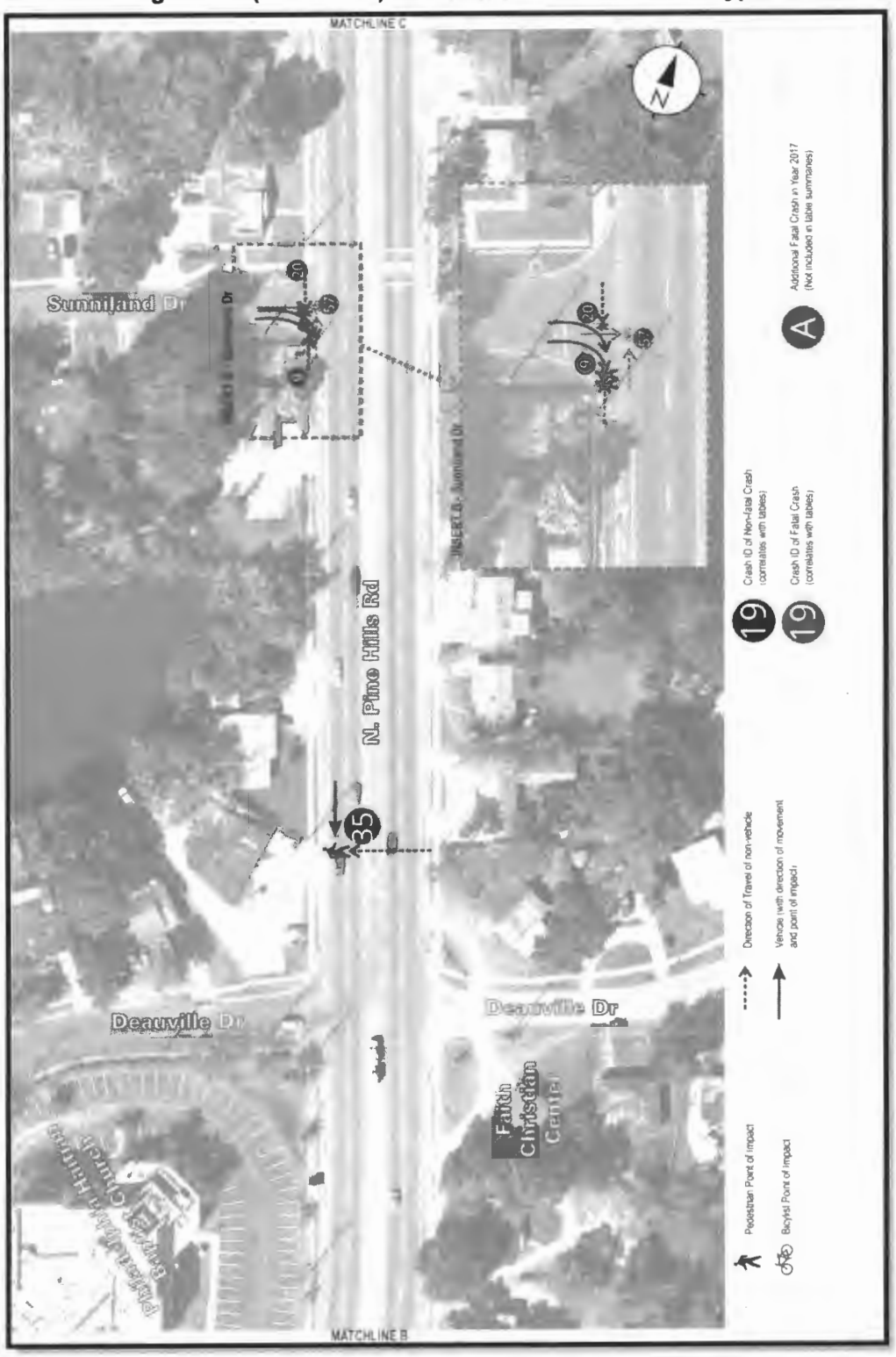


Figure 4.7 (continued): Past Crash Locations and Types

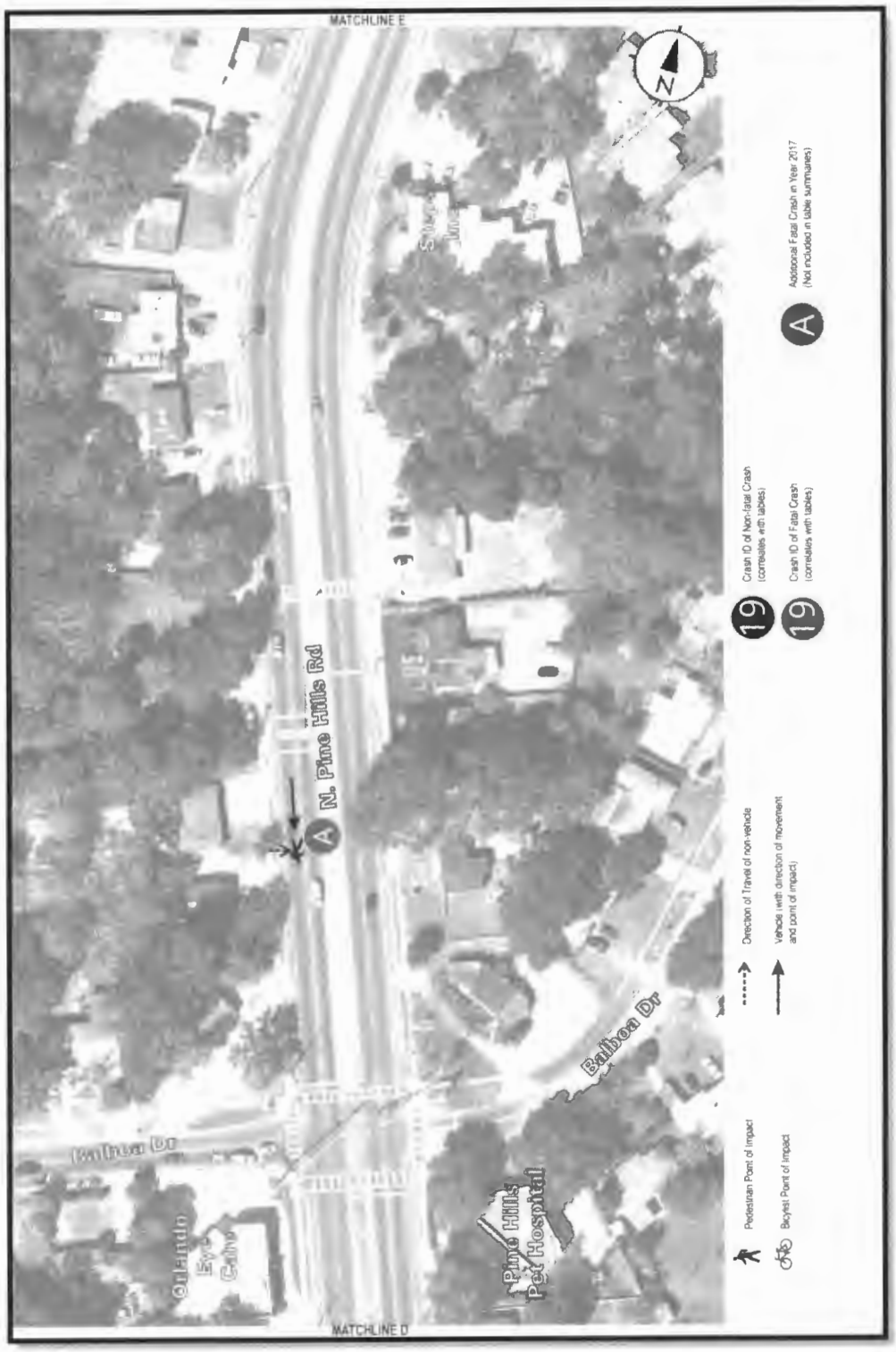


Figure 4.7 (continued): Past Crash Locations and Types

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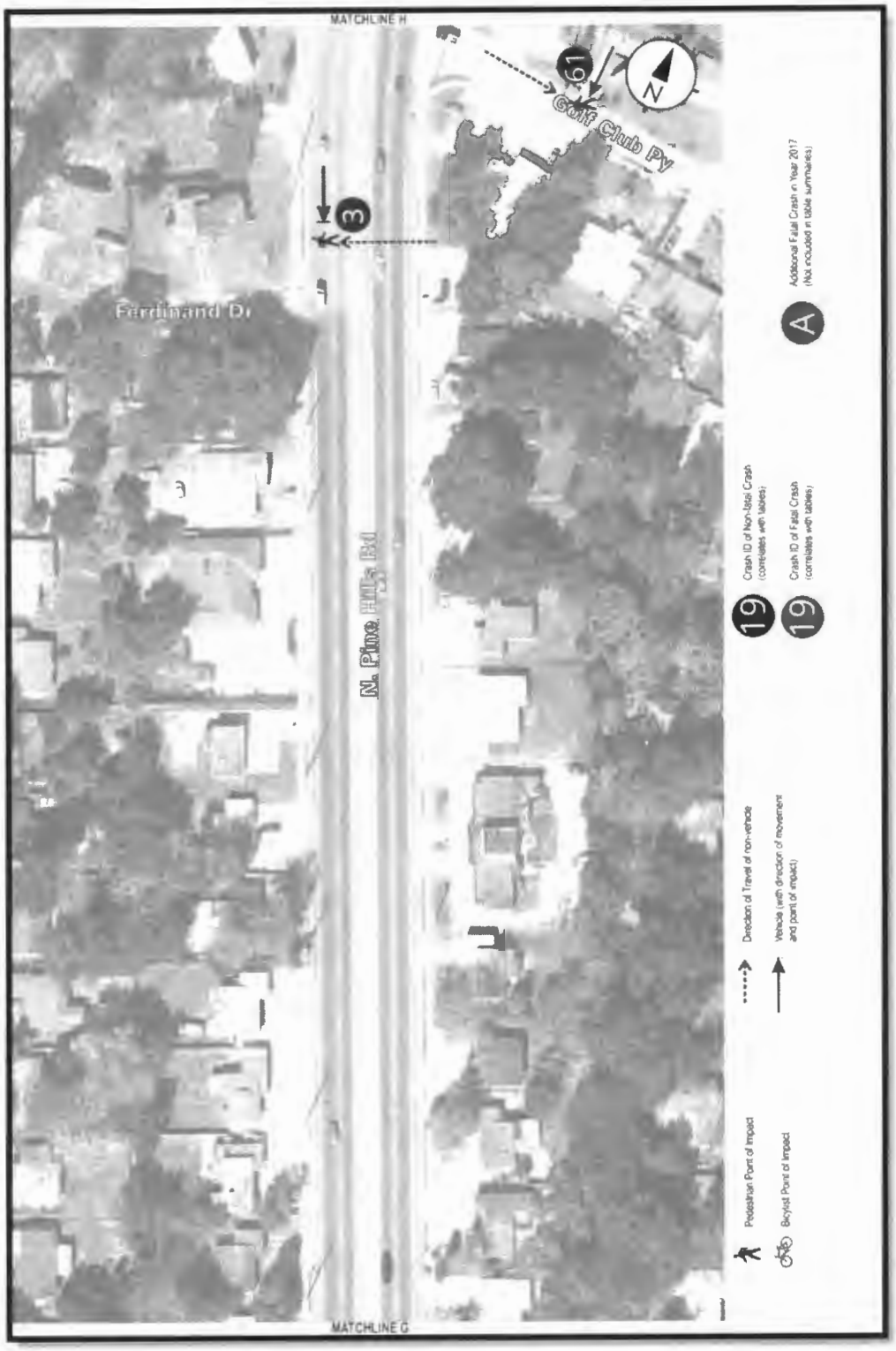

Figure 4.7 (continued): Past Crash Locations and Types

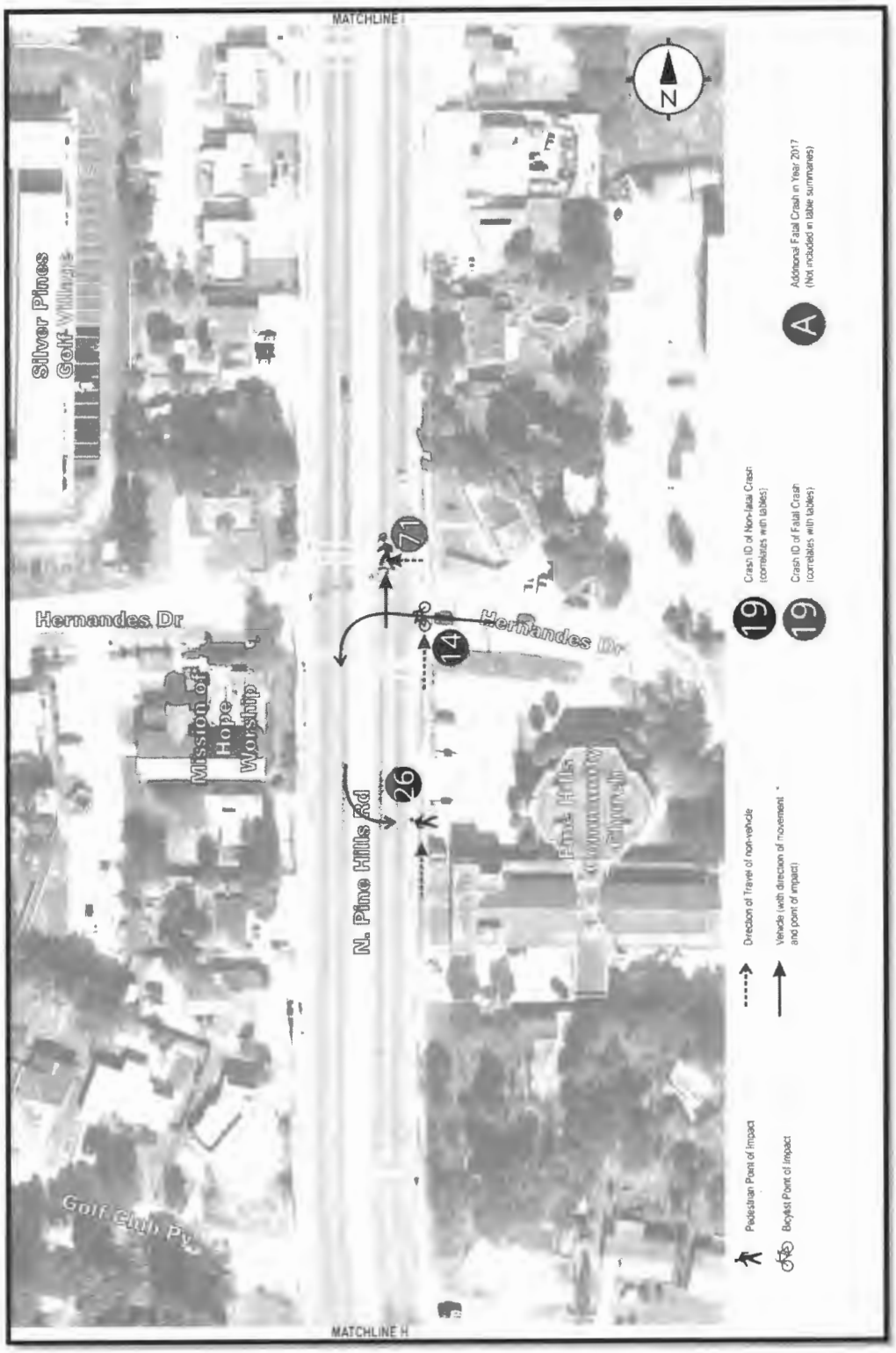

Figure 4.7 (continued): Past Crash Locations and Types

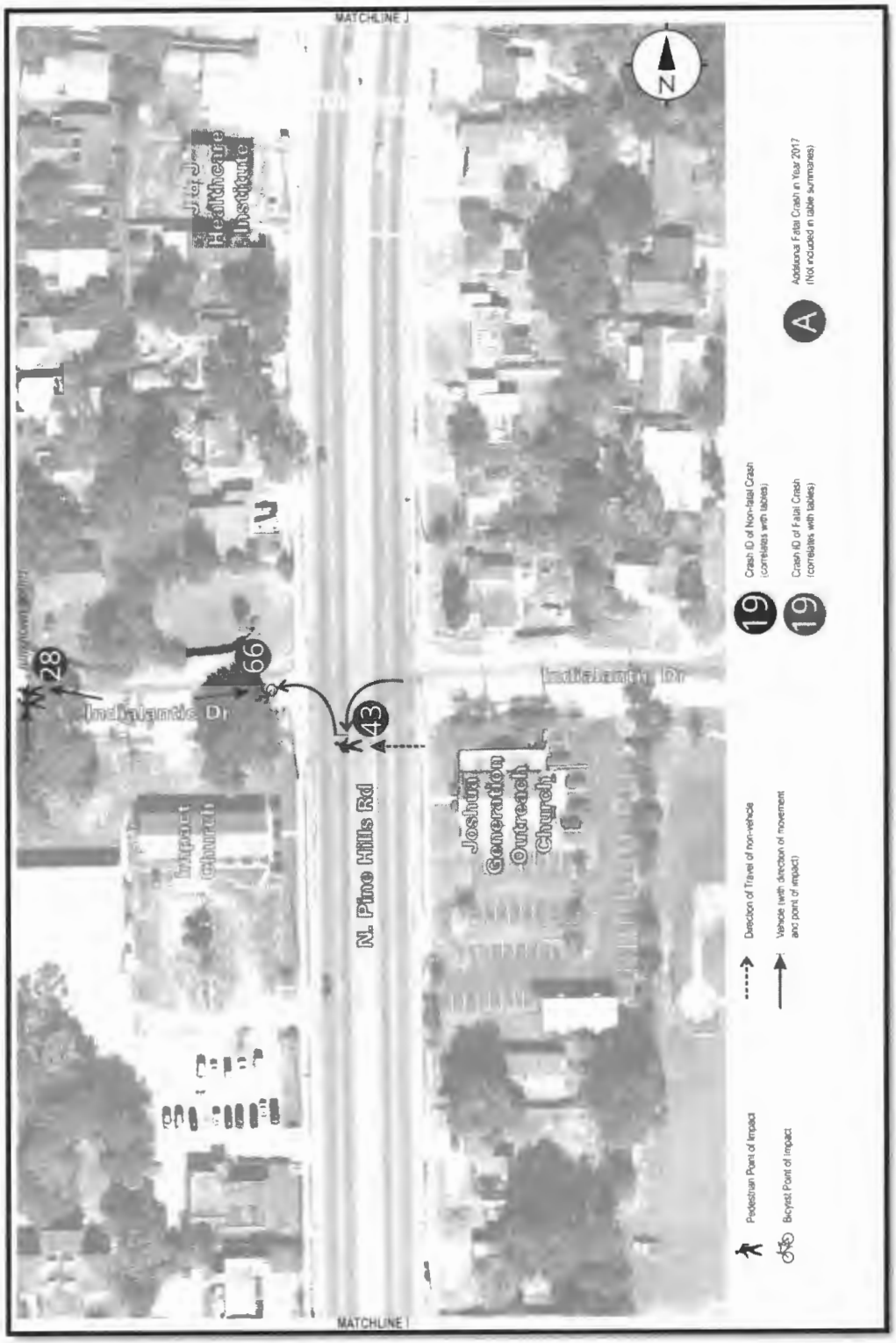

Figure 4.7 (continued): Past Crash Locations and Types

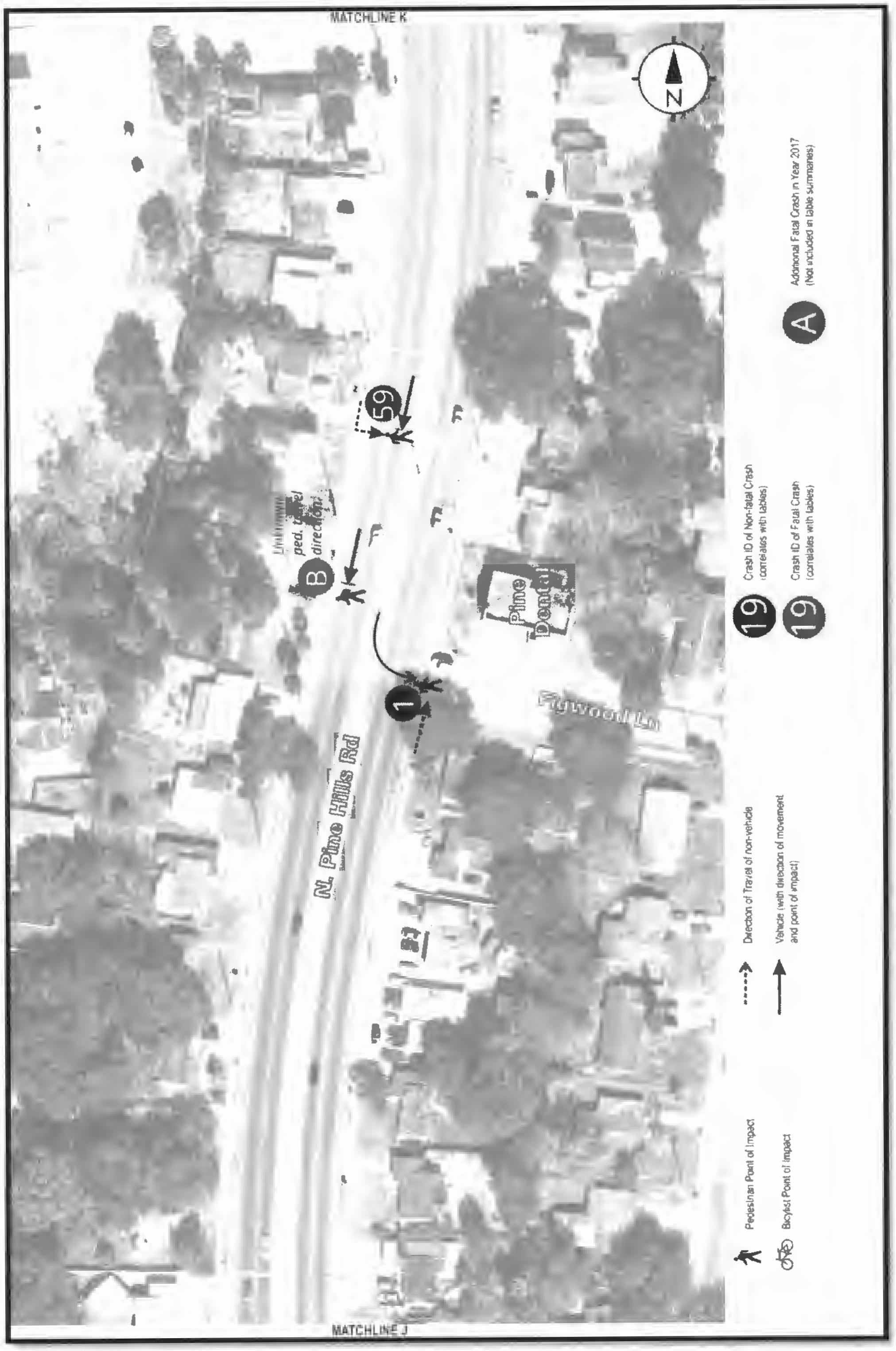

Figure 4.7 (continued): Past Crash Locations and Types

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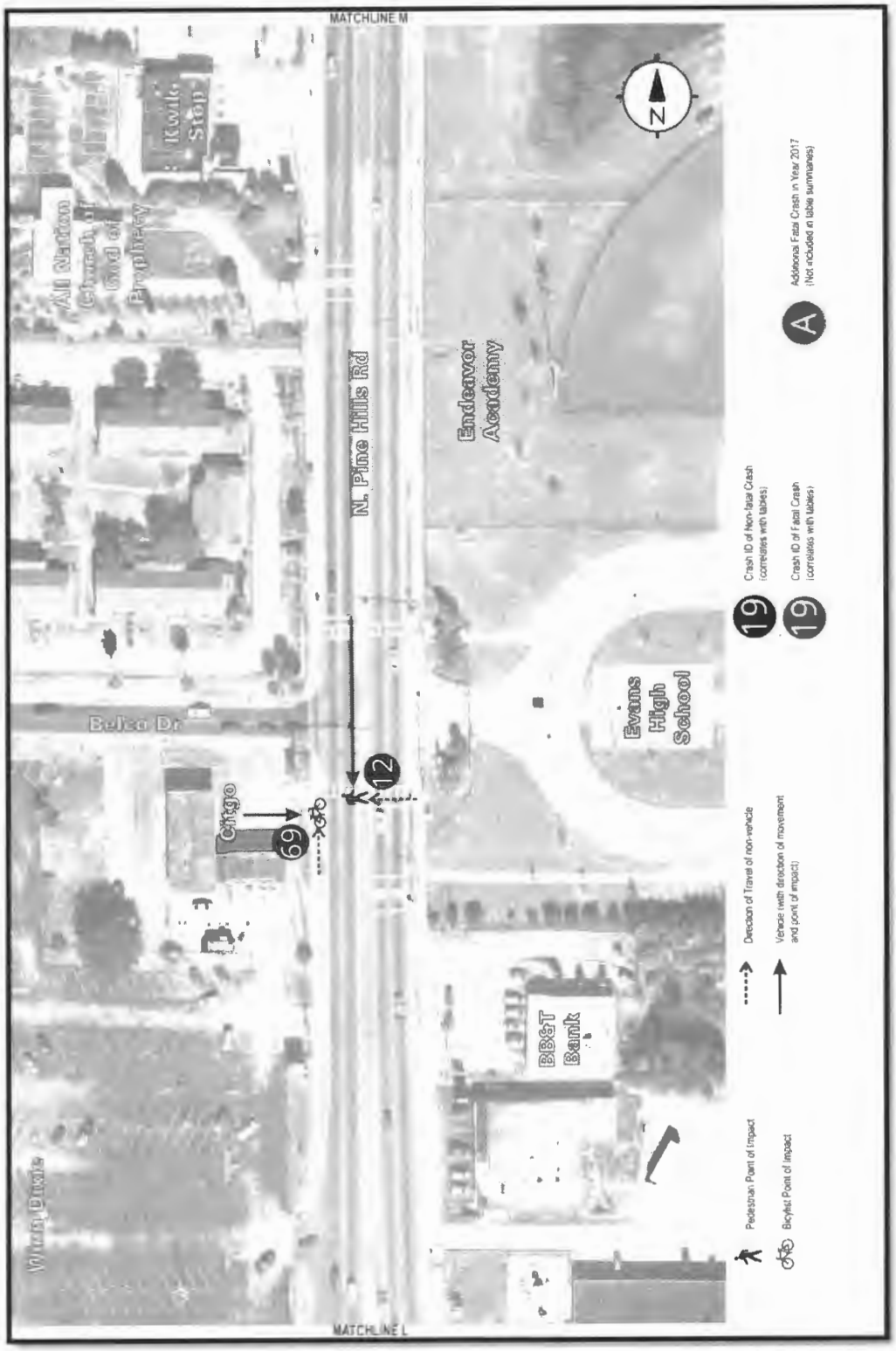

