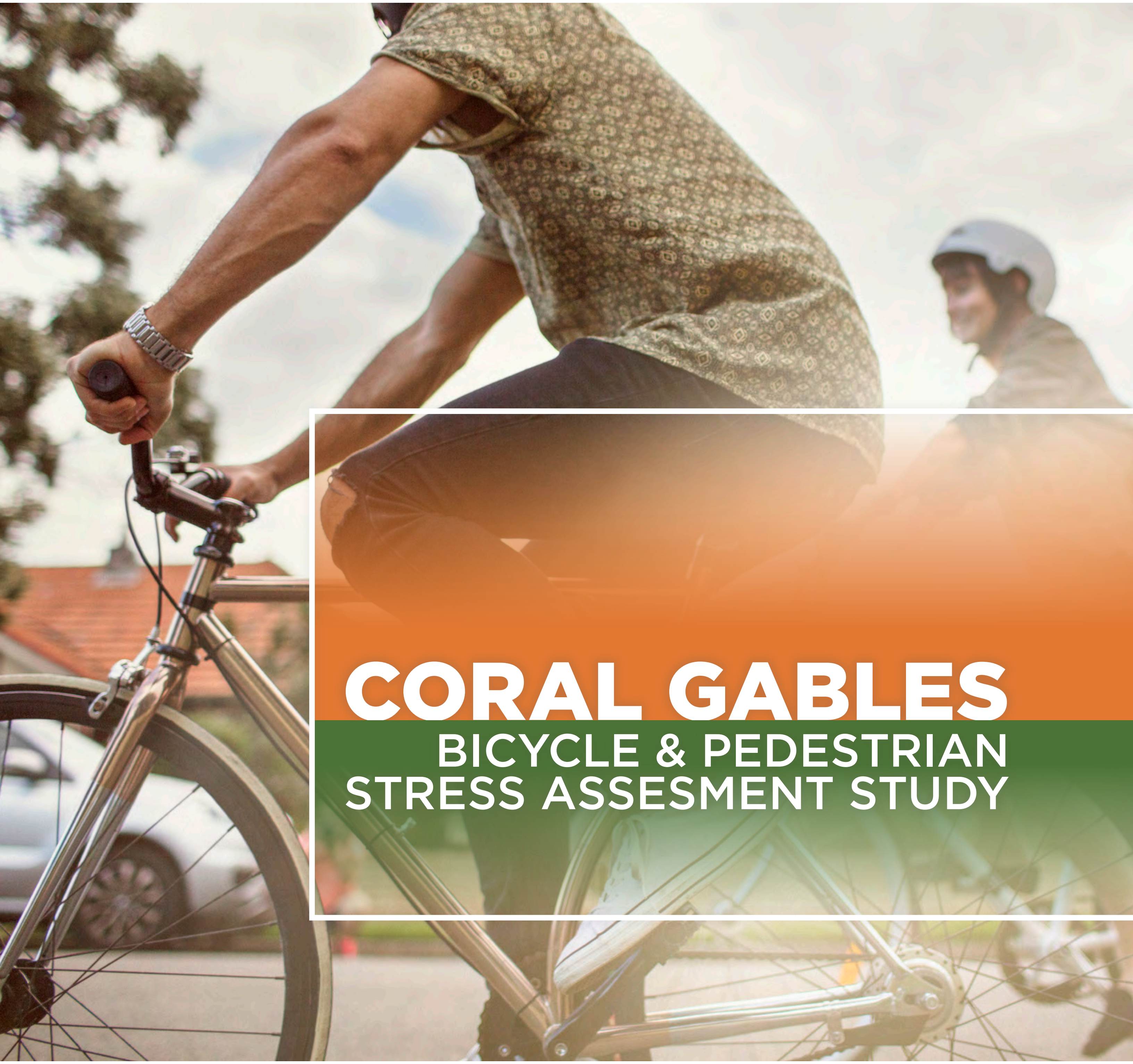
CORAL GABLES
THE CITY BEAUTIFUL



CORAL GABLES
BICYCLE & PEDESTRIAN STRESS ASSESEMENT STUDY

APRIL 2019

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

There is a direct correlation between whether people will ride a bike or walk and the amount of stress they experience while using the transportation network. The goal of this study is to work towards a safe, multimodal network in the City of Coral Gables for people of all ages and abilities.

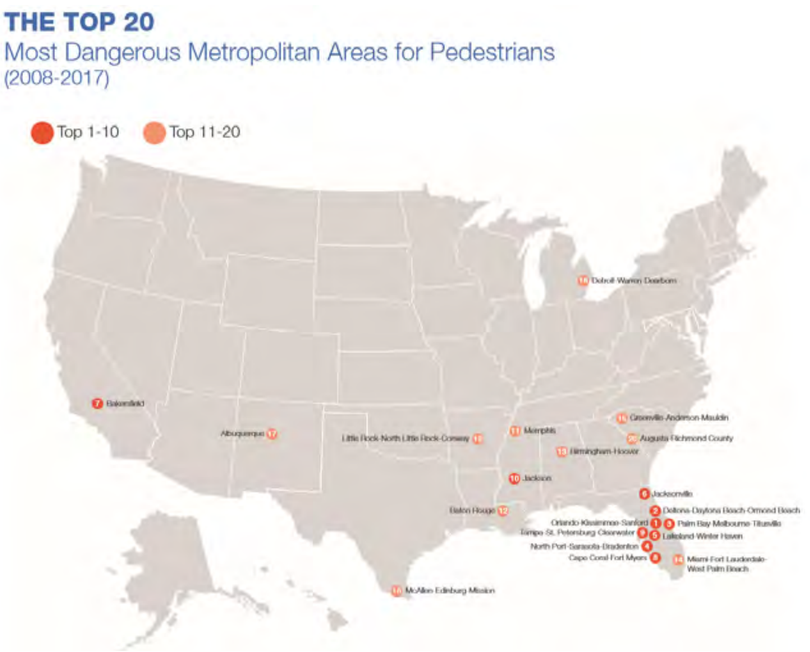
The City of Coral Gables envisions a city where all residents can safely walk or cycle to school, work or recreation opportunities. The creation of a safe, protected bike and pedestrian transportation network supports Coral Gables' sustainability goals while having enormous public health benefits which accrue from daily physical activity. Creating more sustainable transportation options can also reduce the number of shorter automobile trips, helping to mitigate congestion and reduce vehicular emissions.

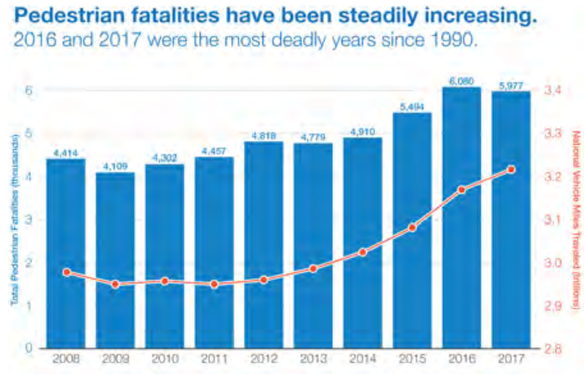
In 2010, the City of Coral Gables began actively investing in expanding pedestrian and bicycle facilities around the City. In 2014, the City adopted the Pedestrian and Bicycle Master Plan, which identified 34 corridors for bicycle facilities. The study allowed for flexibility and left out specific design details which would be determined at a later time. This study further assesses the recommendations of the 2014 Master Plan and refines and justifies an implementation plan for an expanded and improved bicycle and pedestrian network.

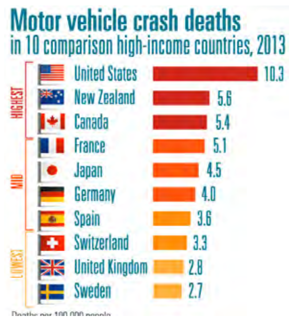
Research has shown that nearly 70 percent1 of the population is interested in biking, but only 13 percent do so on a regular basis. Similarly, most people express an interest to walk more, but only 10 percent[1] do so as a primary form of transportation. This mis-match between desire and reality is largely due to the lack of continuous and comfortable multimodal networks in our transportation system.