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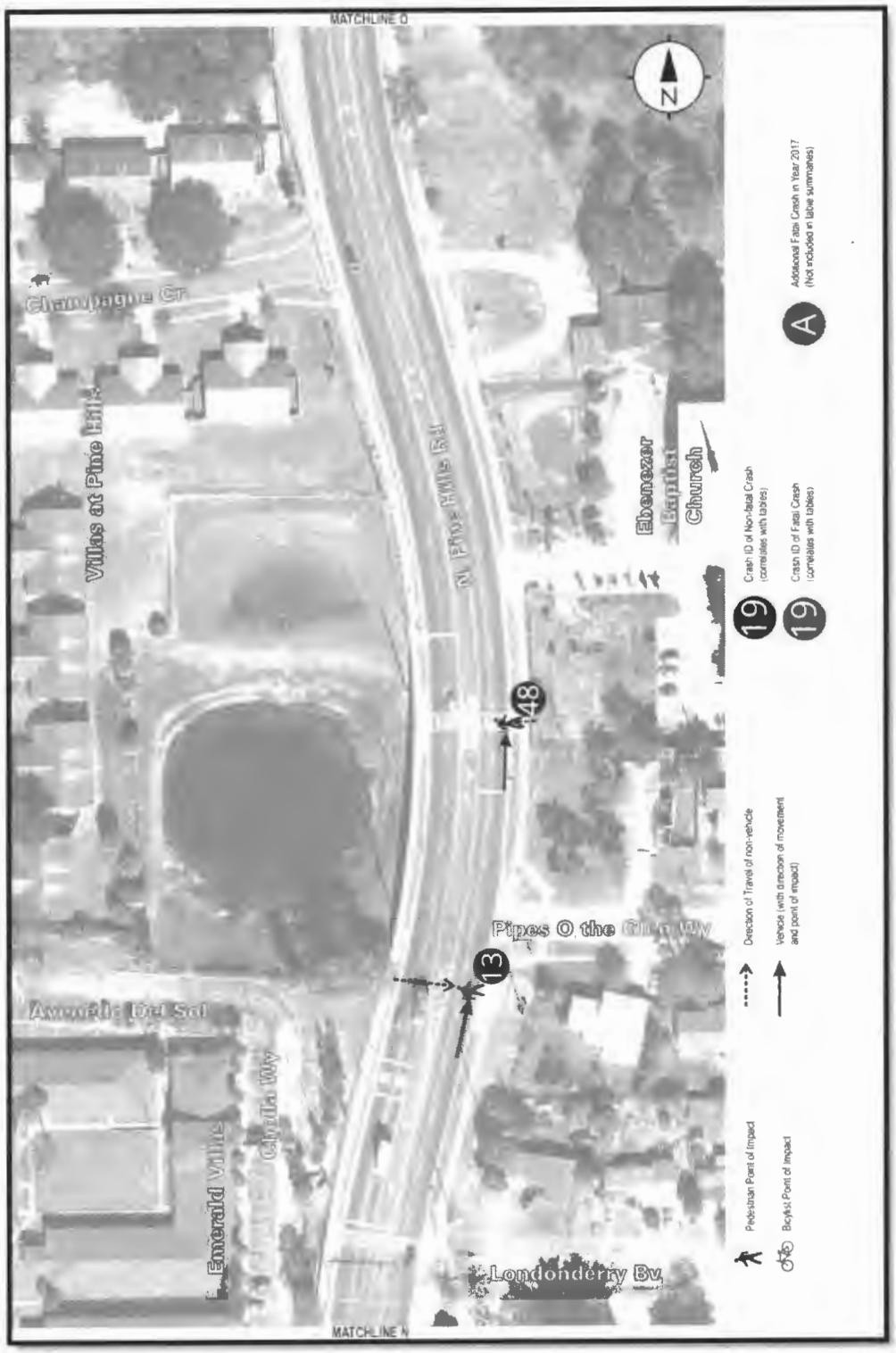

Figure 4.7 (continued): Past Crash Locations and Types

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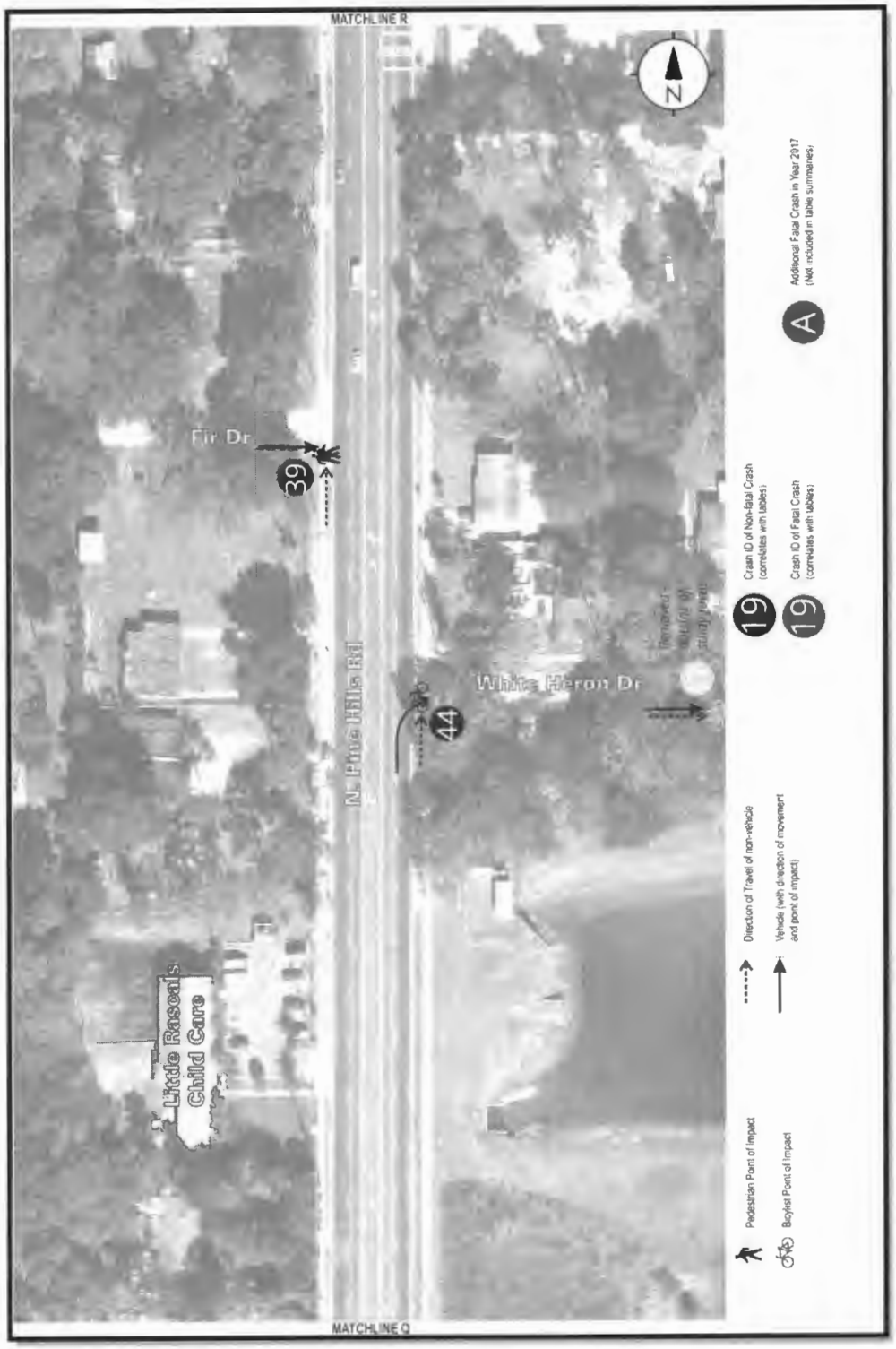
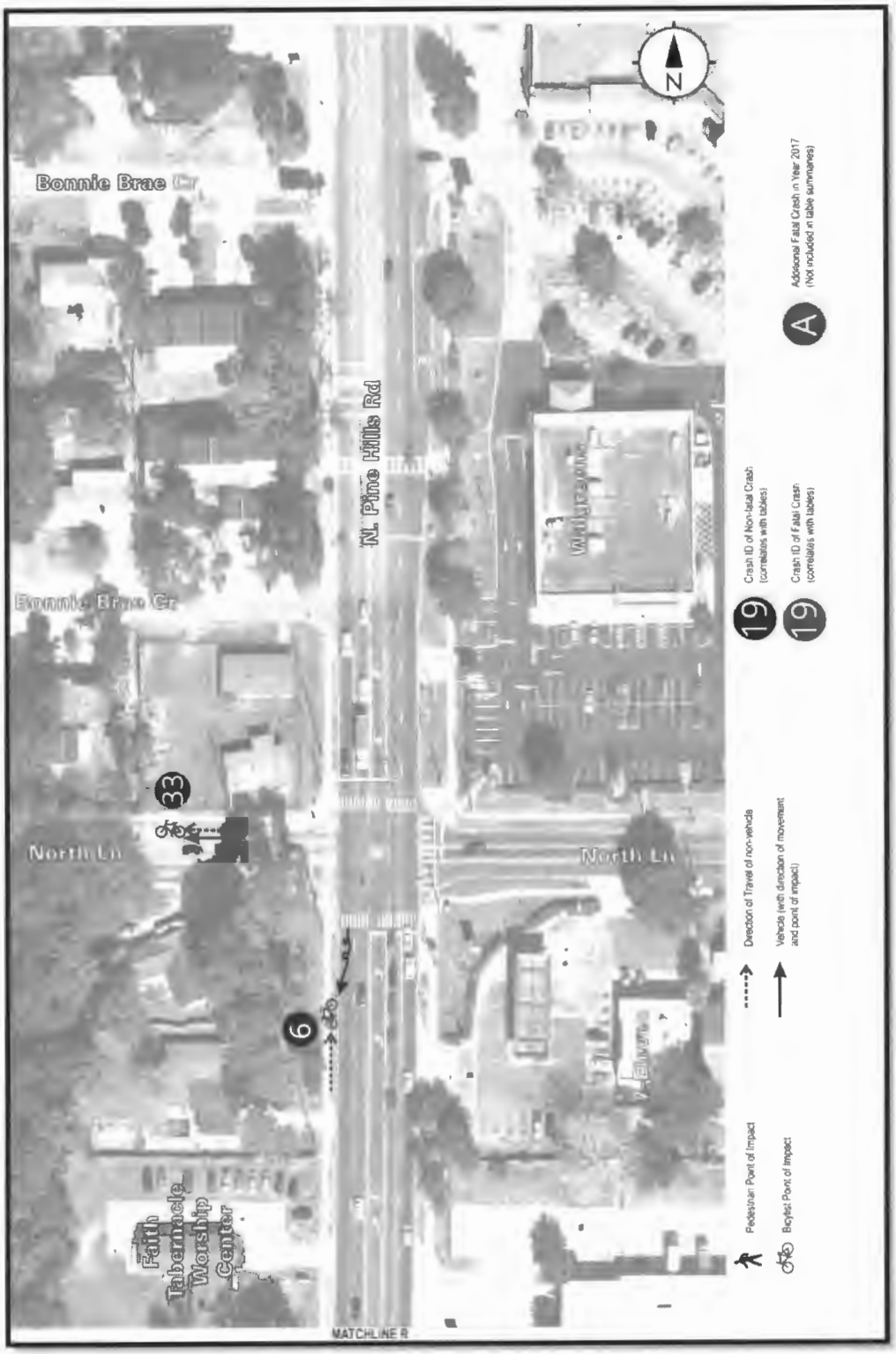


Figure 4.7 (continued): Past Crash Locations and Types



4.5.2 Crash Summary

Based on the crash data from January 2014 to December 2016, a total of 73 pedestrian and bicycle crashes were recorded within the corridor from 2014-2016 and early 2017 which reflected less than 5% of the total 1,462 crashes. Per the police reports, 59 crashes (81 percent) resulted in some type of injury, and seven crashes (10 percent) resulted in a fatality. Based on the pavement conditions mentioned in the police reports, a total of 33 crashes (45 percent) occurred during dusk or night conditions. More details on crashes by year and condition as well as bicycle and pedestrian crashes by signalized intersection and roadway segment within the corridor, including the distribution of crashes along the corridor (crashes by location) are included in *Technical Memorandum No. 3—Existing Conditions*.

4.6 Existing Travel Demand Characteristics

This chapter summarizes existing travel demand characteristics along the Pine Hills Road corridor, using daily and hourly traffic volume data for vehicular traffic, bicycle traffic, and pedestrian traffic.

4.6.1 Existing Travel Volumes

Weekday daily and hourly traffic volumes along the corridor were collected by LTEC and supplemented from Florida Transportation Information (FTI). These counts included the following:

- 6-hour turning movement counts from 7:00 – 9:00 AM, 11:00 – 1:00 PM and 4:00 – 6:00 PM; at 22 intersections (Type A)
- 8-hour turning movement counts from 7:00 – 9:00 AM, 11:00 – 1:00 PM and 2:00 – 6:00 PM; at 7 intersections (Type B)
- AM and PM Major driveway counts at 6 locations from 7:00 – 9:00 AM and 4:00 – 6:00 (Type C)
- 72-hour bidirectional volume counts (12 locations) (Type D)
- 24-hour classification counts (2 locations) (Type E)
- Mid-block crossing pedestrian and bicycle counts at 11 locations over three days for 4 hours from 7:00 – 9:00 AM and 4:00 – 6:00 (Type F)
- 72-hour speed counts (3 locations) (Type G)
- Gap Studies (Type H)

The counts were collected in January and February, 2017. **Table 4.4** contains a detailed list of each count location containing a 72-hour traffic volume count. The peak-hour counts illustrated in **Figure 4.8** represent the highest hour of each of the peak study periods, AM (7:00-9:00), Mid-Day (11:00-1:00 PM), School (2:00-4:00 PM, signalized intersections only) and PM (4:00-6:00 PM).

Based on the 72-hour volume counts, the annual average daily traffic (AADT) along the Pine Hills Road corridor ranges from a low of 25,060 daily trips south of Deauville Drive to a high of 34,733 daily trips south of Silver Star Road (SR 438). North of Silver Star Road, AADT volumes range from 29,606 to 32,671 daily trips. The AADT traffic volumes are summarized in **Table 4.5**.

The percentage of truck volumes along the corridor range from a low of approximately 7.2 percent of the AADT north of Balboa Drive to a high of approximately 8.2 percent of AADT north of Belco Drive.

Table 4.5: 72-Hour Traffic Volume Counts

Roadway/ Segment ID	Roadway/ Segment	Traffic Count Date	Measured Characteristics							Seasonal Factor	Adjusted AADT
			ADT	Peak Hour Total	NB/EB Volume	SB/WB Volume	Peak Time	"K"	"D"		
36	Pine Hills Rd: South of Deauville Dr	1/17/17-1/19/17	24,213	1,913	1,328	586	4:45-5:45 PM	0.079	0.694	1.035	25,060
37	Pine Hills Rd: South of Silver Star Rd	1/17/17-1/19/17	33,558	2,648	1,556	1,093	5:00-6:00 PM	0.079	0.588		34,733
38	Pine Hills Rd: South of Indian Hill Rd	1/17/17-1/19/17	31,566	2,401	1,305	1,095	5:00-6:00 PM	0.076	0.544		32,671
39	Pine Hills Rd: South of North Ln	3/7/17-3/9/17	28,605	2,101	1,187	914	5:00-6:00 PM	0.073	0.565		29,606
40	Balboa Dr: West of Pine Hills Rd	1/17/17-1/19/17	4,652	448	191	258	5:15-6:15 PM	0.096	0.576		4,815
41	Dolores Dr: East of Pine Hills Rd	1/17/17-1/19/17	315	22	11	12	5:00-6:00 PM	0.069	0.569		326
42	Hernandes Dr: East of Pine Hills Rd	1/17/17-1/19/17	2,055	214	107	109	6:00-7:00 PM	0.104	0.509		2,127
43	Hernandes Dr: West of Pine Hills Rd	1/17/17-1/19/17	1,247	138	56	83	5:15-6:15 PM	0.111	0.601		1,291
44	Silver Star Rd: East of Pine Hills Rd	1/17/17-1/19/17	46,177	4,140	2,999	1,142	5:00-6:00 PM	0.090	0.724		47,793
45	Silver Star Rd: West of Pine Hills Rd	1/17/17-1/19/17	38,841	2,869	1,791	1,078	5:00-6:00 PM	0.074	0.624		40,200
46	Belco Dr: West of Pine Hills Rd	1/17/17-1/19/17	2,329	241	112	128	7:00-8:00 AM	0.103	0.531		2,411
47	Evan HS: East of Pine Hills Rd	1/17/17-1/19/17	111	8	5	3	7:00-8:00 AM	0.072	0.667		115
48	Londonderry Blvd: East of Pine Hills Rd	1/17/17-1/19/17	3,999	326	144	183	3:15-4:15 PM	0.082	0.561		4,139
49	Indian Hill Rd: West of Pine Hills Rd	1/17/17-1/19/17	6,734	555	237	318	5:15-6:15 PM	0.082	0.573		6,970
50	North Ln: East of Pine Hills Rd	1/17/17-1/19/17	10,145	839	397	440	5:30-6:30 PM	0.083	0.524		10,500
51	North Ln: West of Pine Hills Rd	1/17/17-1/19/17	7,703	616	310	308	5:00-6:00 PM	0.080	0.503		7,973

Figure 4.8: Turning Movement Counts

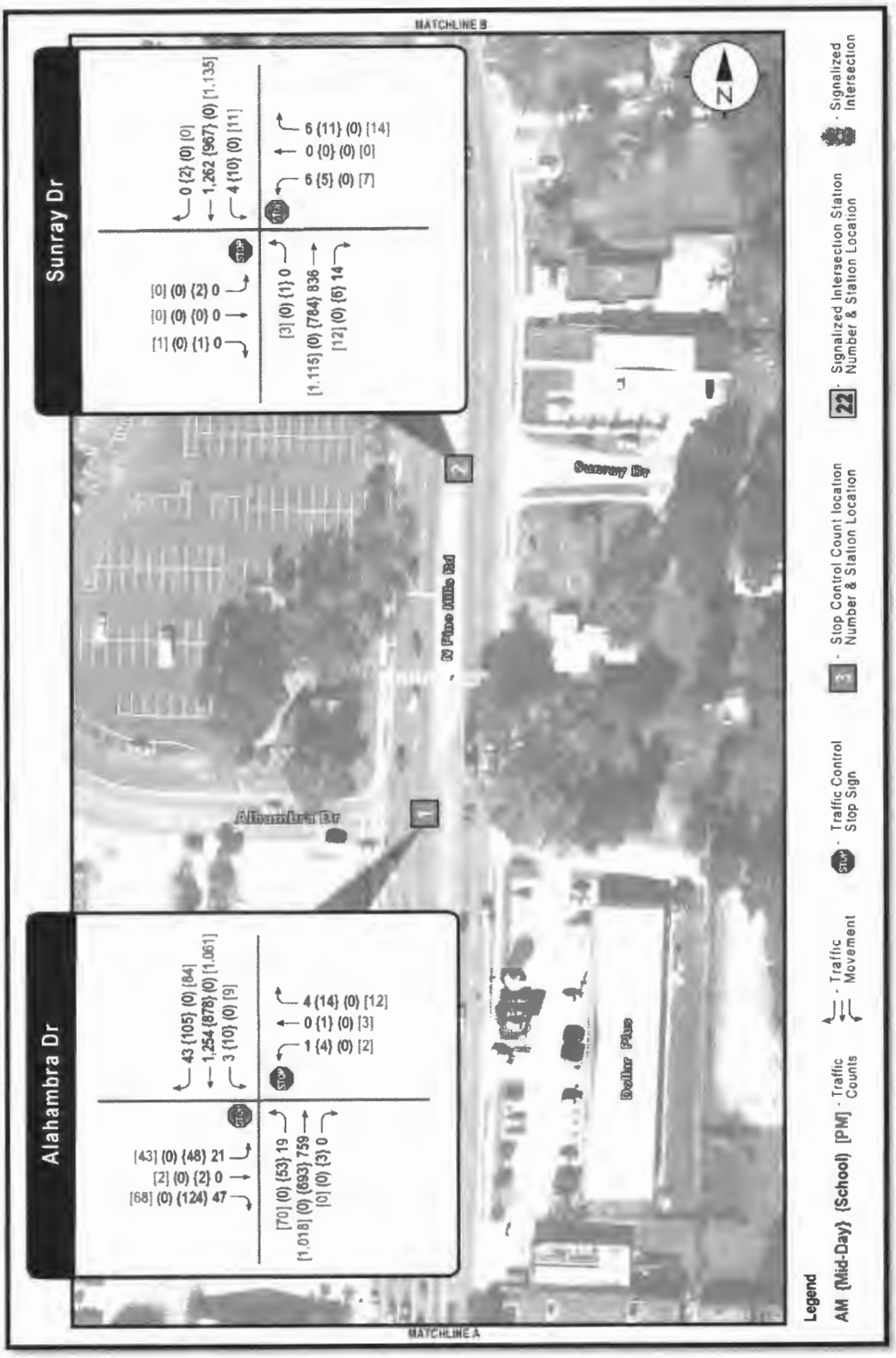


Figure 4.8 (continued): Turning Movement Counts

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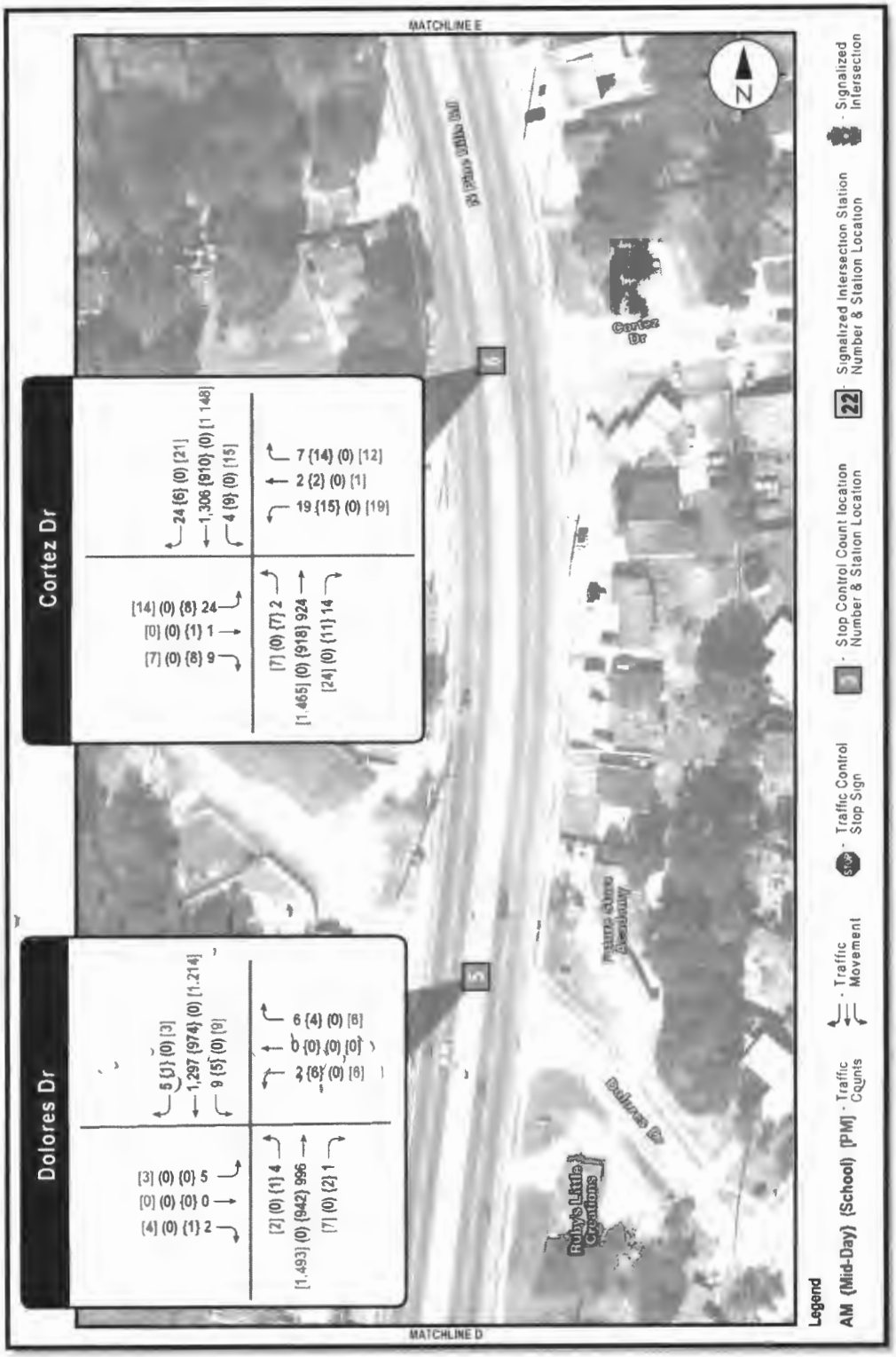

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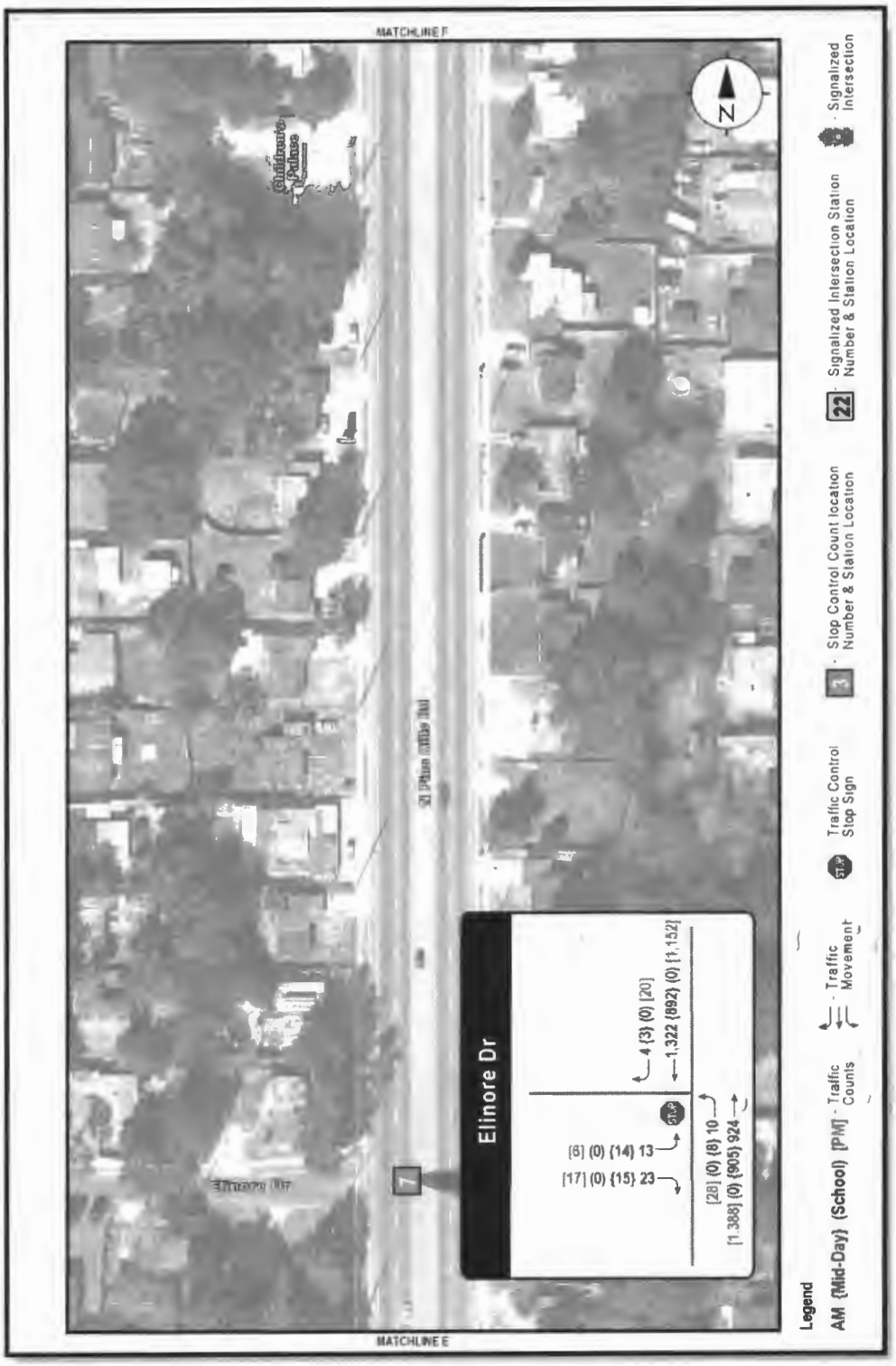

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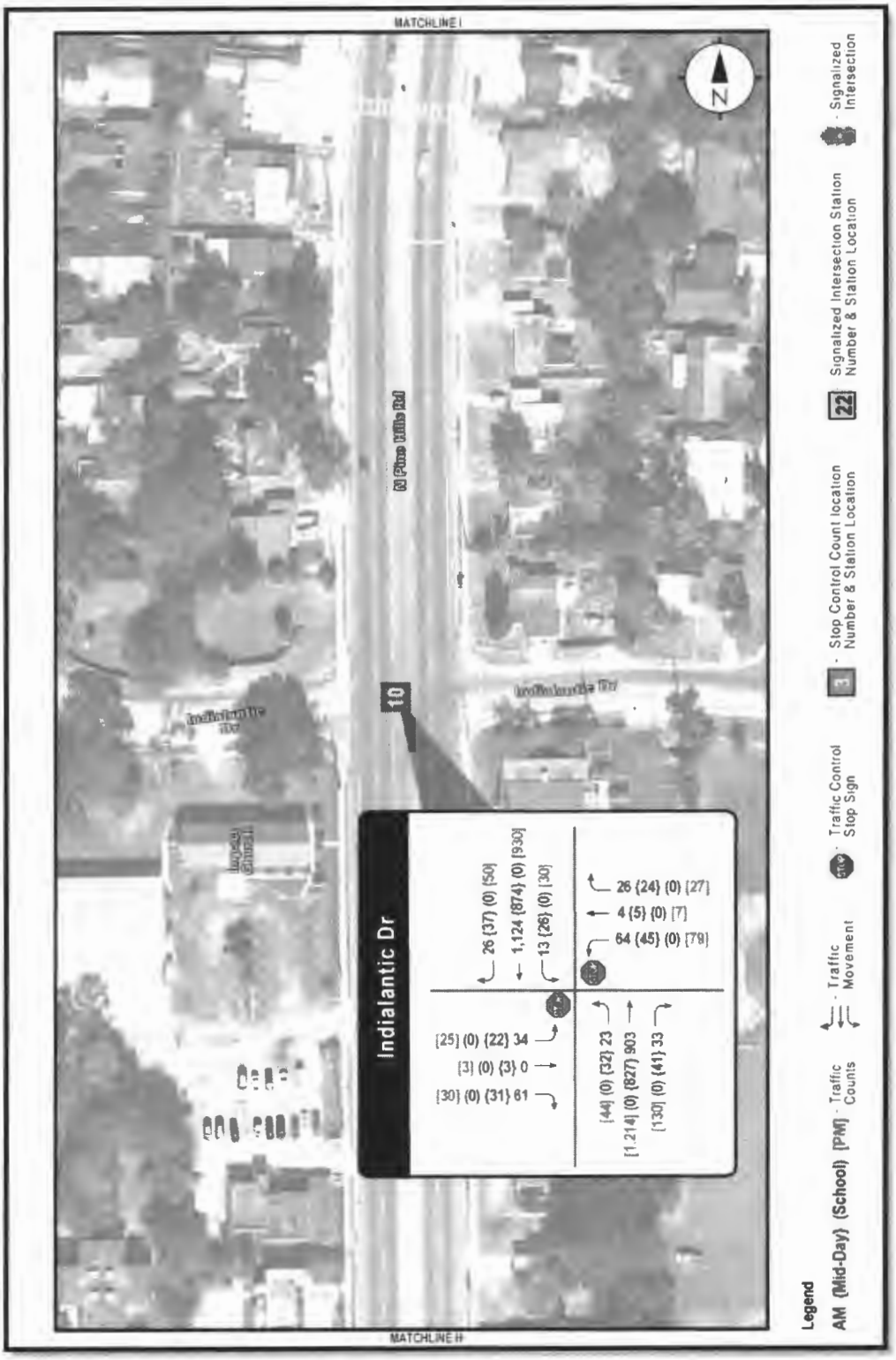

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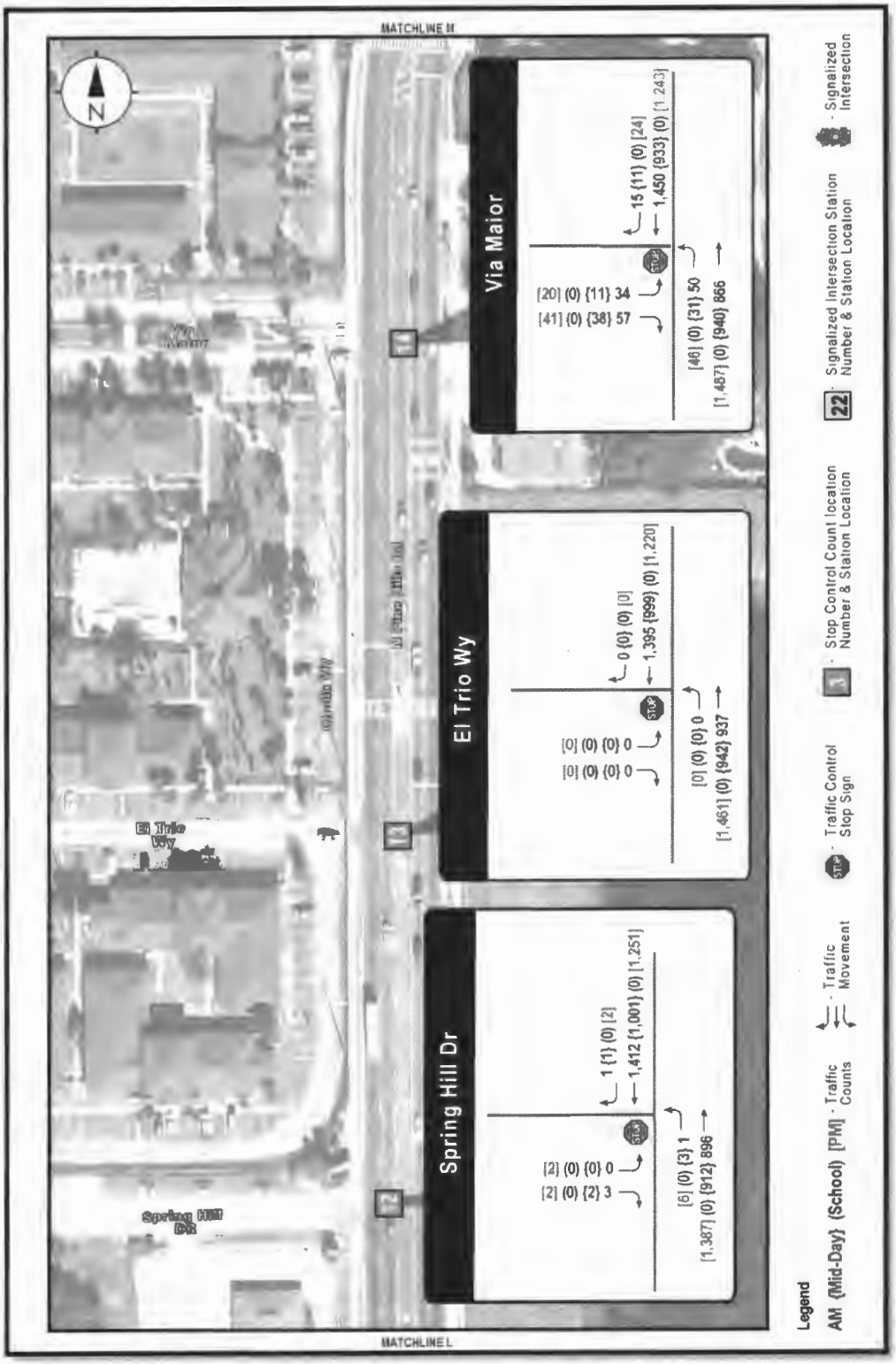

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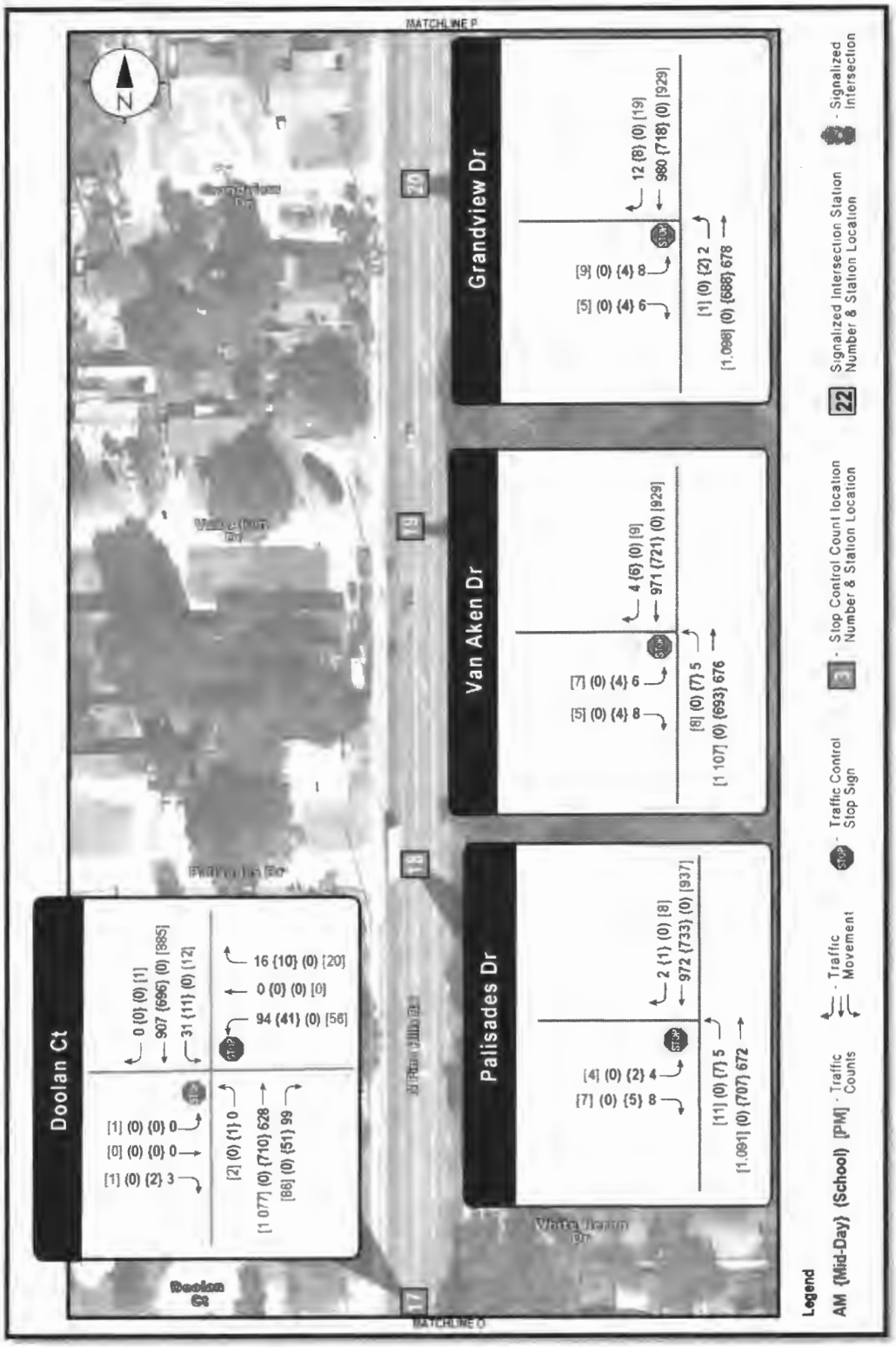

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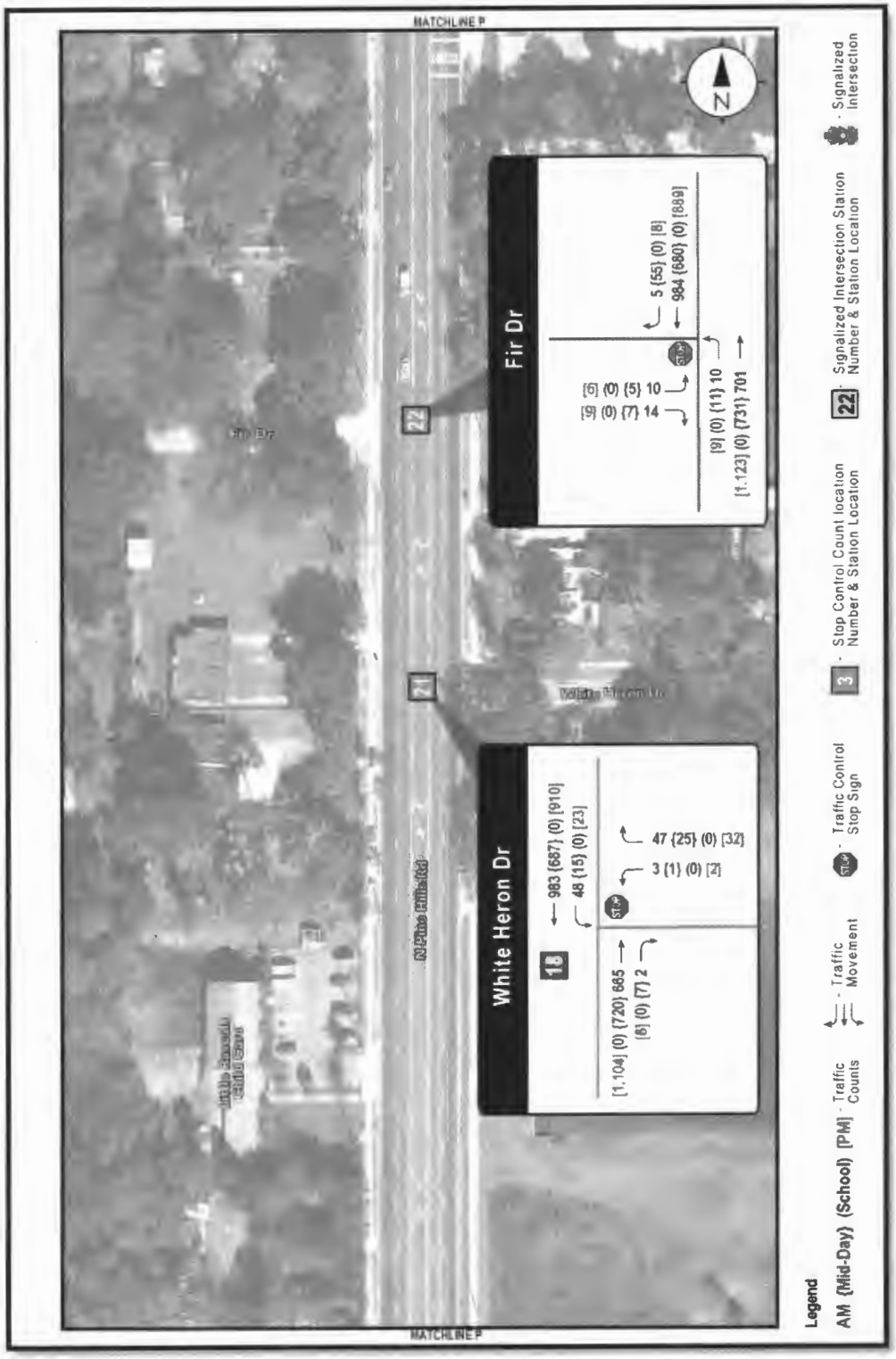