There is a direct correlation between the level of comfort a person feels while walking and biking and their likelihood to walk or bike. The City has recognized that the implementation of this plan will only be successful if the facilities constructed lead to building a safe, multimodal network for all ages and abilities. This study utilizes well researched principles to assess the existing conditions of Coral Gables' network and recommends the most appropriate bike facilities for bike corridors identified in the 2014 Master Plan. The study also used these same principles to assess the comfort level of pedestrians at key intersections and identifies new pedestrian crossings in key places throughout the City. Finally, the study included a sidewalk gap analysis, where missing sidewalks were identified in the vicinity of parks and schools and Metrorail stations.

1 *Dill, Jenifer and McNeil, Nathan, Four Types of Cyclists?: Testing a Typology to better Understand Bicycling Behavior and Potential. Portland State University, 2012*







"America has one of the highest fatality rates of first world countries and pedestrian fatalities have been rising since 2013. This Plan seeks to address roadway safety issues throughout the City of Coral Gables, by proposing infrastructure that improve safety conditions for all users of the roadway."

Sources / Smart Growth America 2019 Dangerous by Design (Left) and WHO Global Status Report on Road Safety 2015

The Analysis

To help define the baseline conditions for the level of comfort for bicycle and pedestrians and assess new opportunities for multi-modal connectivity, the following analysis was conducted:

Bicycle Level of Traffic Stress (LTS)

Many people will only choose to ride a bike if they feel safe for the entire trip. There is a direct correlation between a bicyclists' level of comfort riding and the amount of stress they feel interacting with traffic. This analysis uses parameters such as traffic speed, traffic volume, bike facility type and parking presence to measure the perceived comfort of people riding a bike on the street or facility. Streets are assigned a score of LTS 1 through LTS 4, where a score of LTS 1 is comfortable for most users and a score of LTS 4 is uncomfortable stressful for even confident bicyclist. These scores can also help use roadway characteristics to identify the most appropriate bicycle facility to implement. For instance, bicycle boulevard treatments are comfortable on LTS 1 and 2 streets but are inappropriate on LTS 4 streets. Conversely, a physically separated bike lane is the only way for a street with an LTS score of 4 to be considered a low stress facility.

Sidewalk Gap Analysis

Sidewalk gaps were identified within a 1/4-mile walkshed of key pedestrian generators and attractors, being the areas of highest need. This includes generators such as schools, parks, and Metrorail stations.

Pedestrian Intersection Analysis

Fifty intersections within the study area were selected to evaluate the comfort and safety of each intersection for pedestrians. This was done by developing a methodology based on LTS principles and used parameters focused on crossing treatments, out-of-direction travel, delay and time to cross the street to evaluate how comfortable the intersection was for pedestrians. The intersection analysis did not incorporate ADA compliance into the score as ADA compliance is required by law.

Pedestrian Connectivity Analysis

Several corridors within the City that have limited pedestrian crossing opportunities were assessed to identify new and upgrading crossings that would improve pedestrian connectivity throughout the network.

Recommendations & Implementation

Each specific recommendation in this plan is prioritized based on factors such as connectivity, safety, demand and equity. Recommendations were prioritized into three tier's or phases.

The implementation schedule for each Tier/Phase breaks down as follows:

TIER/PHASE 1	TIER/PHASE 2	TIER/PHASE 3
1 TO 3 YEARS	3 TO 6 YEARS	6 TO 10 YEARS

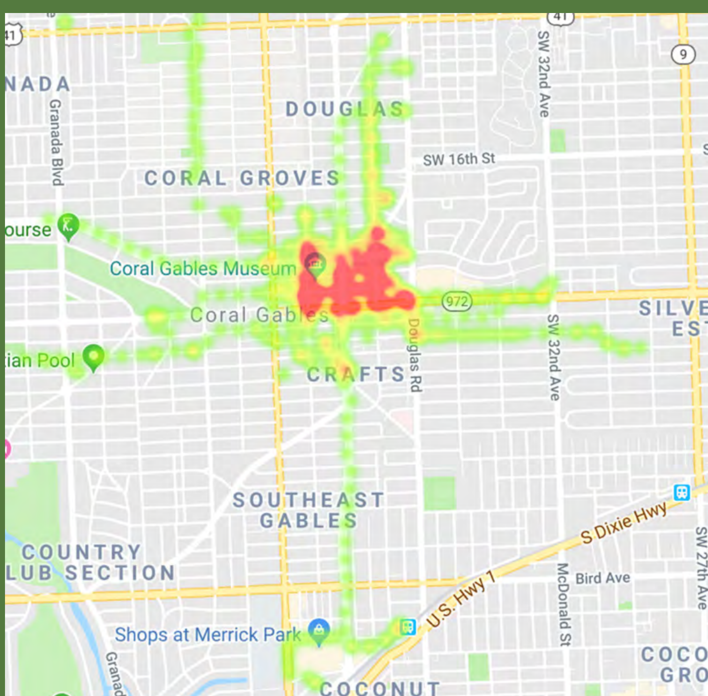
These recommendations strive to build the backbone of a low stress, safe, multimodal network within 3 years, with full build-out anticipated within 10 years.

The previously mentioned network analysis resulted in detailed recommendations for the bicycle and pedestrian network. The recommendations that are critical for implementation include:

/ Implement the recommended improvements to the protected bicycle network. This is critical to developing a "backbone" network of low stress bicycle infrastructure.

/ Construct sidewalks where they are missing in all the priority areas identified in the plan.

/ Adjust signal timing at intersections that scored "Worst", "Poor" or "Fair" in the pedestrian intersection evaluation. The three critical signal timing changes include reducing cycle lengths to reduce pedestrian delay, utilizing Pedestrian Leading Intervals (LPIs) to create "Walk" phases protected from left turning vehicles, and increasing the pedestrian clearance interval to allow adequate time to cross the street.



The above heat map of scooter ridership in the city speaks to the need for additional protected bike infrastructure to support scooters and future micro mobility devices. Many scooter riders already use designated bike routes like Galiano Street and Ponce de Leon

The map of Strava data featured to the right depicts a heat map of where bicycle riders who use the Strava App logged rides from July 2016 to July 2018.

(Source: Strava.com/heatmap, 2018)

Seattle has seen over a 400 percent increase in bicycle ridership after upgrading a key corridor from a painted bike lane to a protected bike lane.

(Source: StreetsblogUSA, 2019)