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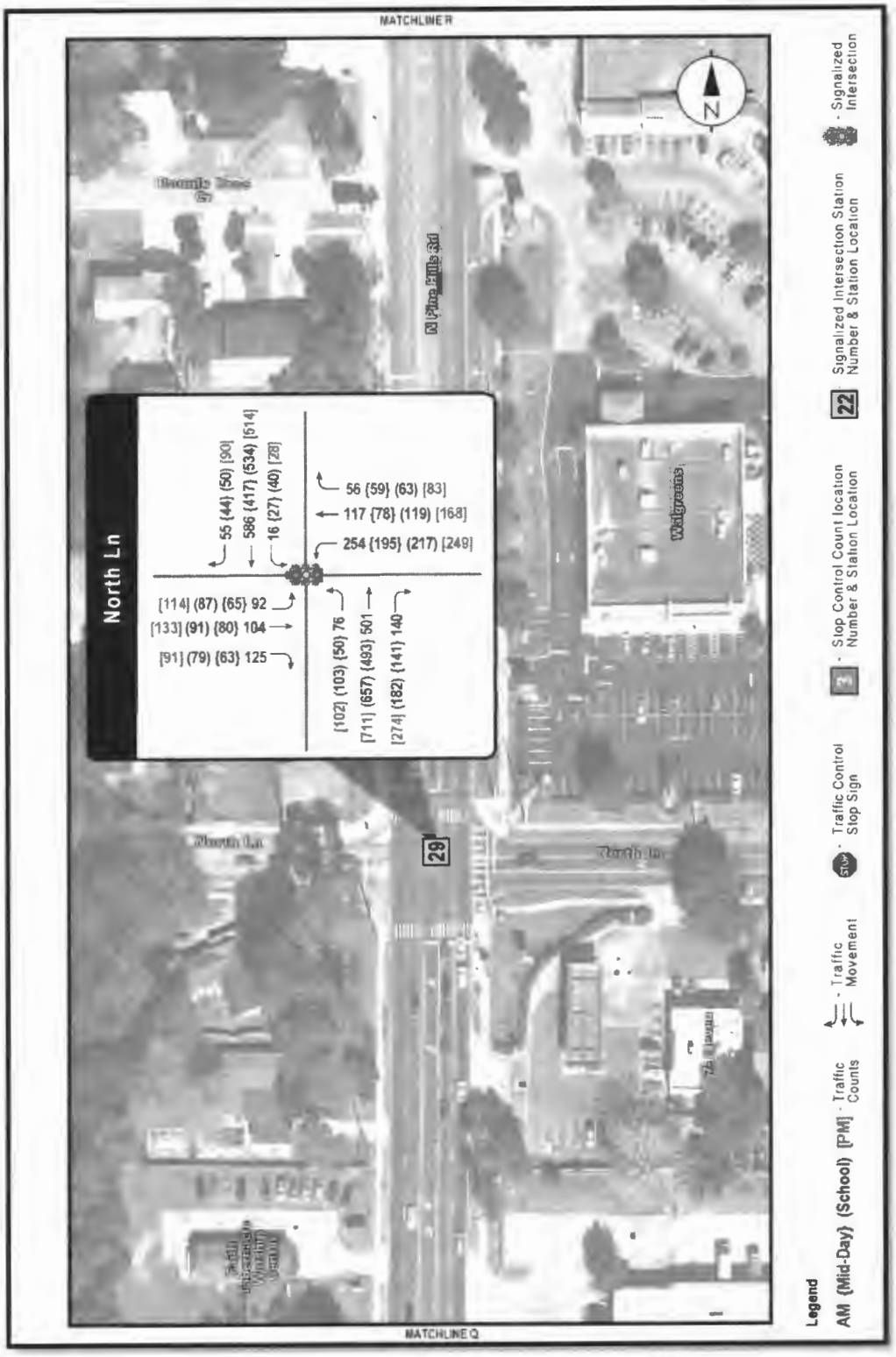


4.6.2 Pedestrian and Bicycle Traffic Volumes

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.

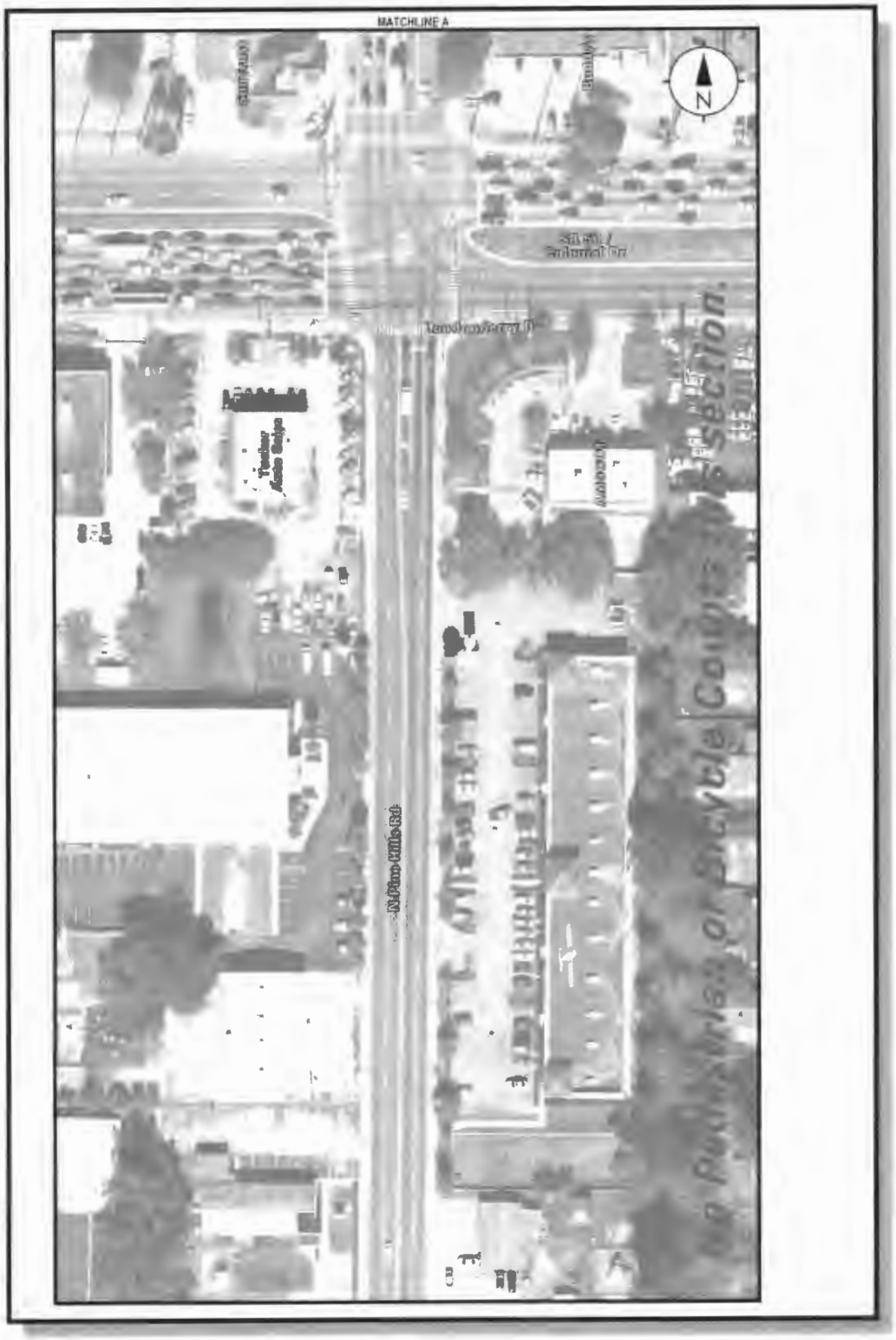
Pedestrian and bicycle counts were also collected at **unsignalized intersections** during 7:00-9:00 AM, 11:00 AM -1:00 PM mid-day and 4:00-6:00 PM peak periods. At the unsignalized intersections along the study area, the highest pedestrian and bicycle traffic volumes were observed at the intersection 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.*

Figure 4.9: Pedestrian and Bicycle Movement Counts



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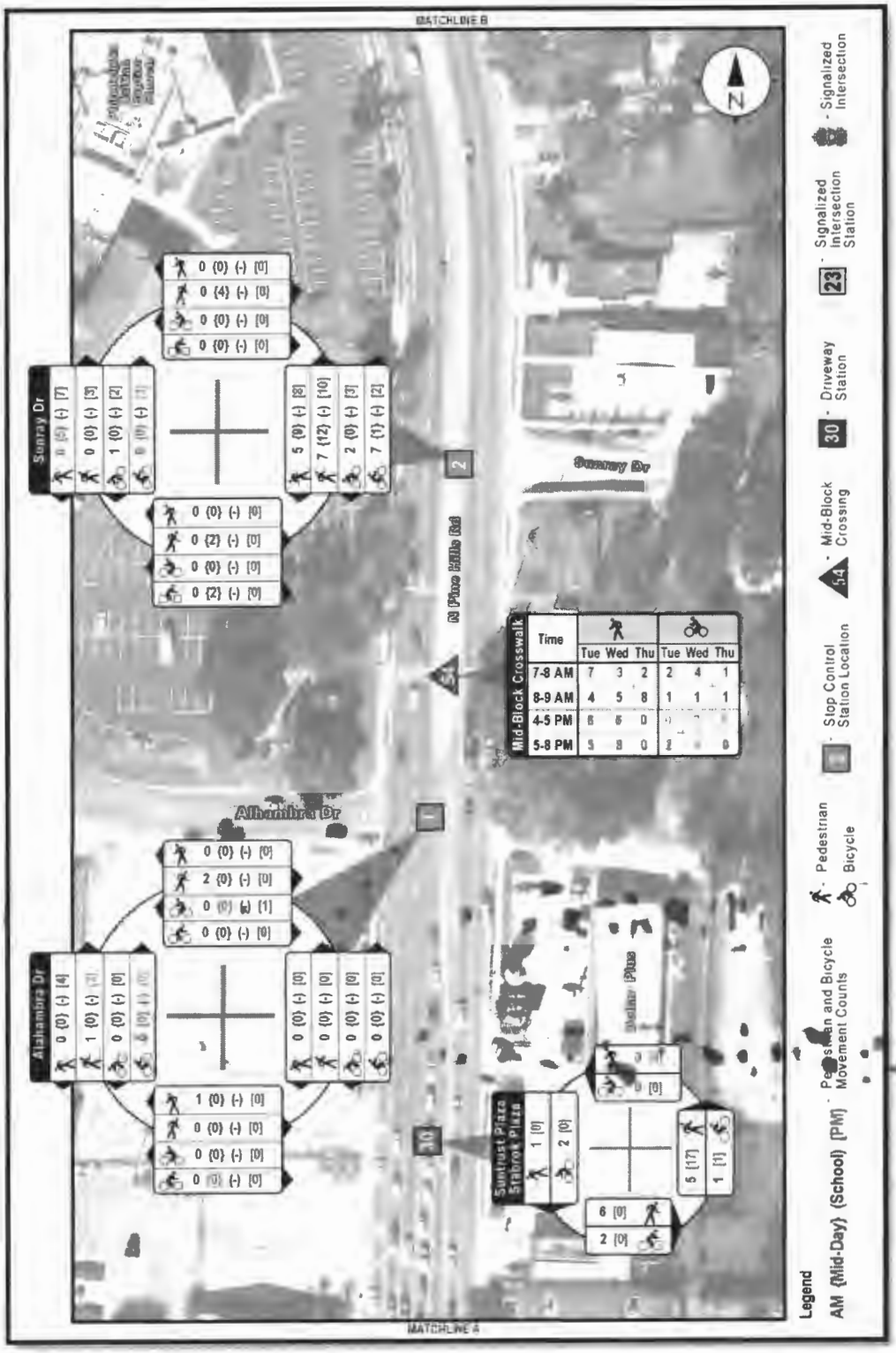

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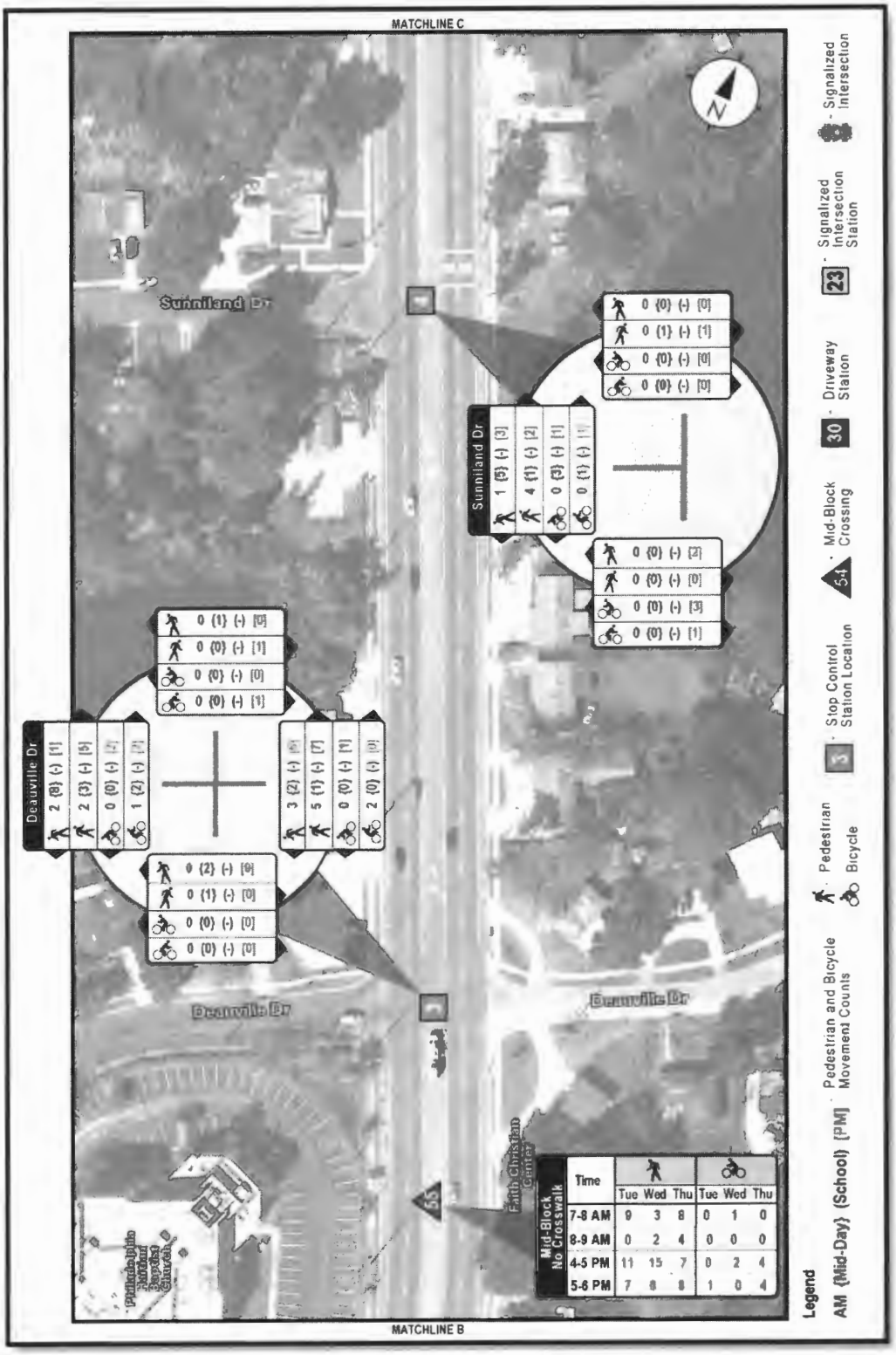

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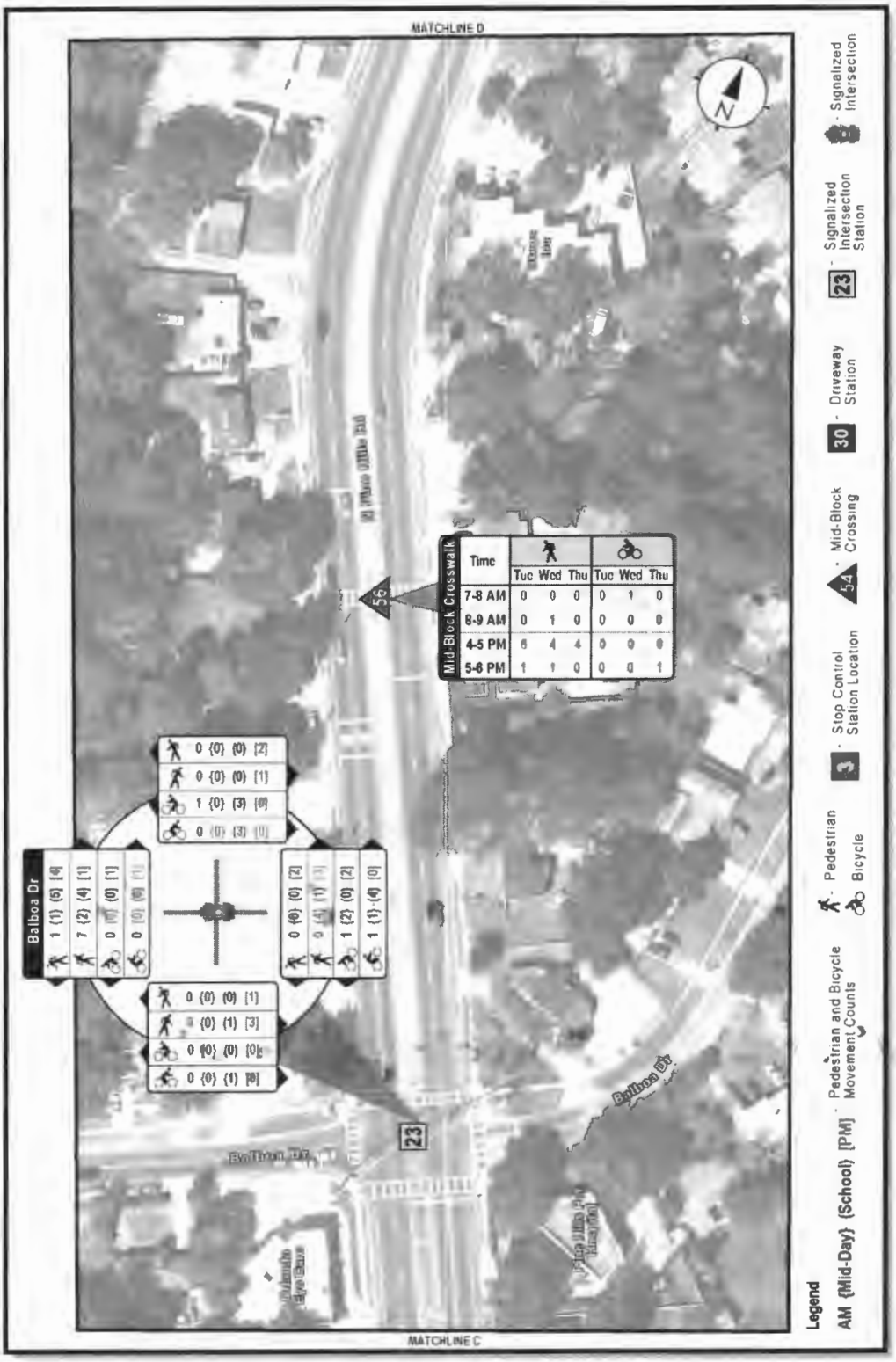

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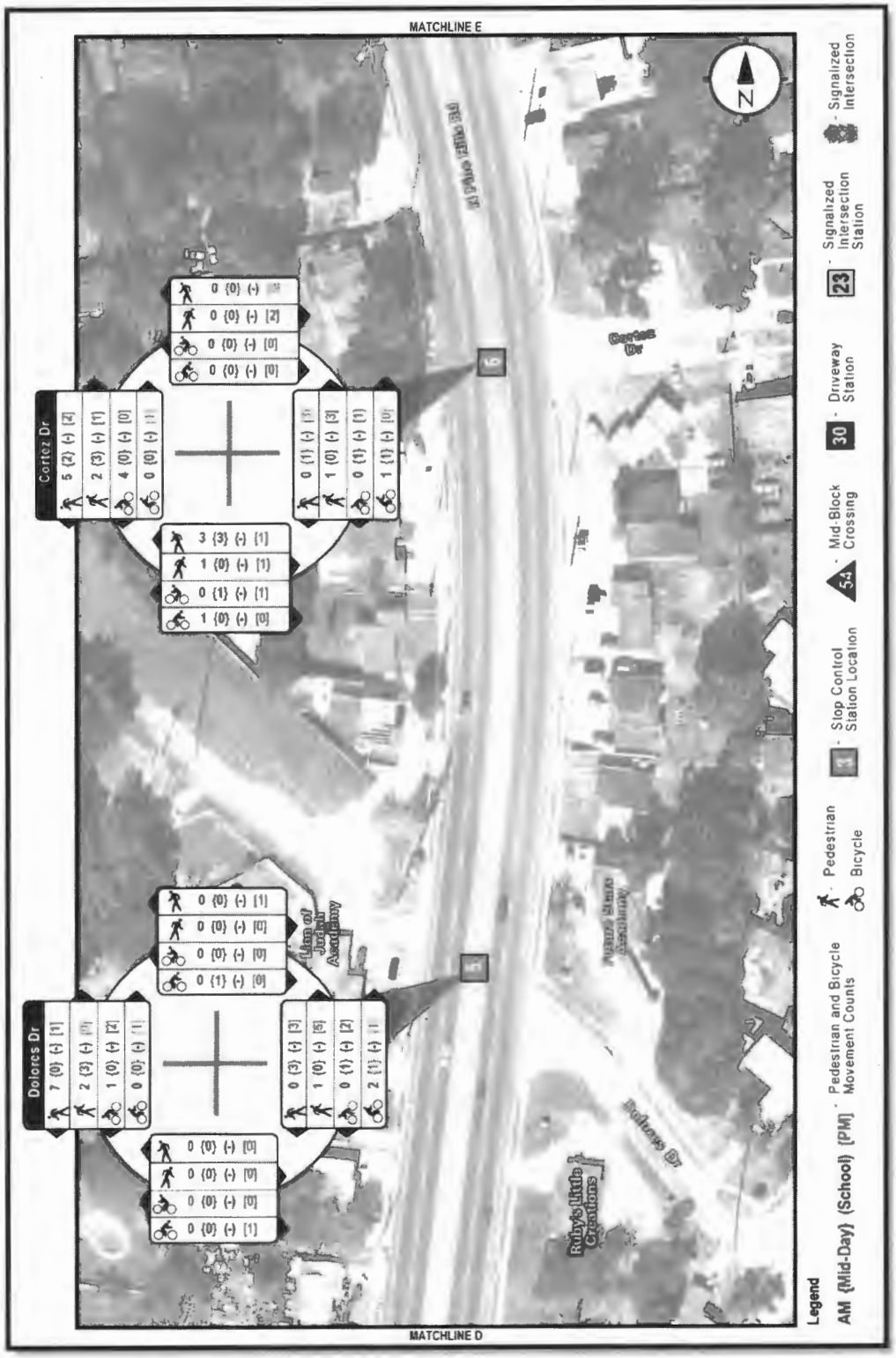