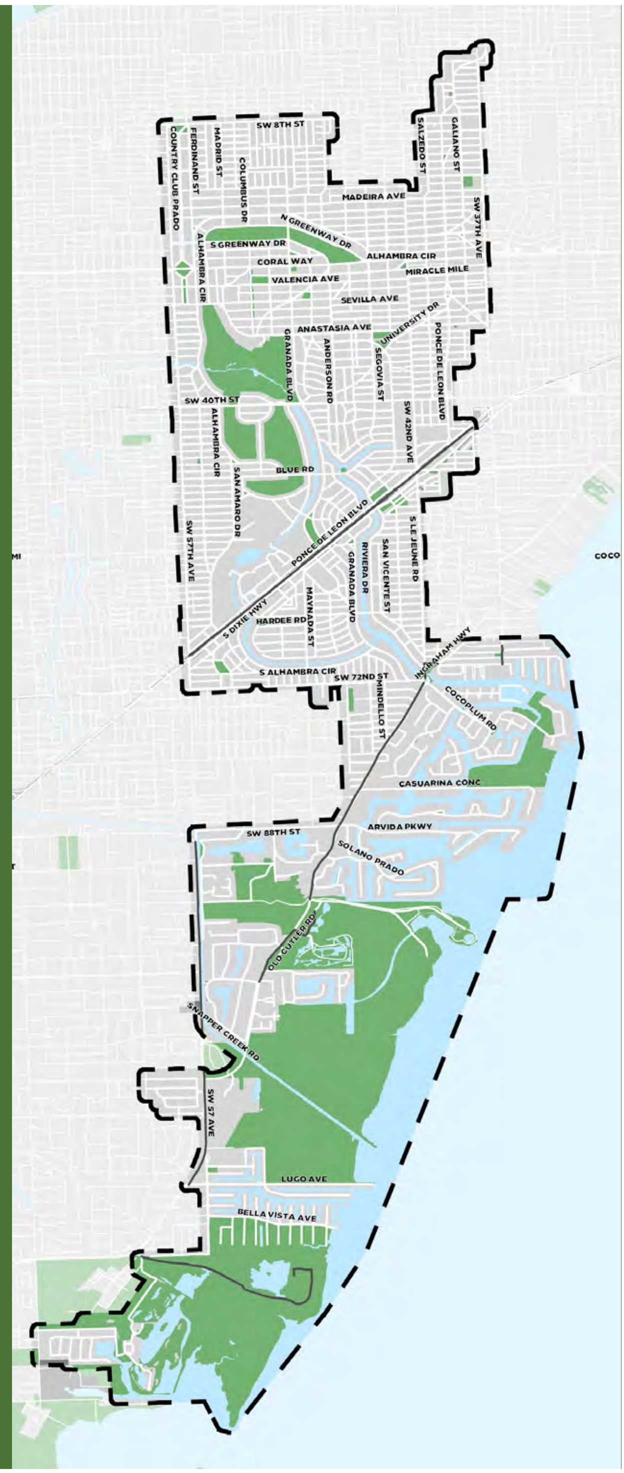
INTRODUCTION

INTRODUCTION

Background

In 2010, the City Commission of Coral Gables approved an investment of $400,000 into expanding bicycle facilities around the city. Simultaneously, the City also planned on repaving city streets and implementing traffic calming projects. Following these commitments, a Citywide Bicycle/Pedestrian Plan was adopted in 2014 with the purpose of recommending pedestrian and bicycle infrastructure projects could be implemented in the short and long term, while identifying future bicycle and pedestrian investments. In 2014, Coral Gables adopted a Bicycle and Pedestrian Master plan that proposed more than 27 miles of new or improved bikeways, sidewalk and crosswalk. The existing bicycle network, which consists of 10.5 miles, was proposed to be expanded with an additional 34 miles of new bikeways. The projects outlined in the 2014 Plan also proposes protected bicycle and pedestrian connections to existing Metrorail stations and to SMART Plan Corridors on either side of the city, including Flagler Corridor BERT, and the Kendall Corridor, South Dade Transitway, S. Miami-Dade Express, and SW Miami-Dade Express via the M Path.

In 2016, the city kicked off a Multi-Modal Plan, which aimed to increase transportation options and better manage traffic congestion. This fine-grain approach has not been completed as of this writing, but the extensive proposed traffic calming plans include measures such as roundabouts, speed tables, speed cushions, medians, and general intersection improvements. The Multi-Modal Plan focuses on downtown, the areas west of downtown, and on either side of the Dixie Highway. This study, while not providing a similar level of detail for pedestrian improvements, aims to supplement the Plan by identifying high priority recommendations.