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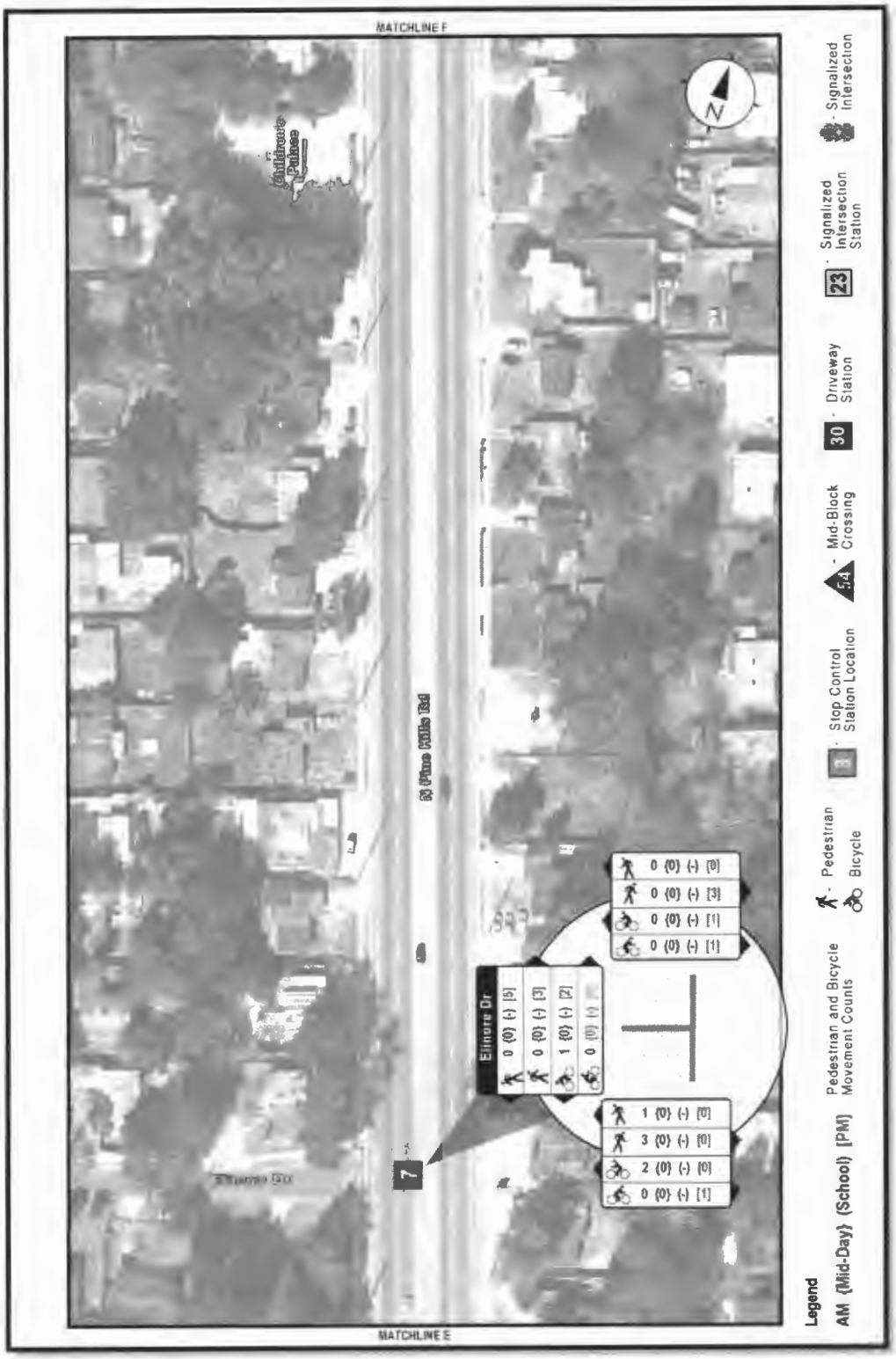

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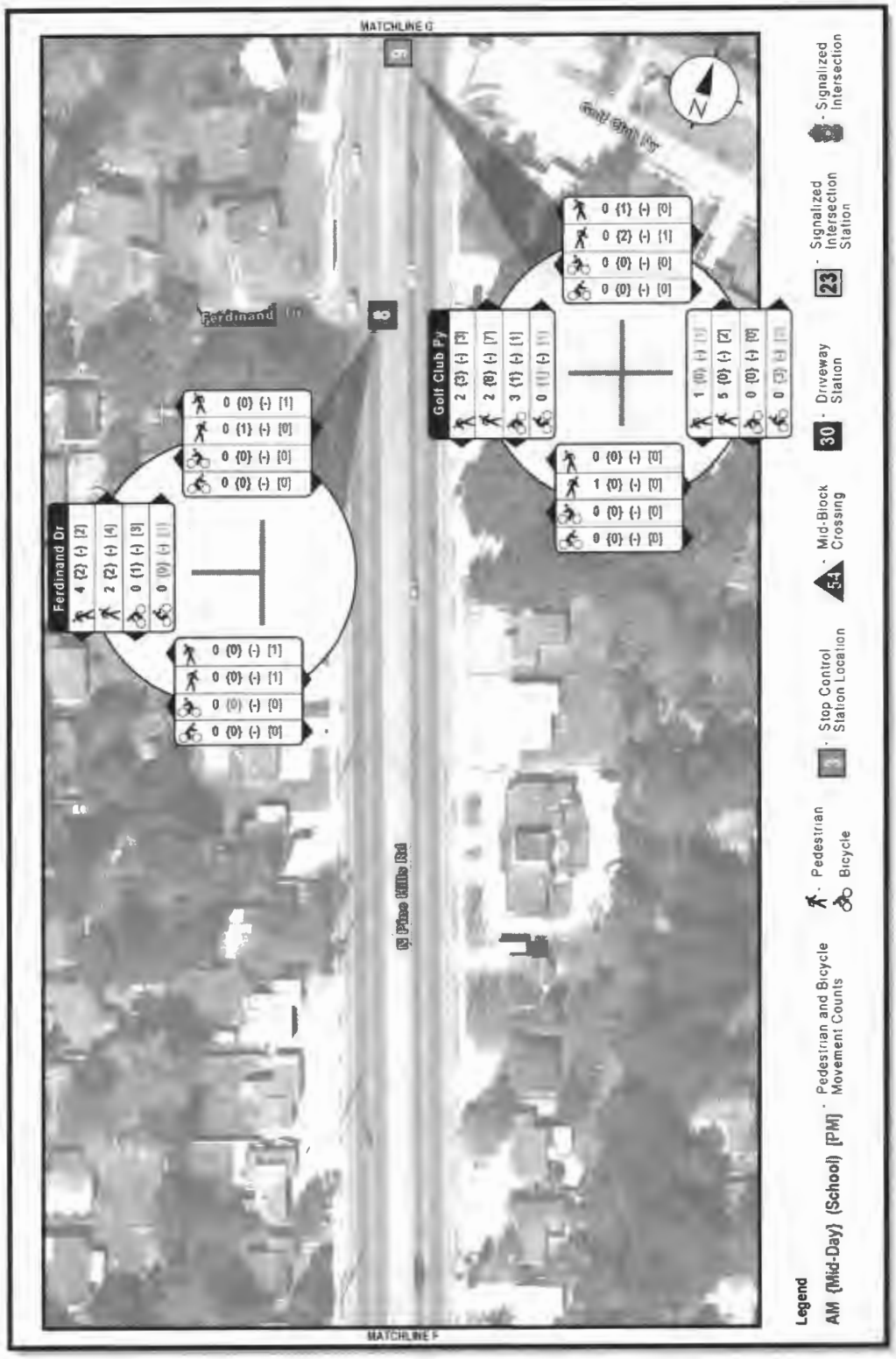

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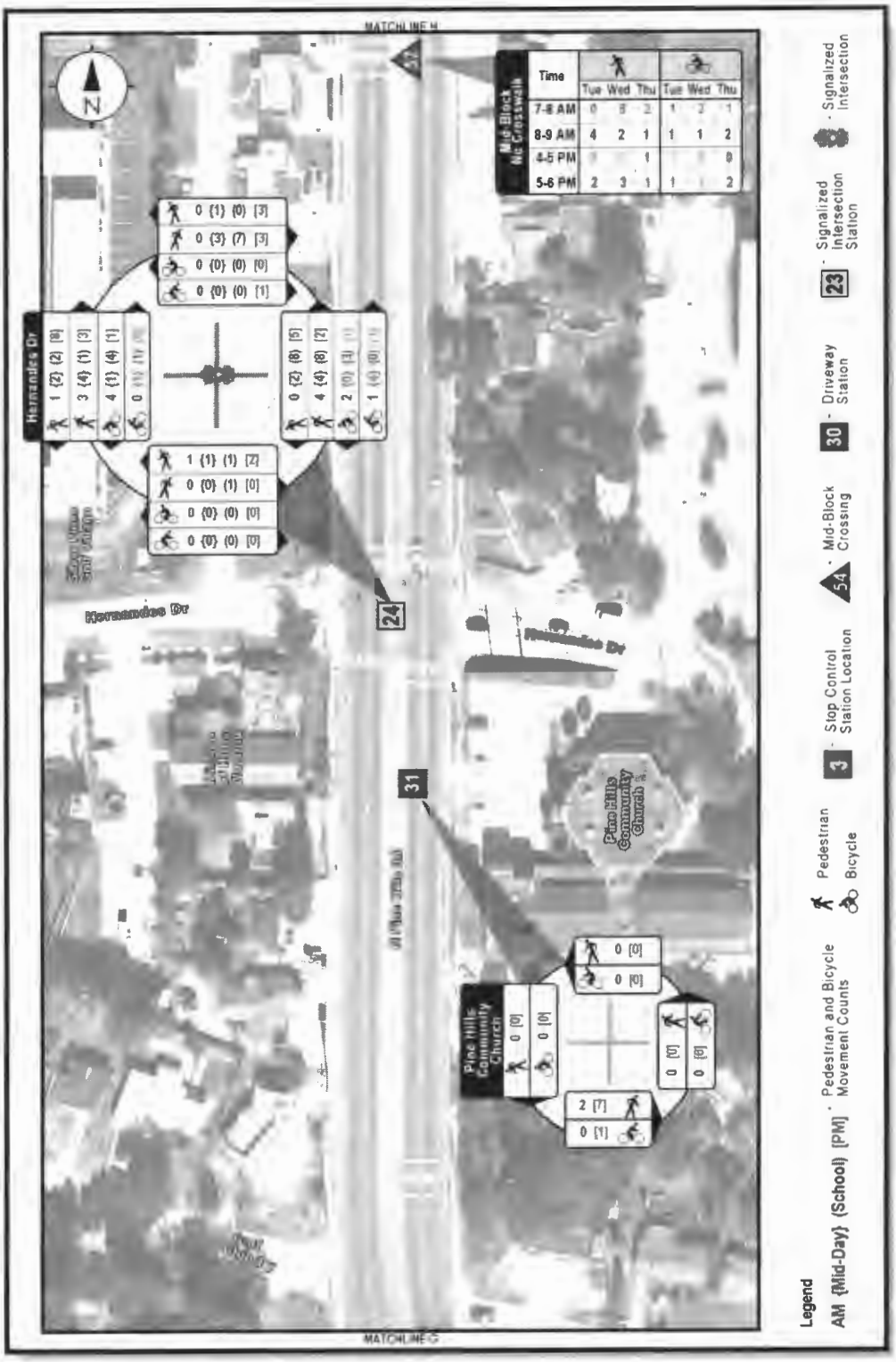

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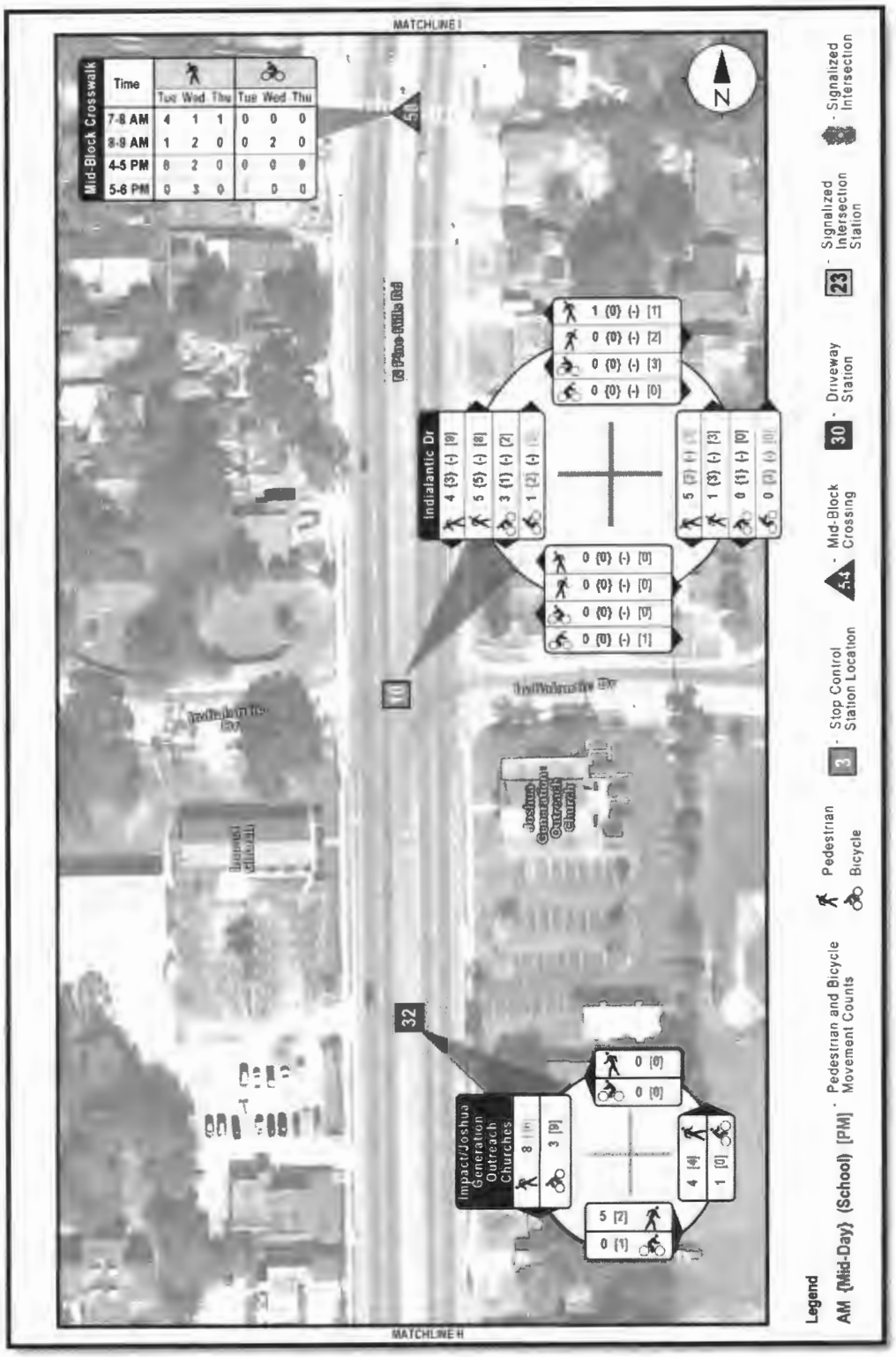
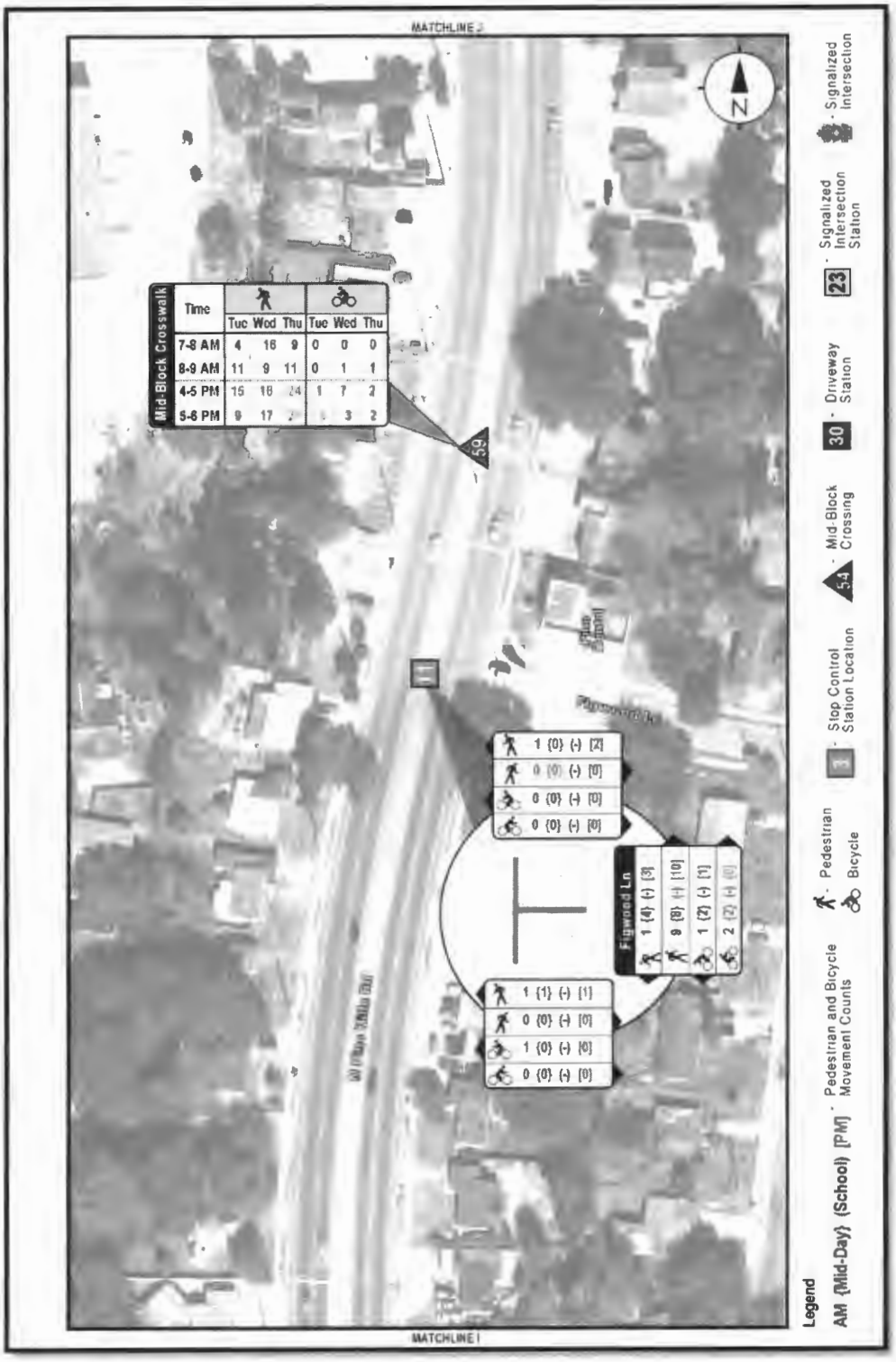


Figure 4.9 (continued): Pedestrian and Bicycle Movement Counts



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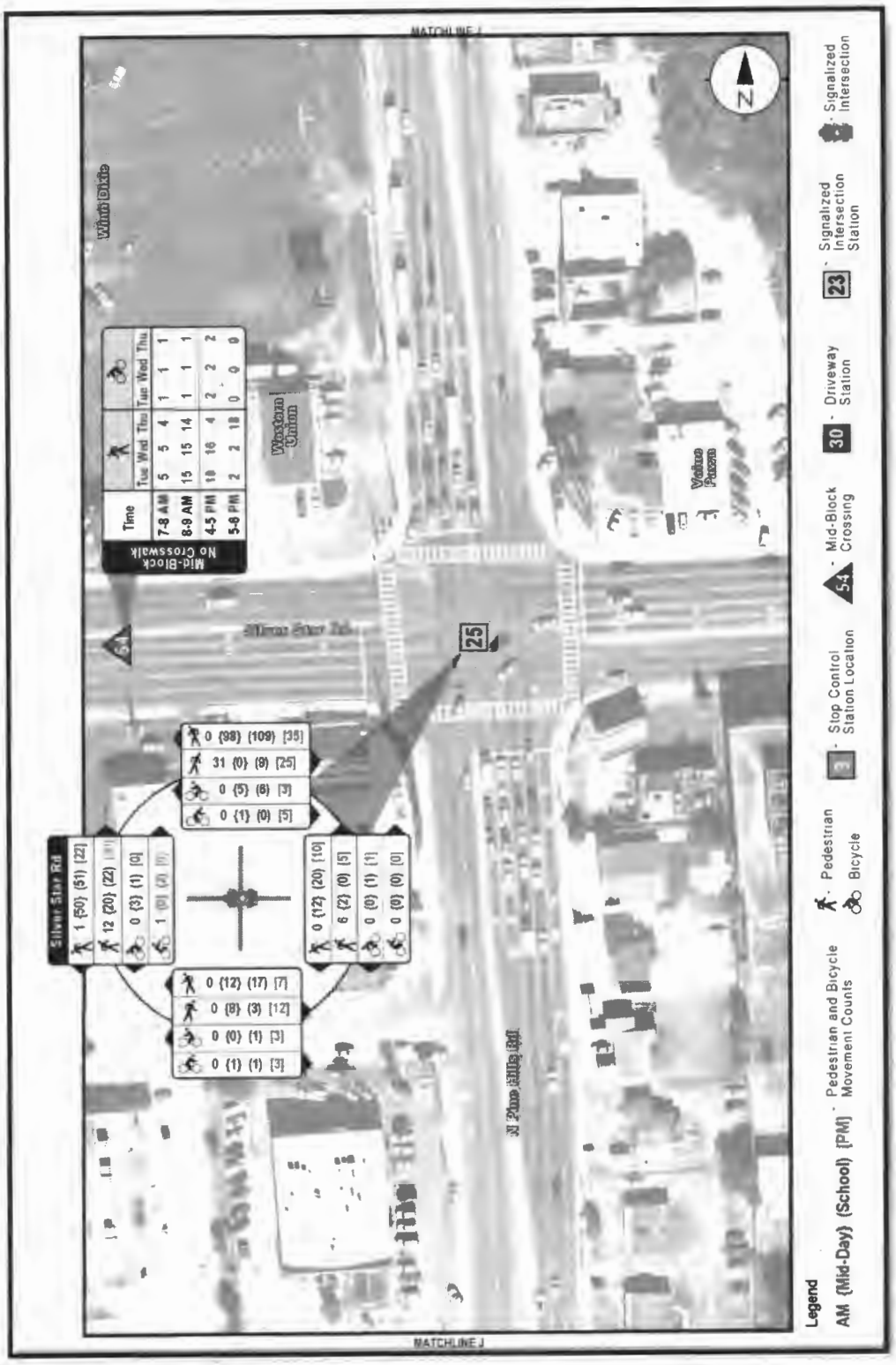

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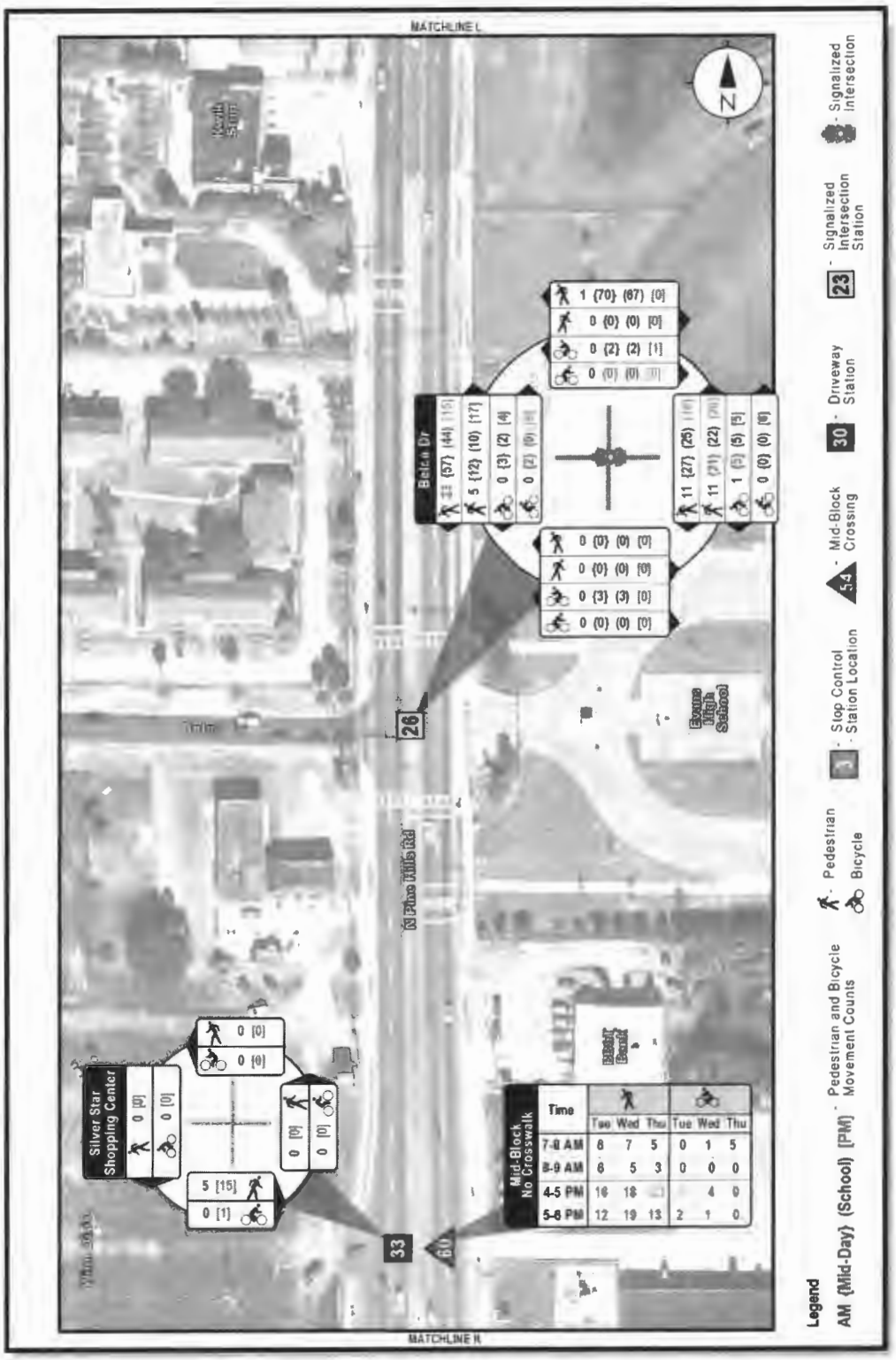

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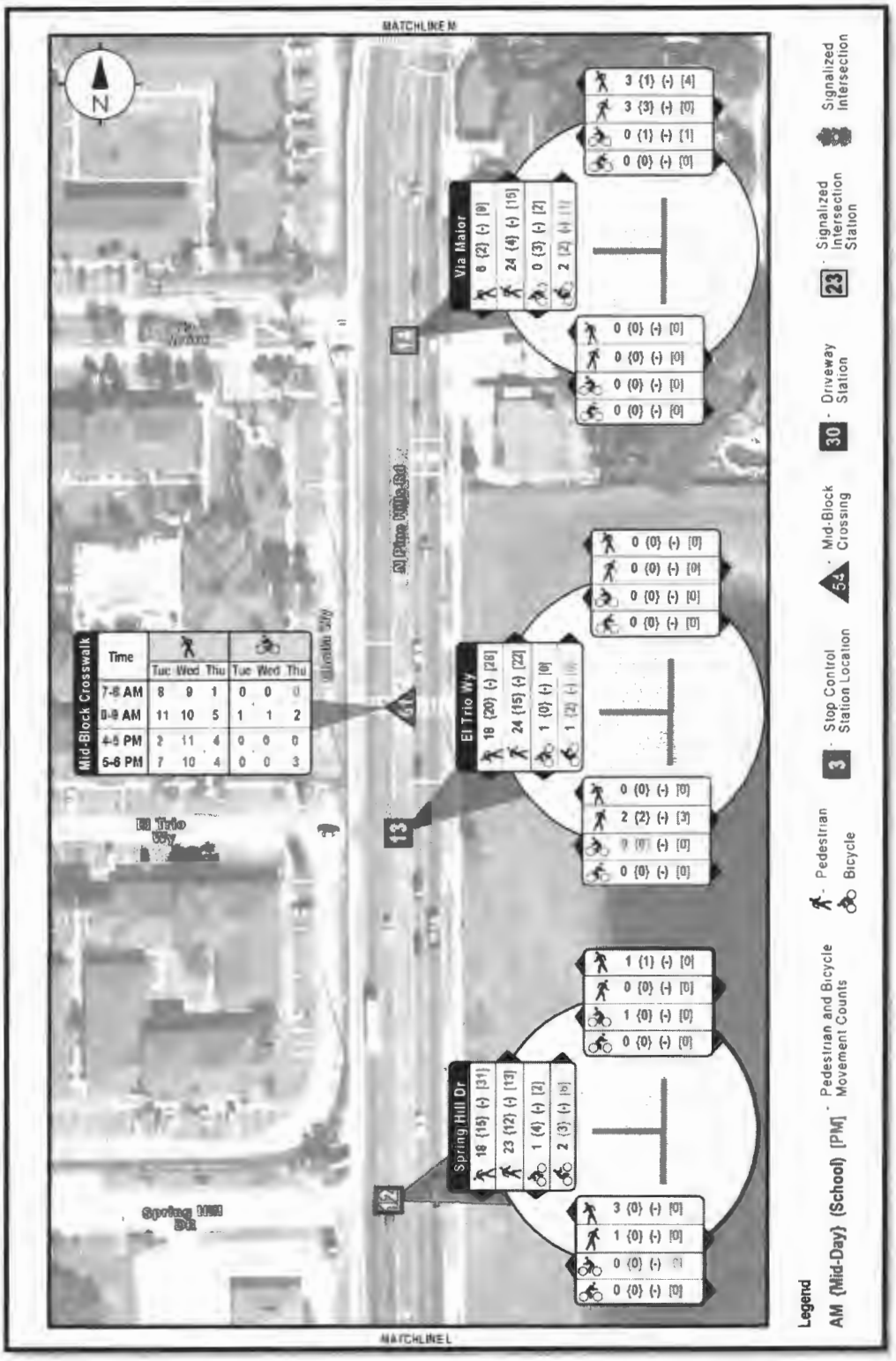

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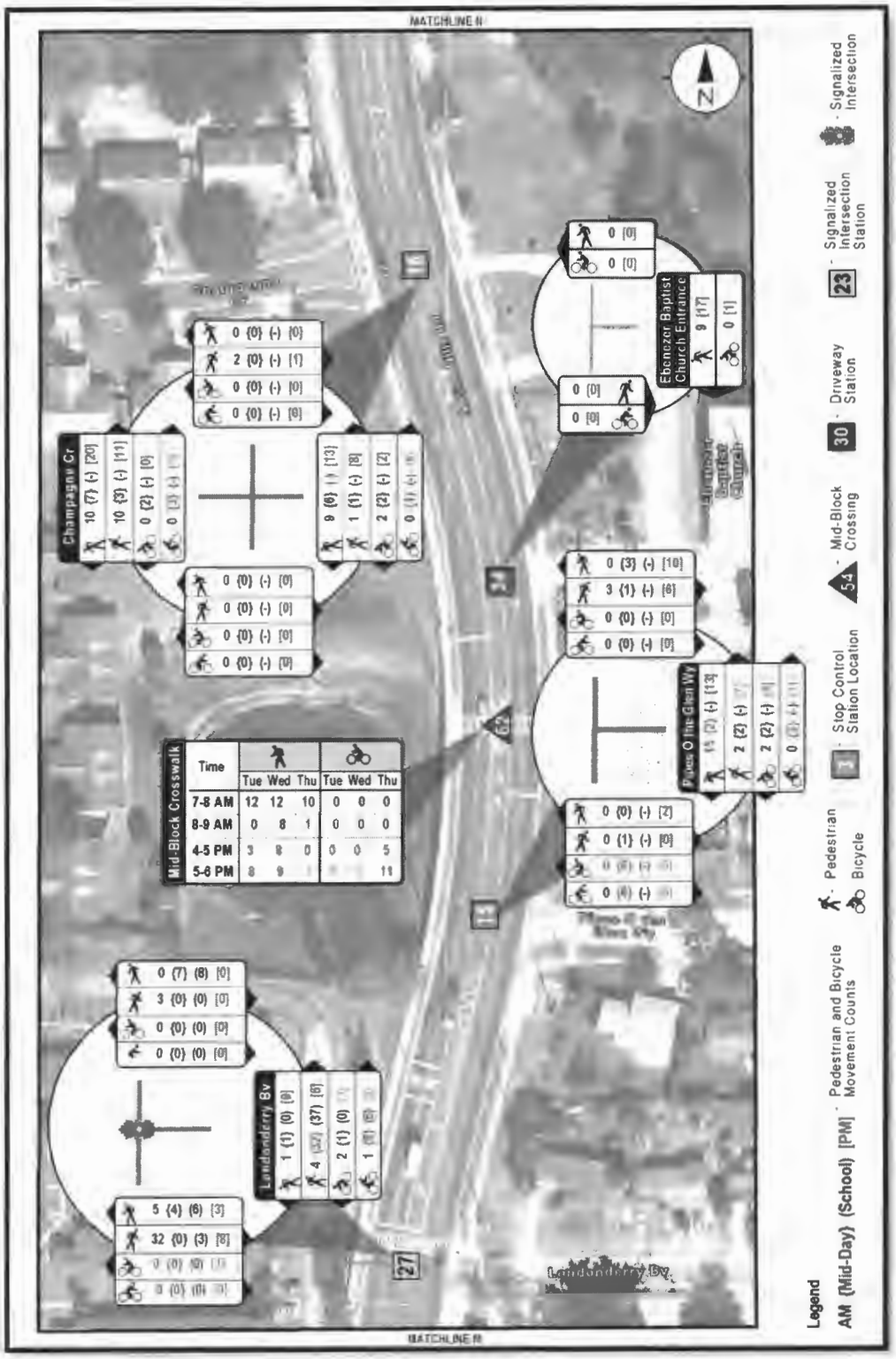

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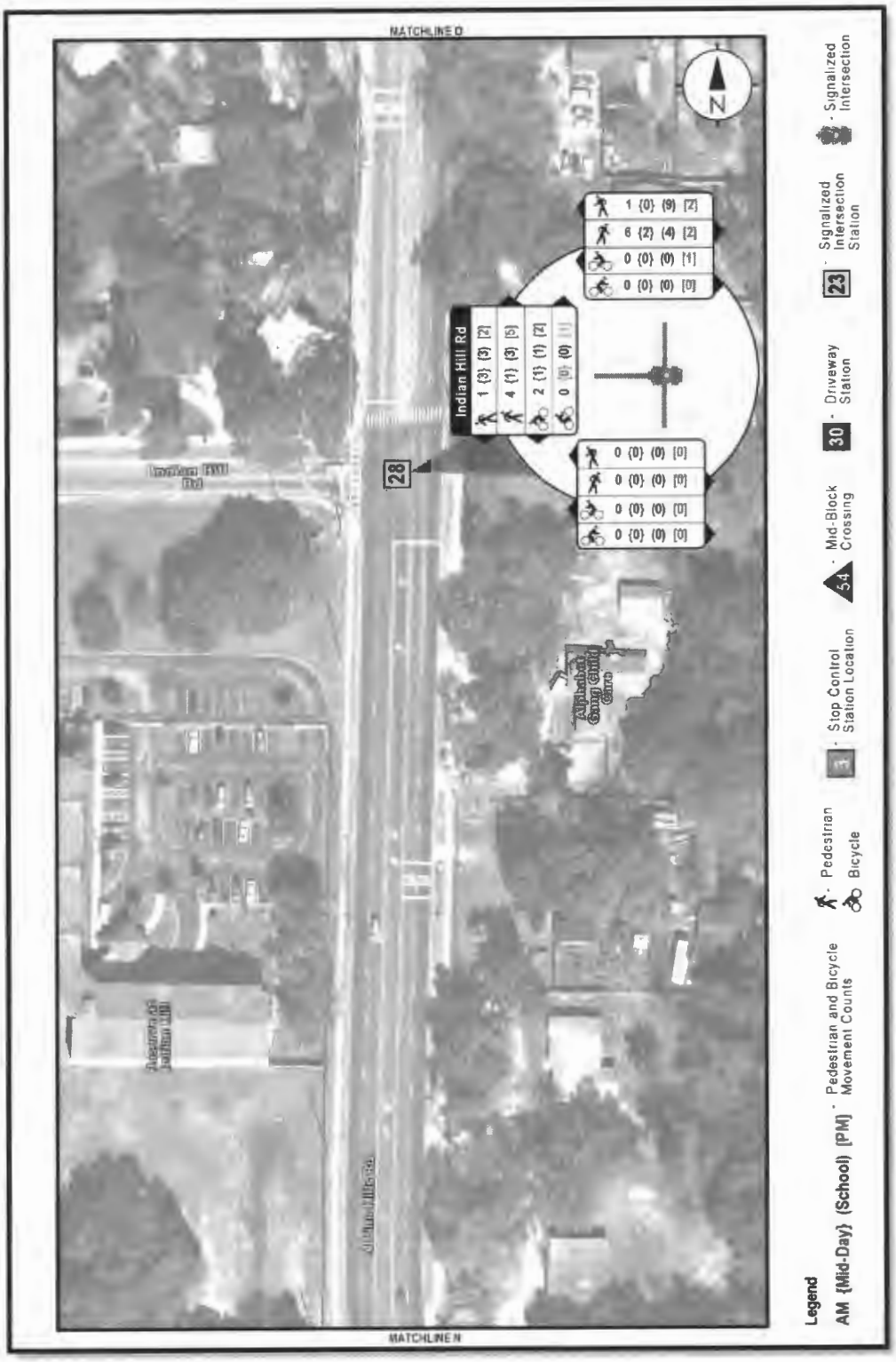

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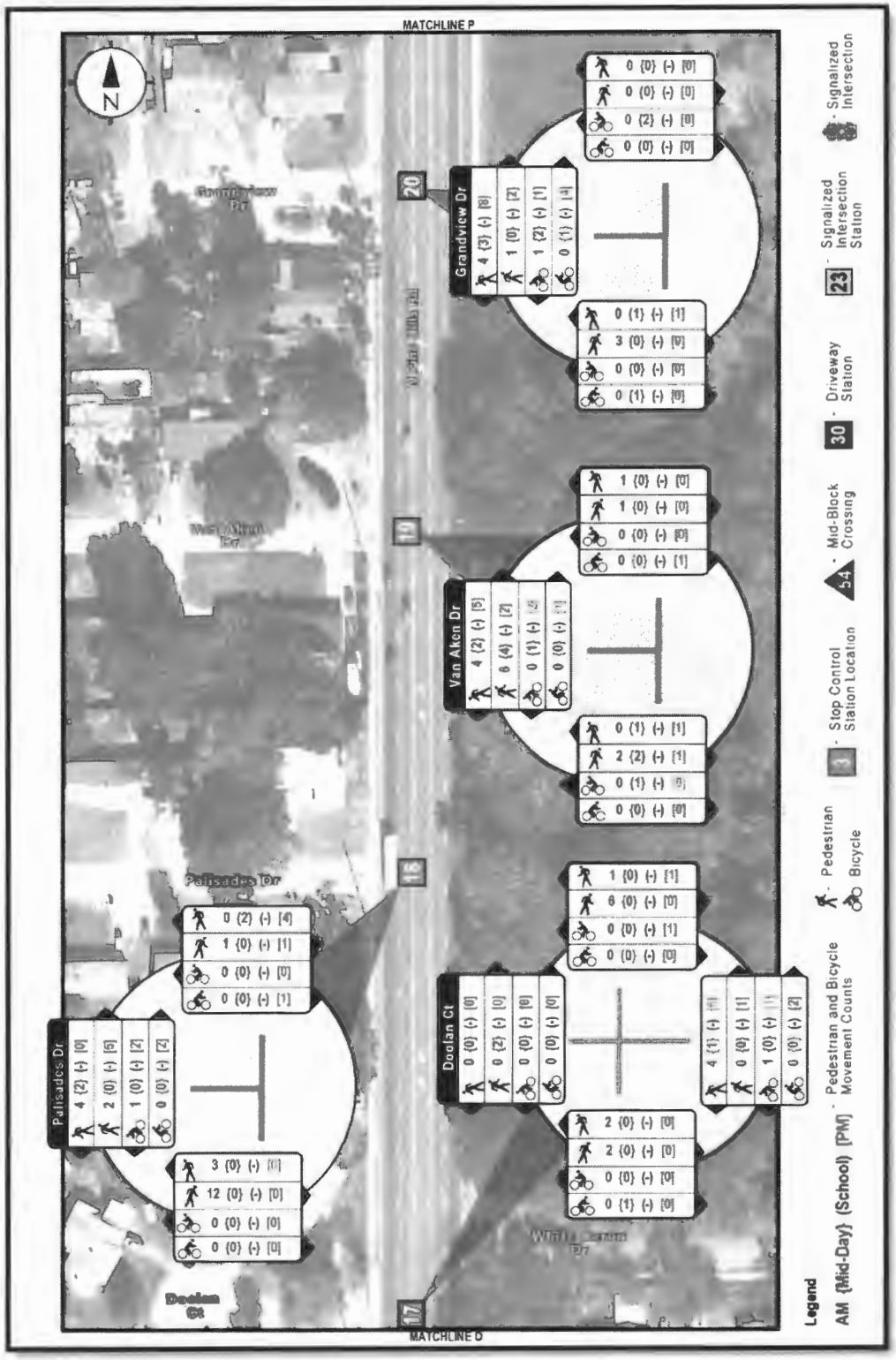

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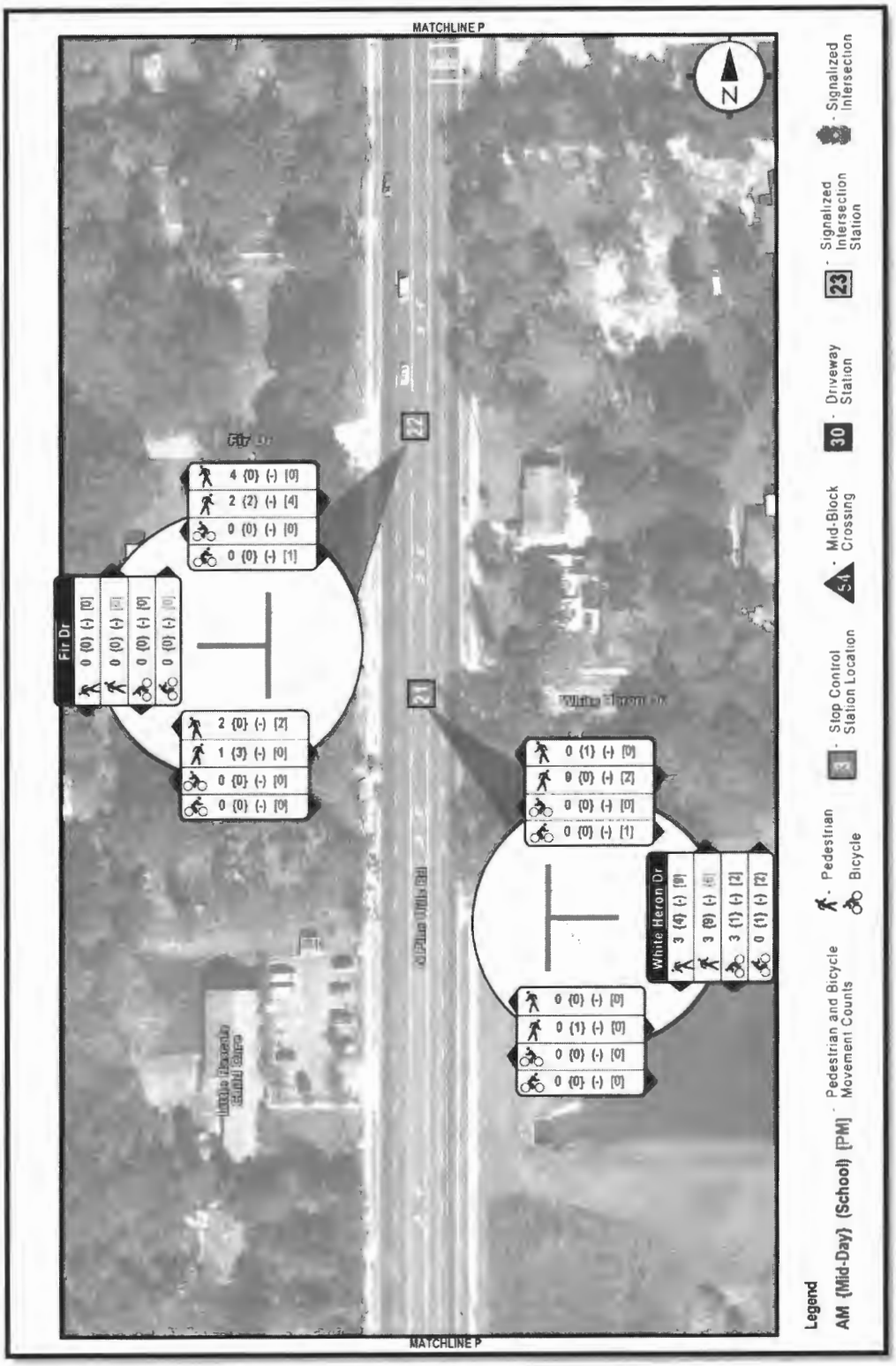

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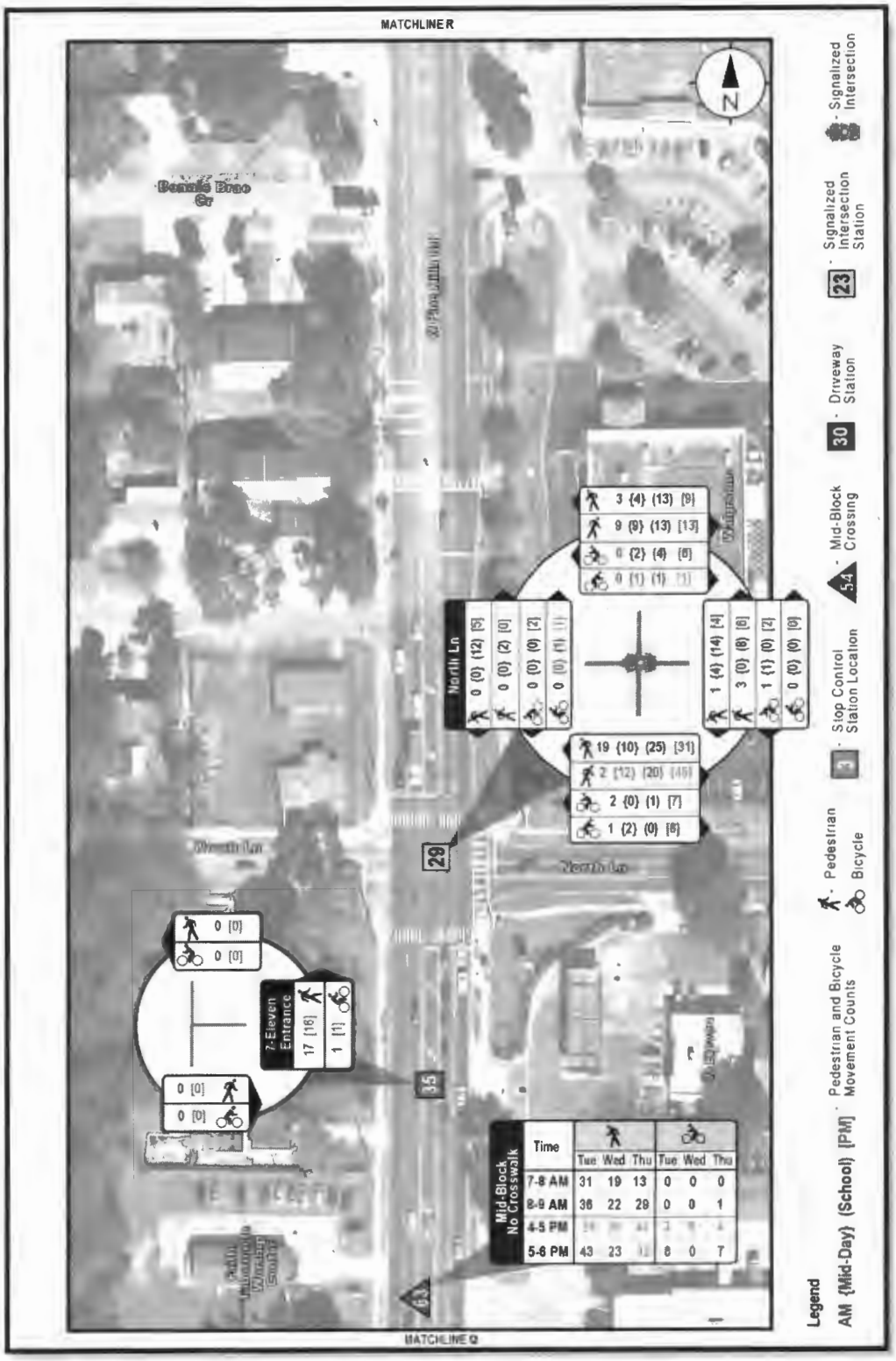


4.6.3 Existing Corridor Operations Summary

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 level of service 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 level of service 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 Level of Service 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/Level of Service Handbook methodology) at unsignalized crossings (including mid-block crossings) is determined by the major street traffic volumes.