Purpose of Study

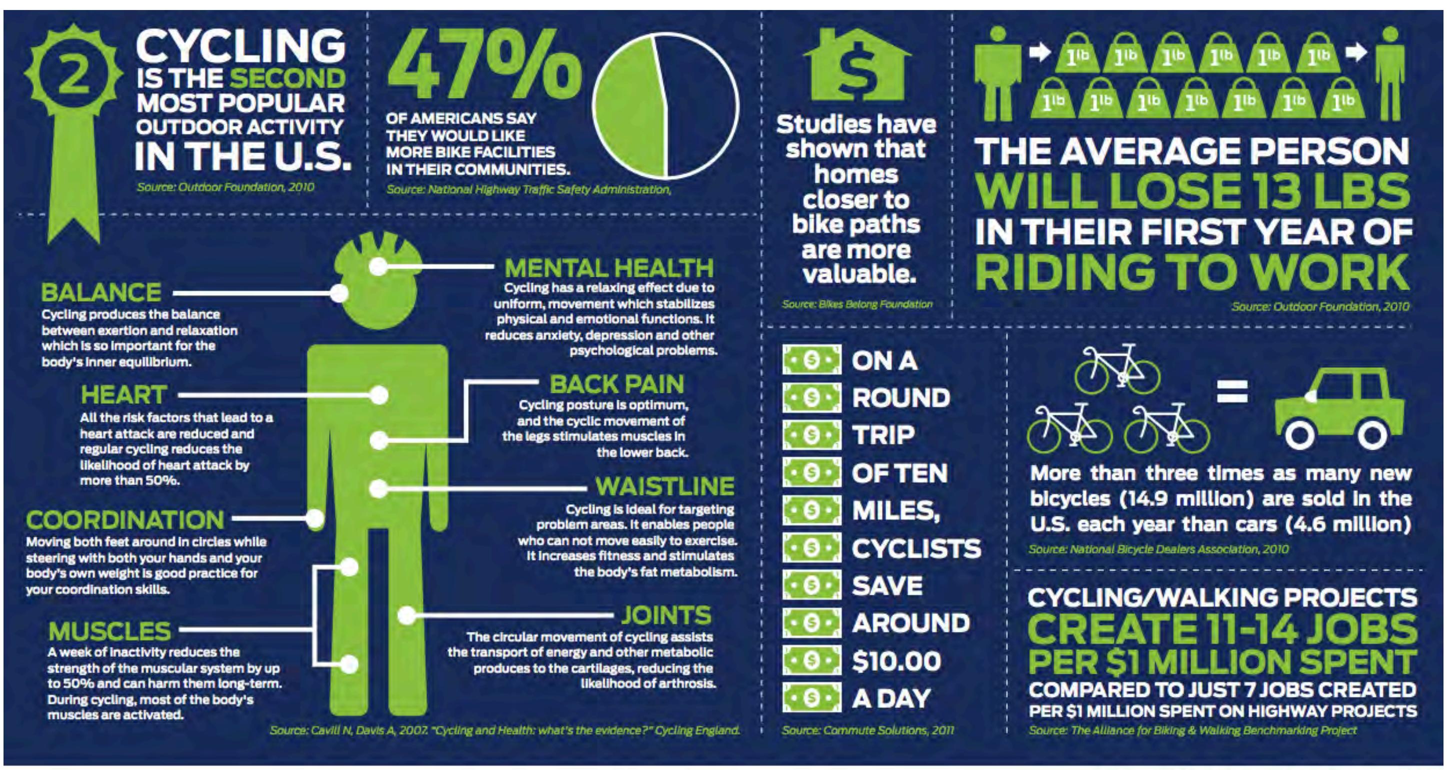
The purpose of the Study is to foster the city's goal to expand the bicycle and pedestrian network into something that will appeal to all users and motivate people to chose to ride a bike or walk for shorter trips and access to transit. There is a direct correlation between the level of comfort and safety the network provides and whether people chose to ride a bike. The approach included using the Level of Traffic Stress (LTS) methodology to support all-age facility recommendations. Building upon the 2014 bike plan, this study will update the assessments of arterial and collector corridors that were conducted in the 2014 plan, categorize the corridors into high- and low-level stress bicycle and pedestrian facilities, and make corridor-specific recommendations that will ultimately achieve a more connected multimodal network.

Pedestrians are among our transportation system's most vulnerable users. They are fully exposed, having to burden all the impact when involved in a crash. The faster the vehicle speed, the less likely the pedestrian will survive the crash. The pedestrian network in Coral Gables needs to provide a high level of safety to allow pedestrians to reach their destination without any fear of being involved in a crash. Coral Gables' vision is to create a multimodal network for all ages and abilities.