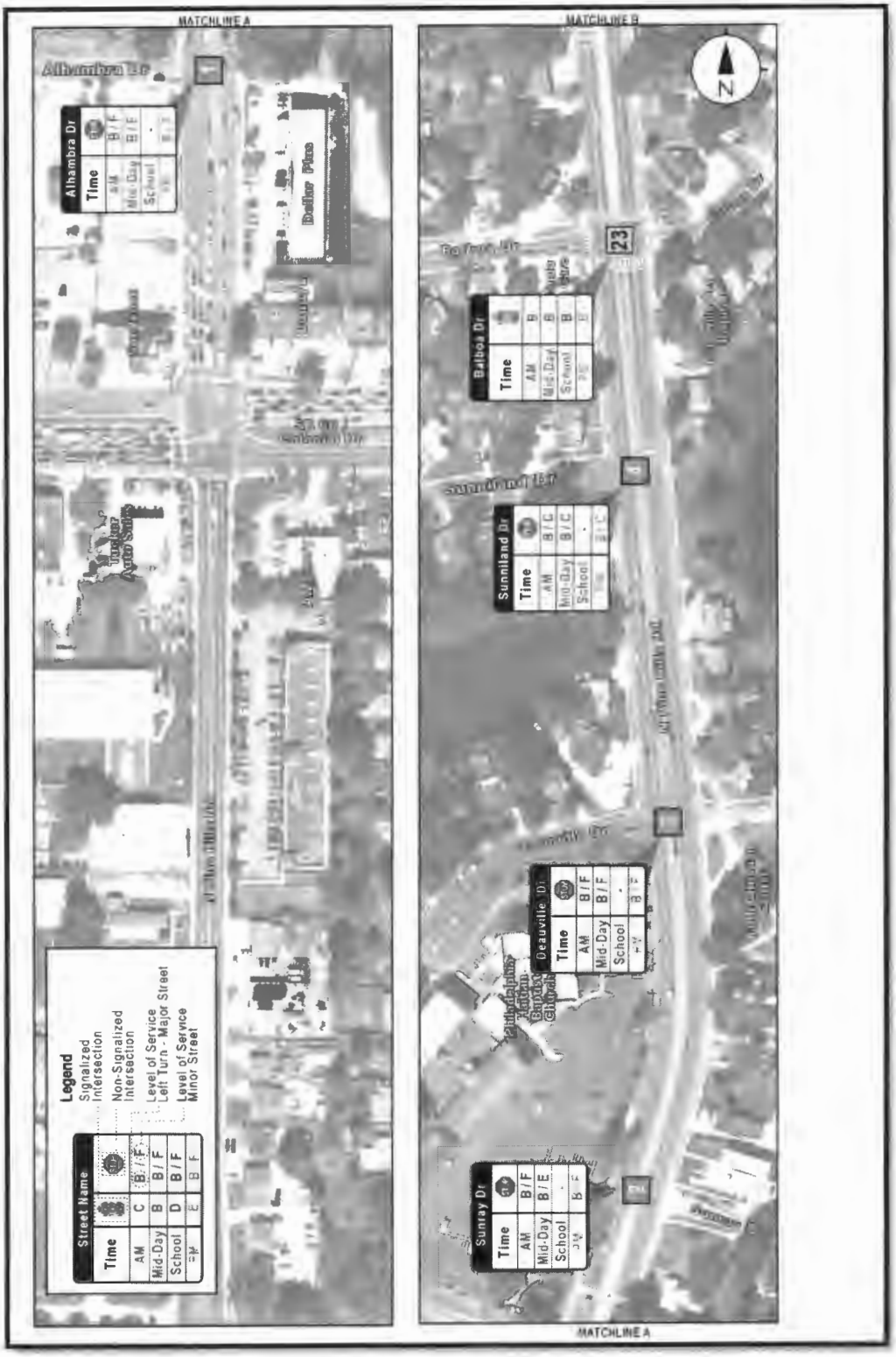
Table 4.6: Pedestrian and Bicycle Traffic Volumes Crossing Pine Hills Road LOS at Mid-block Crossing Locations

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 Level of Service for the AM, mid-day, school (signalized intersections only) and PM peak hours.

More details on Level of Service for automobiles and pedestrian and bicycles are included in *Technical Memorandum No. 3—Existing Conditions.*

Figure 4.10: Automobile Level of Service



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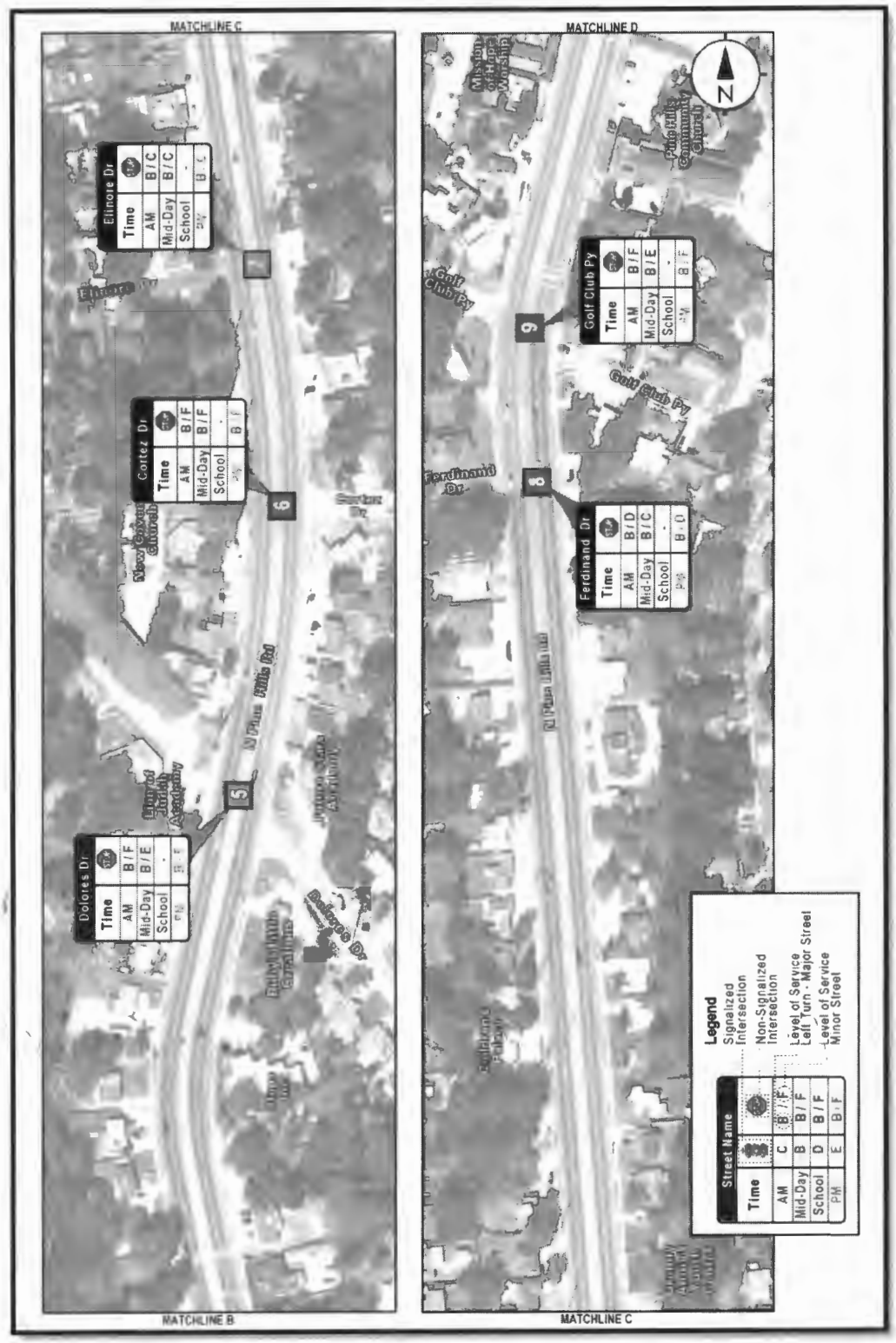

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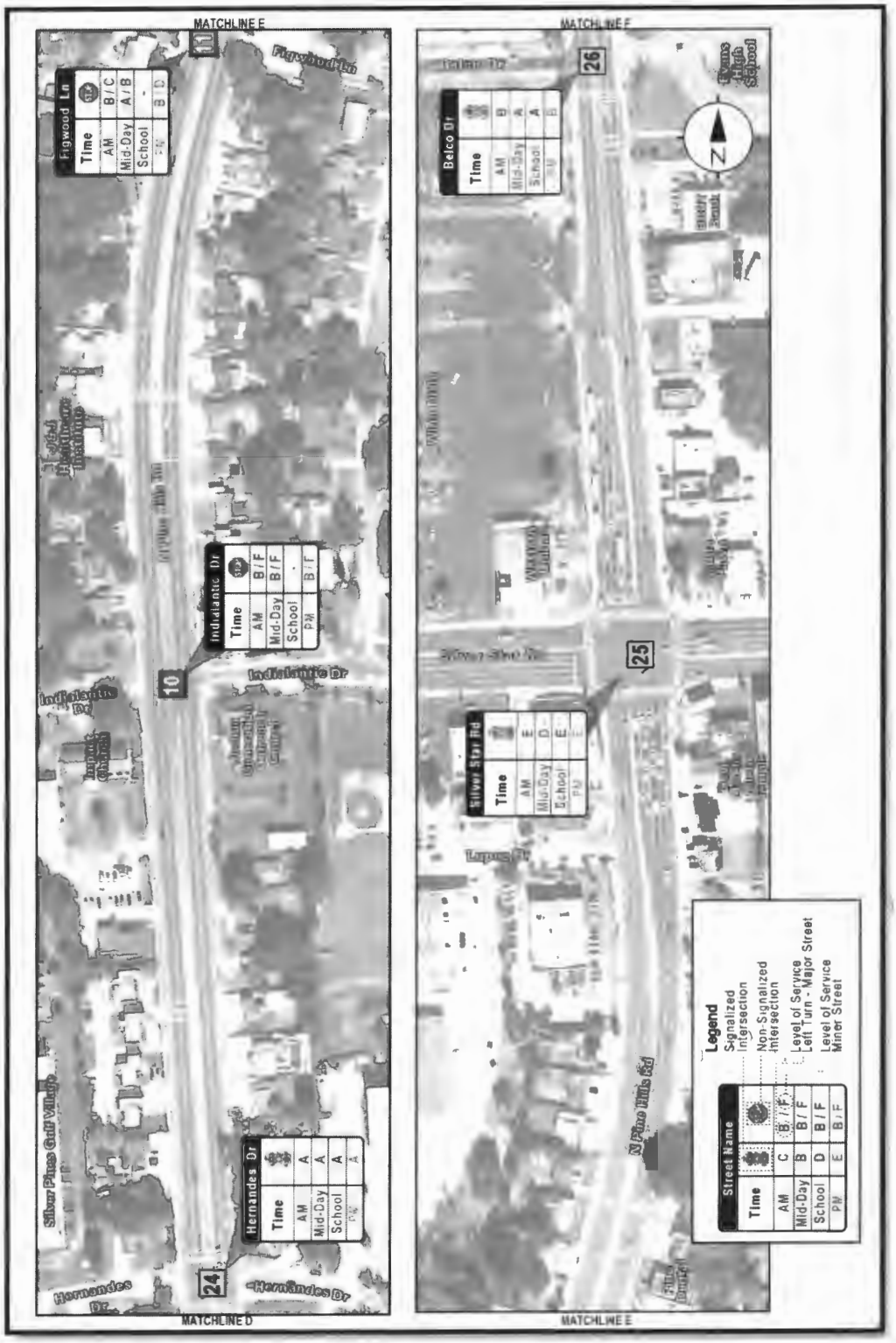


Figure 4.10 (continued): Automobile Level of Service

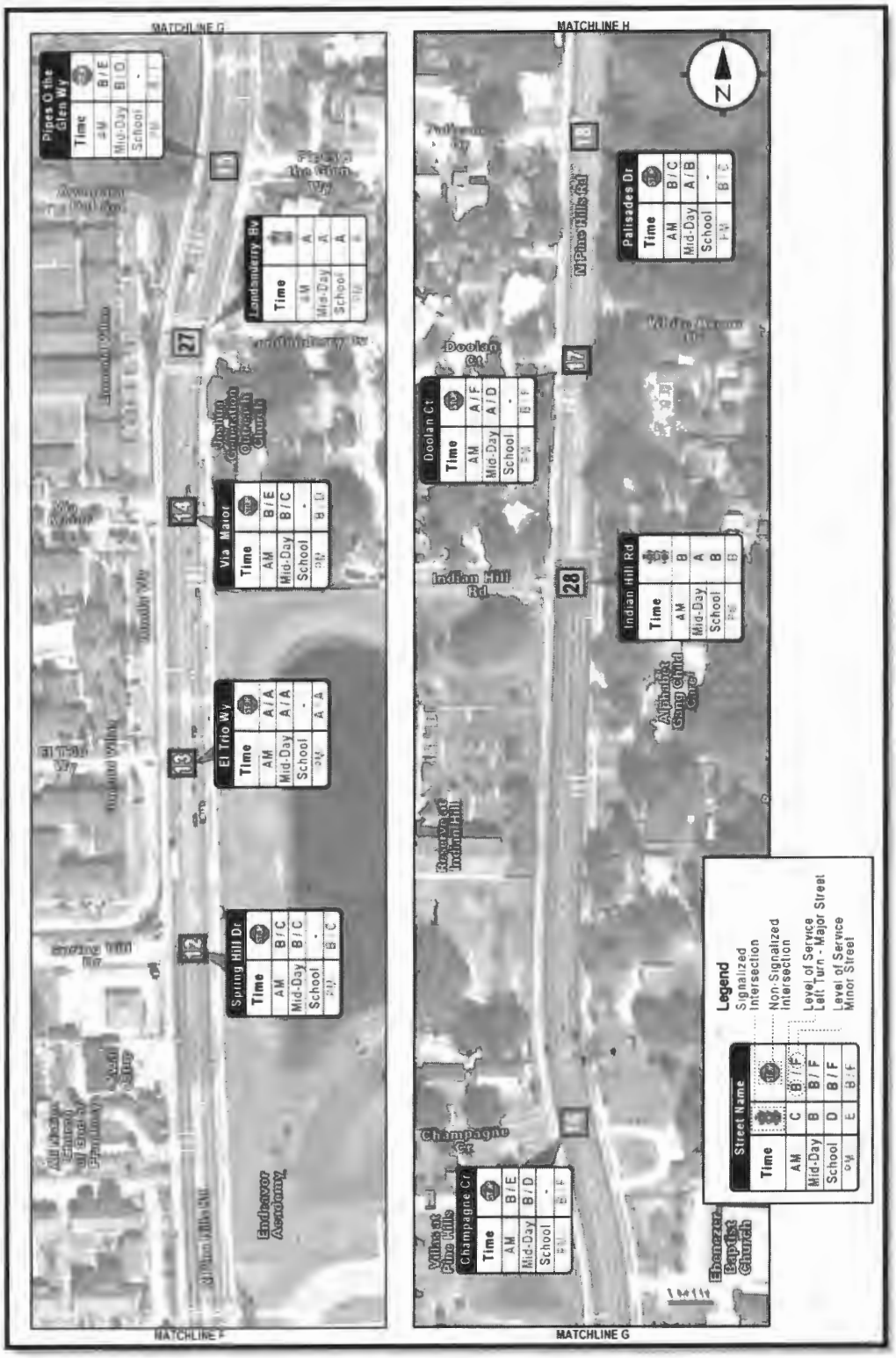
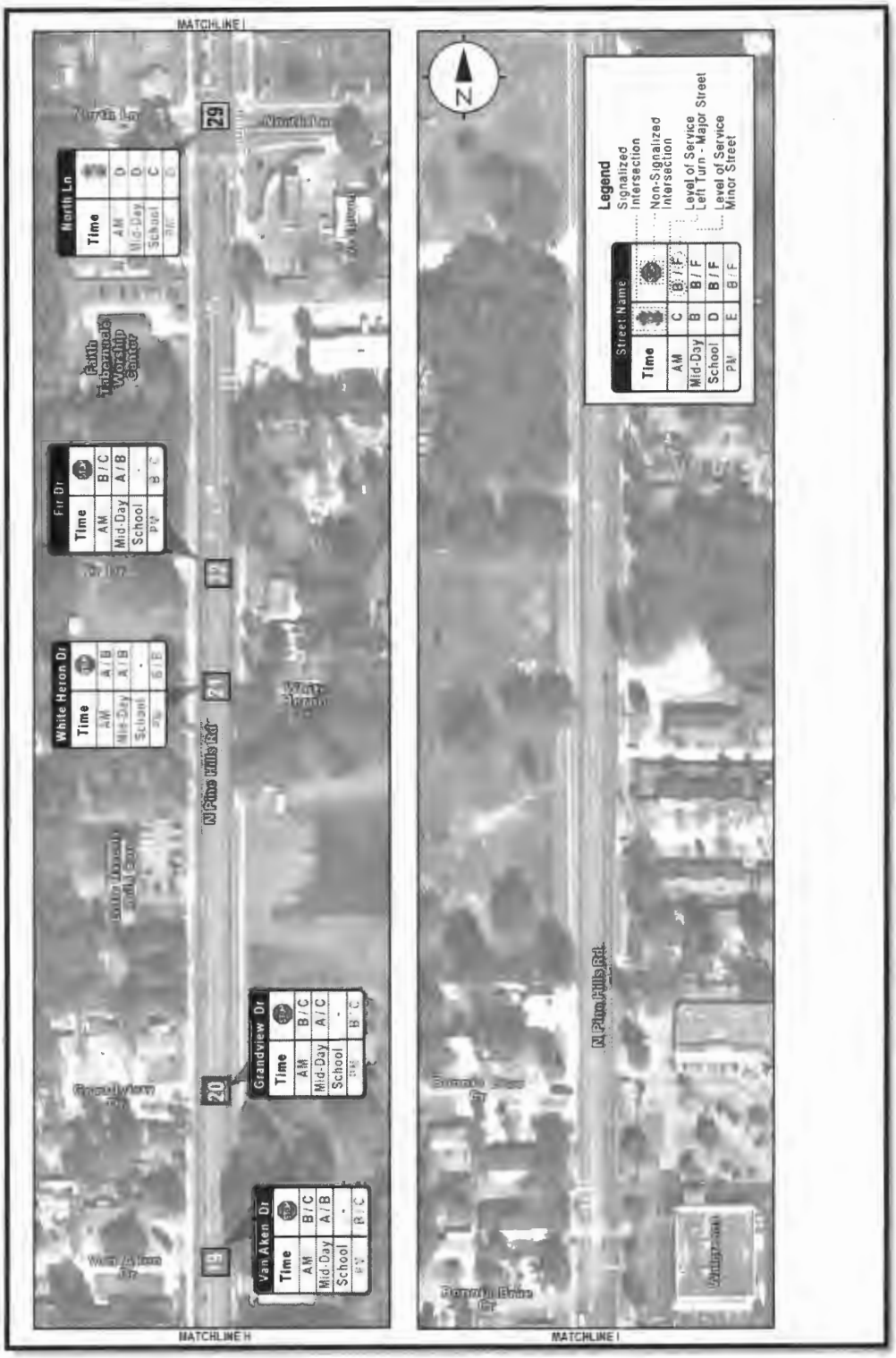


Figure 4.10 (continued): Automobile Level of Service



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 crash rates, 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 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.

    - Reconstruct the curb returns at the northeast and southwest quadrants by reducing the acceleration lanes, thereby allowing shorter crossing distances.

- 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

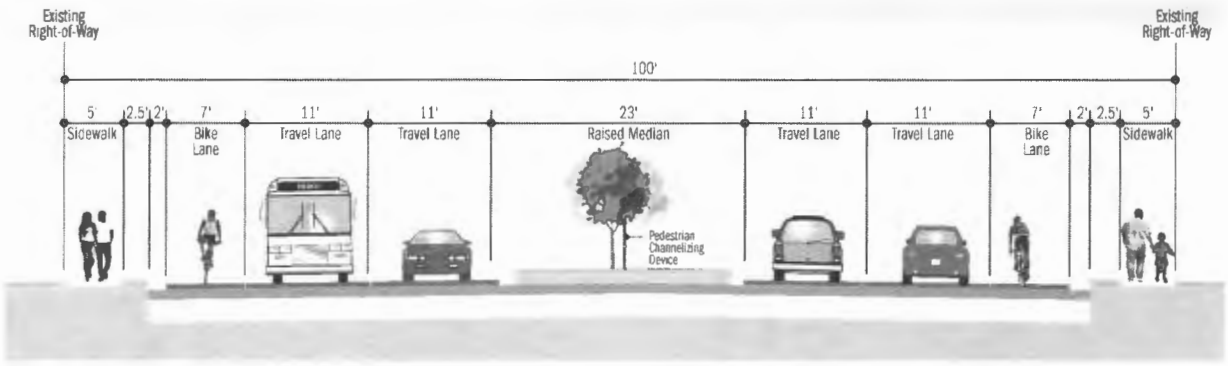
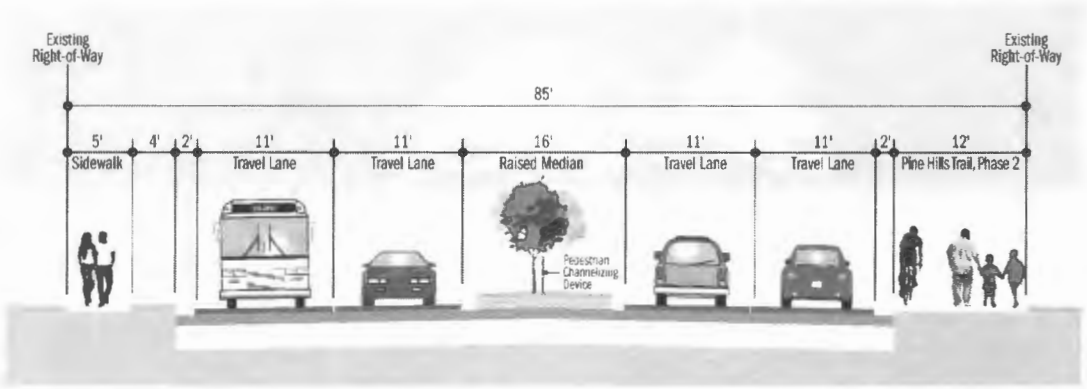


Figure 4.12: Proposed Typical Section: Silver Star Road to Bonnie Brae Circle



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*.

5. 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 though 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*.

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**.

5.2 Operational Analysis Results

The opening year (2020) and design year (2040) operational analyses were conducted to determine the Level of Service (LOS) for the signalized study area intersections (including intersections with proposed signal improvements), for both the No Build and Build Alternatives (including the Build Alternative). 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 LOS

A summary of the automobile operational LOS results for the No Build and Build Alternatives AM and PM peak hours is available in **Figures 7.1 and 7.2** 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.

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.

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 operational LOS for automobile results of the unsignalized intersections are summarized as follows:

- For the No Build Alternative, the Pine Hills Road and Via Maior 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 Via Maior intersection is projected to operate at an acceptable LOS E or better for the minor street movements for both the Opening Year 2020 and the Design Year 2040.

5.2.2 Pedestrian/Bicycle LOS

Based on the No Build Alternative analysis results, the pedestrian/bicycle modes at all of the study signalized intersections except for Silver Star Road are anticipated to operate at LOS D or better, for both Opening Year (2020) and Design Year (2040). Silver Star Road is expected to experience a LOS E condition for westbound, northbound and southbound bicyclist during the AM and PM peak periods. 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 Year (2020) and Design Year (2040).

5.3 Operational Analysis Comparison

Technical Memorandum No. 5 — Future Travel Demand recommended a growth rate of 1.0% per year to develop the intersection peak hour volumes for the No Build Alternative for the Opening Year 2020 and Design Year 2040. Based on the proposed access management plan for the Pine Hills Road study corridor (see *Technical Memorandum No. 4 — Access Management)*, the No Build Alternative peak hour volumes were redistributed to derive the Build Alternative peak hour

volumes which are shown in the following tables. All of the following analyses were performed using Synchro 9, based on the Highway Capacity Manual (HCM) 2010 procedures.

5.3.1 Automobile LOS

A summary of the peak hour Automobile LOS results for Opening Year 2020 and Design Year 2040 are shown in **Tables 5.2** and **5.3** with comparisons for the No Build and Build alternatives. The results are summarized as follows:

- 2020 Opening Year Results
  - With the exception of the Silver Star Road intersection, all the other signalized intersections are projected to operate at LOS C or better under the No Build alternative. The Silver Star Road intersection is projected to continue to operate at LOS E under the Build Alternative in Opening Year 2020.
- 2040 Design Year Results
  - With the exception of the Silver Star Road and the North Lane Road intersections, all of the other signalized intersections are projected to operate at LOS C or better under the No Build Alternative for 2040.
  - The Silver Star Road intersection is projected to operate at LOS F under the No Build Alternative. The North Lane intersection is projected to operate at LOS E under the No Build Alternative.

5.3.2 Pedestrian / Bicycle LOS

A summary of the peak hour Pedestrian and Bicycle LOS results are shown in **Tables 5.4** to **5.7** for Opening Year 2020 and for Design Year 2040, comparing the No-Build and Build alternatives based on HCM 2010 methodologies. 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.

5.3.3 Future Conditions Summary

Based on the multimodal operational analysis of the study intersections, it is anticipated that the proposed access modifications will not adversely impact the traffic operations of any mode (Automobile, Pedestrian or Bicycle) under future conditions (2020 and 2040). The signalized intersection delays would slightly increase under the Build Alternative compared to the No Build alternative, but would not result in failing conditions (LOS F). For the bicycle and pedestrian modes, the No Build and Build alternatives have similar results under future conditions. **Table 5.8** displays the impact of the No Build and Build Alternatives on delays and LOS for weekday AM / PM peak hour periods.

Table 5.2 Automobile 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
29	North Lane	Signal	36.9	D	36.9	D	43.4	D	43.7	D

(1) Automobile delay and LOS based on Synchro 9 and HCM 2010
** Unsignalized Intersection Analysis. Reported for Worst Condition Delay for Major Street Left/Minor Street Movements.*

Table 5.3 Automobile LOS – 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.*

Table 5.4 Pedestrian 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	N/A	N/A	N/A	N/A
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

Table 5.5 Pedestrian LOS – 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	N/A	N/A	N/A	N/A
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	B	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	C	B	B	C	C	B	B	C	C

Table 5.6 Bicycle 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

Table 5.7 Bicycle LOS – 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

Table 5.8 Existing and Future Build Intersection Delay and LOS Comparison

AM Peak												
			Existing		2020				2040			
I #	Intersection	Control	No Build		No Build		Build		No Build		Build	
			Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
23	Pine Hills Road and Balboa Drive	Signal	14.8	B	15.2	B	15.4	B	15.2	B	19.5	B
5	Pine Hills Road and Delores Drive	Stop	12.4 / 100.0	B / F	12.7 / 115.0	B / F			12.4 / 100.0	B / F		
5	Pine Hills Road and Delores Drive	Signal					3.3	A			3.8	A
24	Pine Hills Road and Hernandes Drive	Signal	5.8	A	5.9	A	5.9	A	5.9	A	6.6	A
10	Pine Hills Road and Indialantic Drive	Stop	11.4 / 288.7	B / F	11.6 / 346.6	B / F			12.4 / 100.0	B / F		
10	Pine Hills Road and Indialantic Drive	Signal					12.4	B			14.7	B
25	Pine Hills Road and Silver Star Road	Signal	6.9	E	59.9	E	60.7	E	59.9	E	68.5	E
26	Pine Hills Road and Belco Drive	Signal	18.8	B	19.5	B	20.1	C	19.5	B	33.4	C
27	Pine Hills Road and Londonderry Blvd	Signal	6.6	A	6.8	A	6.7	A	6.8	A	7.8	A
28	Pine Hills Road and Indian Hill Road	Signal	14.7	B	15.0	B	15.1	B	15.0	B	19.2	B
29	Pine Hills Road and North Lane	Signal	35.9	D	36.9	D	36.9	D	36.9	D	43.7	D

PM Peak												
			Existing		2020				2040			
I #	Intersection	Control Type	No Build		No Build		Build		No Build		Build	
			Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
23	Pine Hills Road and Balboa Drive	Signal	18.8	B	19.4	B	19.5	B	15.2	B	26.5	C
5	Pine Hills Road and Delores Drive	Stop	14.1 / 139.3	B / F	14.5 / 173.4	B / F			12.4 / 100.0	B / F		
5	Pine Hills Road and Delores Drive	Signal					4.7	A			7.2	A
24	Pine Hills Road and Hernandes Drive	Signal	8.1	A	8.4	A	10.9	B	5.9	A	13.3	B
10	Pine Hills Road and Indialantic Drive	Stop	13.1 / 1,461.3	B / F	13.5 / 1777.4	B / F			12.4 / 100.0	B / F		
10	Pine Hills Road and Indialantic Drive	Signal					18.9	B			28.1	C
25	Pine Hills Road and Silver Star Road	Signal	69.6	E	71.8	E	72.1	E	59.9	E	72.7	E
26	Pine Hills Road and Belco Drive	Signal	10.0	B	10.2	B	11.0	B	19.5	B	13.1	B
27	Pine Hills Road and Londonderry Blvd	Signal	4.8	A	4.9	A	4.9	A	6.8	A	6.2	A
28	Pine Hills Road and Indian Hill Road	Signal	13.5	B	13.9	B	14.0	B	15.0	B	19.4	B
29	Pine Hills Road and North Lane	Signal	39.8	D	41.0	D	41.0	D	36.9	D	41.0	D

1. *Automobile Delay and LOS based on Synchro 9 Unsignalized and Signalized Intersection analysis*

Note the Unsignalized intersection delay and LOS are reported for worst condition Delay and LOS for the Major Street Left / Minor Street movements.

The Syncro reports for the future conditions are included as in *Technical Memorandum No. 5—Future Travel Demand Report.*

5.4 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. 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 accidents 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 High intensity Activated crossWalK (HAWK), encourages pedestrians/bicyclists to use the crosswalk instead of attempting to cross

at other non-designated locations. In addition, 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.

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
Northbound Direction					
1	N of Colonial Drive	200	81/51	Keep	200
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
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
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
23*	S of Hernandes Drive	280	44/11	Keep	60
24*	S of Indialantic Drive	590	37/4	Keep	50
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
	Remove Stop
	Consolidate & Move Stop

7. 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

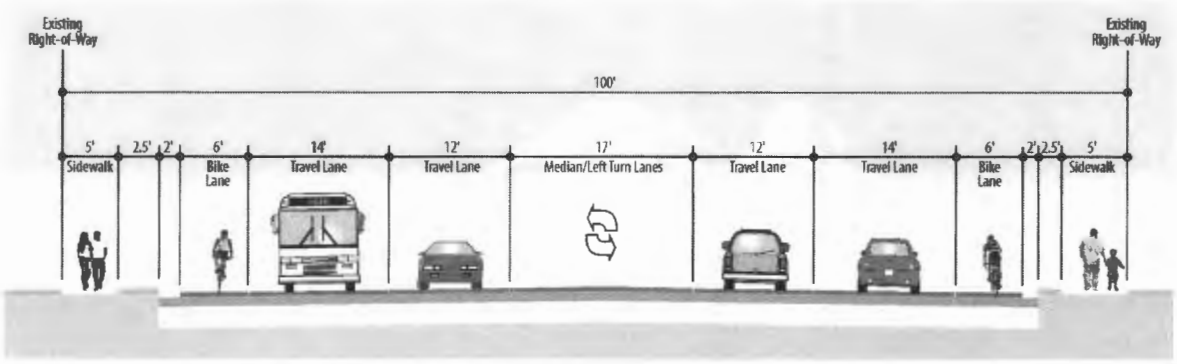
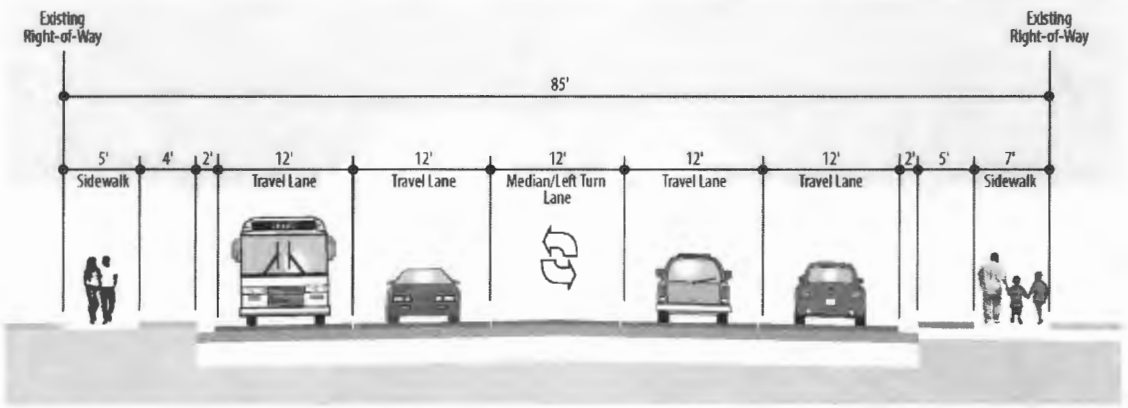


Figure 7.2: No Build Alternative Typical Section: Silver Star Road to Bonnie Brae Circle



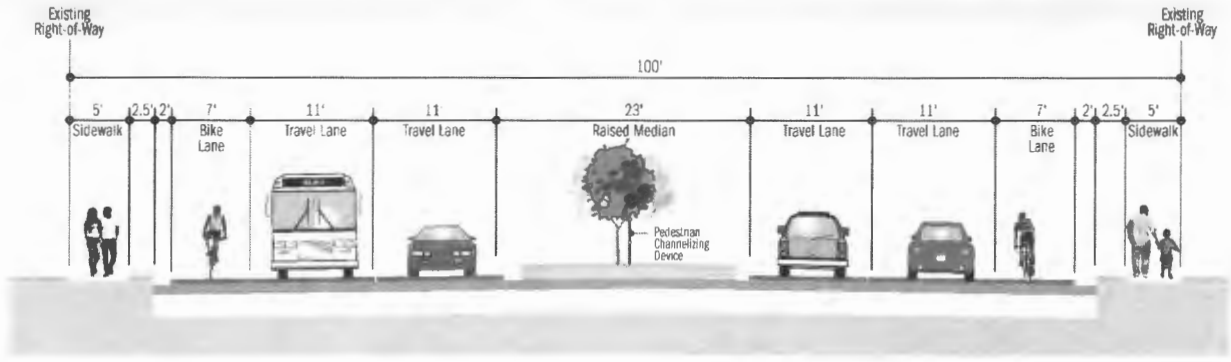
7.1.2 Build Alternatives

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.

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

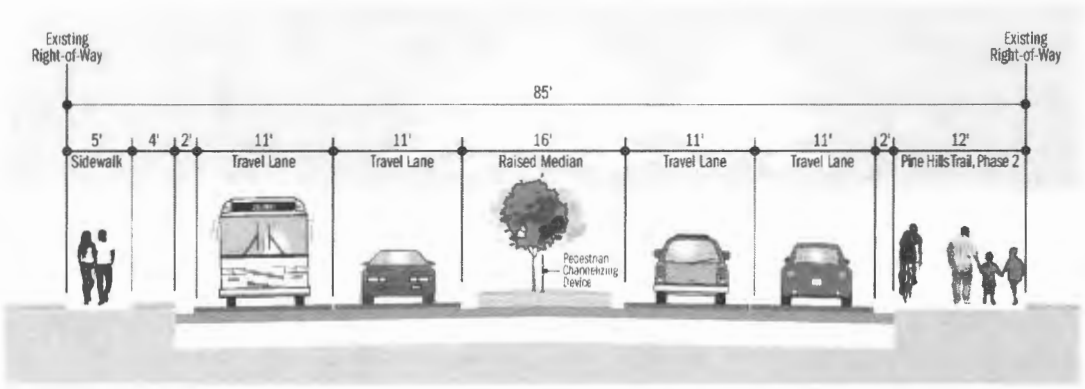


South Segment – Colonial Drive (SR 50) to Silver Star Road (SR 438)

- 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 standard landscaping and pedestrian channelizing devices, 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
- Provide milling and resurfacing for existing remaining pavement
- 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
- Provide 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
- Provide new mast arm signals at Silver Star Road
- Install HAWK signal at Figwood Lane
- Provide pedestrian education opportunities

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 and pedestrian channelizing devices, 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.
- Provide milling and resurfacing for existing remaining pavement
- Install HAWK signal at Fir Drive

Figure 7.5: Build Alternative, Raised Median

Figure 7.5 (continued): Build Alternative, Raised Median

Figure 7.5 (continued): Build Alternative, Raised Median

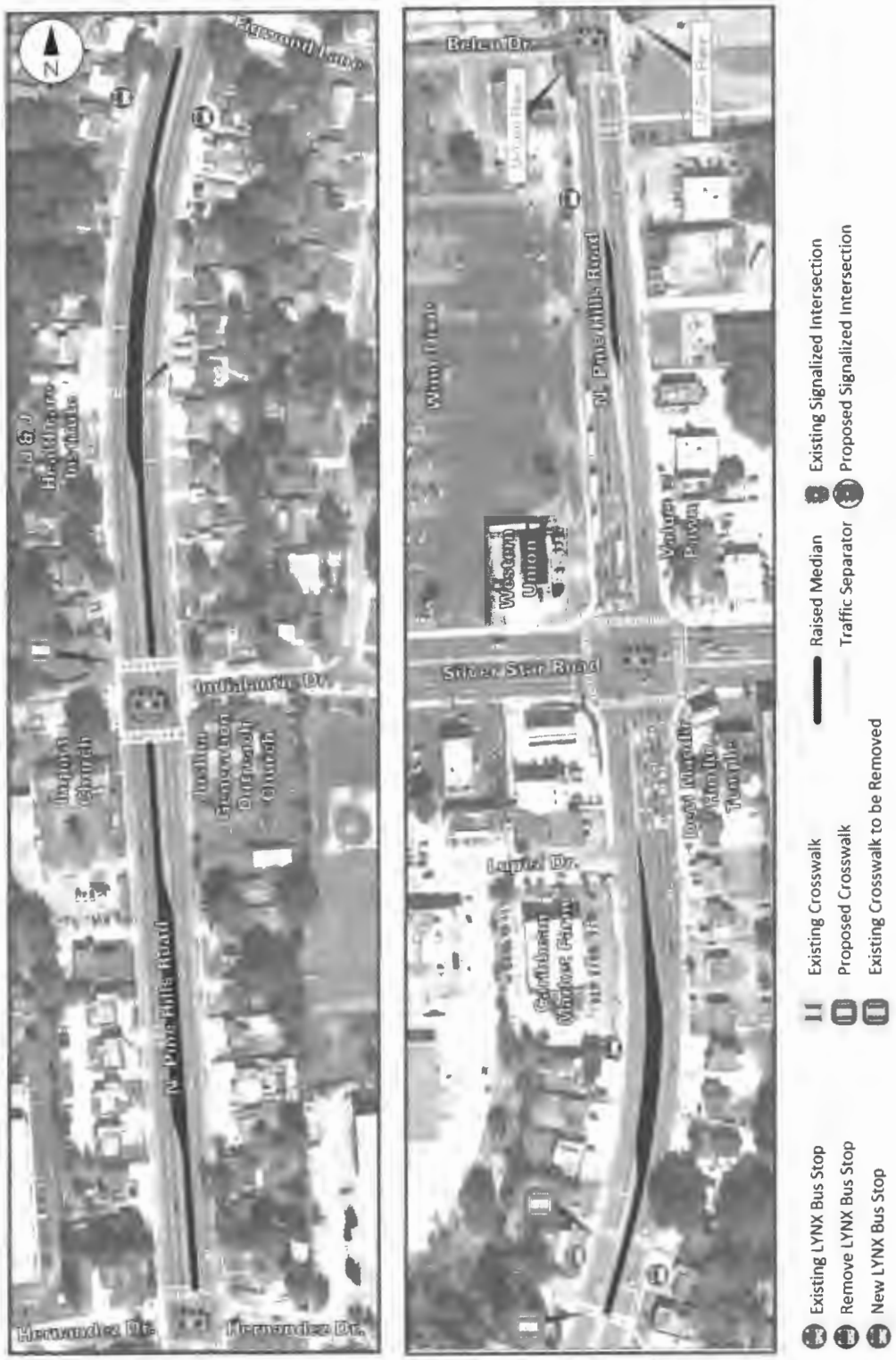


Figure 7.5 (continued): Build Alternative, Raised Median

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.

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 C** 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 at approximately $75,000 per mile.
- 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.
- 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. In some cases, additional right-of-way will be required. These costs are not included in the project cost estimates.

Table 7.2: Proposed Safety Improvements and Preliminary Cost Estimates

Phase No.	Description of Improvement	Estimated Costs
Phase 1 – South Segment Colonial Drive to Silver Star Road	▪ 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 HAWK signal ▪ Install roadway lighting improvements from Colonial Drive to Silver Star Road ▪ Gateway Improvement Features ▪ New Traffic Signals at Silver Star Road ▪ Pedestrian Education	$3.79 million*
Phase 2 – North Segment Silver Star Road to Bonnie Brae Circle	▪ 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 HAWK signal ▪ Pedestrian Education	$2.09 million*

*Does Not Include Enhanced Landscaping, or Right-of-Way Acquisition Costs

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 can be found in **Appendix C,** and the benefit/cost calculations and CMF/CRF data can be found in **Appendix D**.

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 D.**

The CRF's employed by this study are listed below and a more detailed breakdown of this methodology is included in **Appendix D**.

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 (Pine Hills Road)*	$ 178,706	12.57
	- Silver Star Intersection	$ 188,937	7.61
	- Pedestrian Channelizing Devices	$ 50,515	13.79
	- Changes to LYNX Stops	$ 19,825	19.11
	- HAWK Signal	$ 91,435	1.90
	- Pedestrian Education	$ -	
	- Lighting (Colonial Drive to Silver Star Road)	$ 1,082,369	4.12
	- Gateway Improvements (Landscape, Hardscape)	$ 396,993	
	- New Signals at Silver Star Road	$ 372,357	7.61
	- **TOTAL (With Standard Landscaping)***	**$ 3,789,469***	
2	**North of Silver Star Road to Bonnie Brae Circle**		
	Raised Median, Reduced Travel Lanes	$ 1,402,275	7.19
	- Standard Landscaping	$ 64,253	8.28
	- Enhanced Landscaping*	$ 77,643	8.20
	- Reconstruct/Widen Sidewalk	$ 492,986	15.34
	- Pedestrian Channelizing Devices	$ 31,559	8.67
	- Changes to LYNX Stops	$ 5,915	64.04
	- HAWK Signal	$ 91,435	1.90
	- Pedestrian Education	$ -	
	- **TOTAL (With Standard Landscaping)****	**$ 2,088,423****	

* Does Not Include Enhanced Landscaping in Phase 1.

** Does Not Include Enhanced Landscaping, Right-of-Way Acquisition Costs in Phase 2.

8. 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 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 $5.9 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 could 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, the Pine Hills Neighborhood Improvement District (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 E**. The proposed gateway improvements are also recommended to be implemented as part of Phase 1 improvements.

Figure 8.1: Proposed Gateway Improvements