Recently, the City of Coral Gables has undertaken several efforts to improve pedestrian conditions. In addition to looking at new bikeways, the 2014 Master Plan identified locations where sidewalks and crosswalks should be constructed. The dozen sidewalk improvements focused on downtown gaps, gaps near transit, and along major arterials, with the dozen crosswalk improvements focusing on signalized intersections and near transit.

This study builds on the 2014 Master Plan by assessing the comfort of the pedestrian network. Three analyses were conducted: a sidewalk gap analysis, a pedestrian intersection accommodation, and a pedestrian connectivity analysis. From these combined analyses, opportunities to improve the pedestrian network were identified. A lack of a continuously connected sidewalk network is one of the main challenges the City's network faces. The study identified key sidewalk gaps within the vicinity of schools, parks and major transit stations. The assessment also included completing a baseline analysis of the condition of several intersections and mid-block crossings based on substantial community feedback regarding signal timing issues. The city has received numerous community comments regarding excessive signal cycle lengths, right and left vehicle turn conflicts during "Walk" signal phases, and a lack of marked crossings in residential neighborhoods, especially on collector streets. Based on this assessment, several recommendations were identified to improve existing intersections and create new crossings with the goal of making the pedestrian network more permeable.

This Study will provide a guiding framework for identifying and implementing projects that provide a connected and comfortable network for biking and walking in Coral Gables.



Infographic designed by Jonathan Hart

EXISTING CONDITIONS ASSESMENT

EXISTING CONDITIONS ASSESSMENT

Data Collection

Key data on roadway and land use characteristics were critical to assessing the baseline level of comfort the network provided for pedestrians and bicyclists. GIS data from various sources was compiled to conduct the existing conditions analysis. The table below summarizes the GIS data collected and its source.

Additionally, where data was not readily available, the following assumptions were made:

- The road's functional classification was determined based on the road's class. Roads designated as Class 1 and 2 represent the US 1 Highway. Roads designated as Class 3 were considered collectors. All other roadway classes, were designated as a local road.
- When assigning posted speed limit to road networks, road functional classification is considered. For local roads, the assumed speed was 25mph as no local streets are posted above 25 mph. For a collector, the average speed limit is 30 mph. As for a major arterial, US 1 for example, the speed limit is 45 mph.

TABLE 1 **SUMMARY OF THE DATA SOURCES USED IN THE EXISTING CONDITIONS ANALYSIS**

Data	Source	Analysis Purpose
Street	Coral Gables Miami-Dade County	Bicycle level of traffic stress Pedestrian connectivity analysis
Bike Facilities	Coral Gables	**Bicycle level of traffic stress**
Speed	Coral Gables	**Bicycle level of traffic stress**
Paved paths	Miami-Dade County	**Bicycle level of traffic stress**
Land use	Coral Gables	**Bicycle level of traffic stress**
Bike counts	TPO	**Bicycle level of traffic stress**
Sidewalk Gaps	Coral Gables	**Sidewalk gap analysis**
School sites	Coral Gables	**Sidewalk gap analysis**
Bus Routes	Miami-Dade County	**Sidewalk gap analysis**
Bus Stops	Miami-Dade County	**Sidewalk gap analysis**
Pedestrian counts	TPO	**Pedestrian intersection accommodation**
Signal timing plans	Miami-Dade County	**Pedestrian intersection accommodation**

Existing Conditions Analysis

To define the baseline conditions for the level of comfort for bicycles and pedestrians on the City of Coral Gables' network, the following analyses were used:

/ **Bicycle Level of Traffic Stress (LTS)**
This analysis uses parameters such as traffic speed, traffic volume, bike facility type and parking presence to measure the perceived comfort of people riding a bike on the street or facility. Streets are assigned a score of LTS 1 through LTS 4, where a score of LTS 1 is comfortable for most users and a score of LTS 4 is uncomfortable stressful for even confident bicyclist.

/ **Sidewalk Gap Analysis**
Sidewalk gaps were identified within a 1/4-mile walkshed of key pedestrian generators and attractors, being the areas of highest need. This includes generators such as schools, parks, and Metrorail stations.

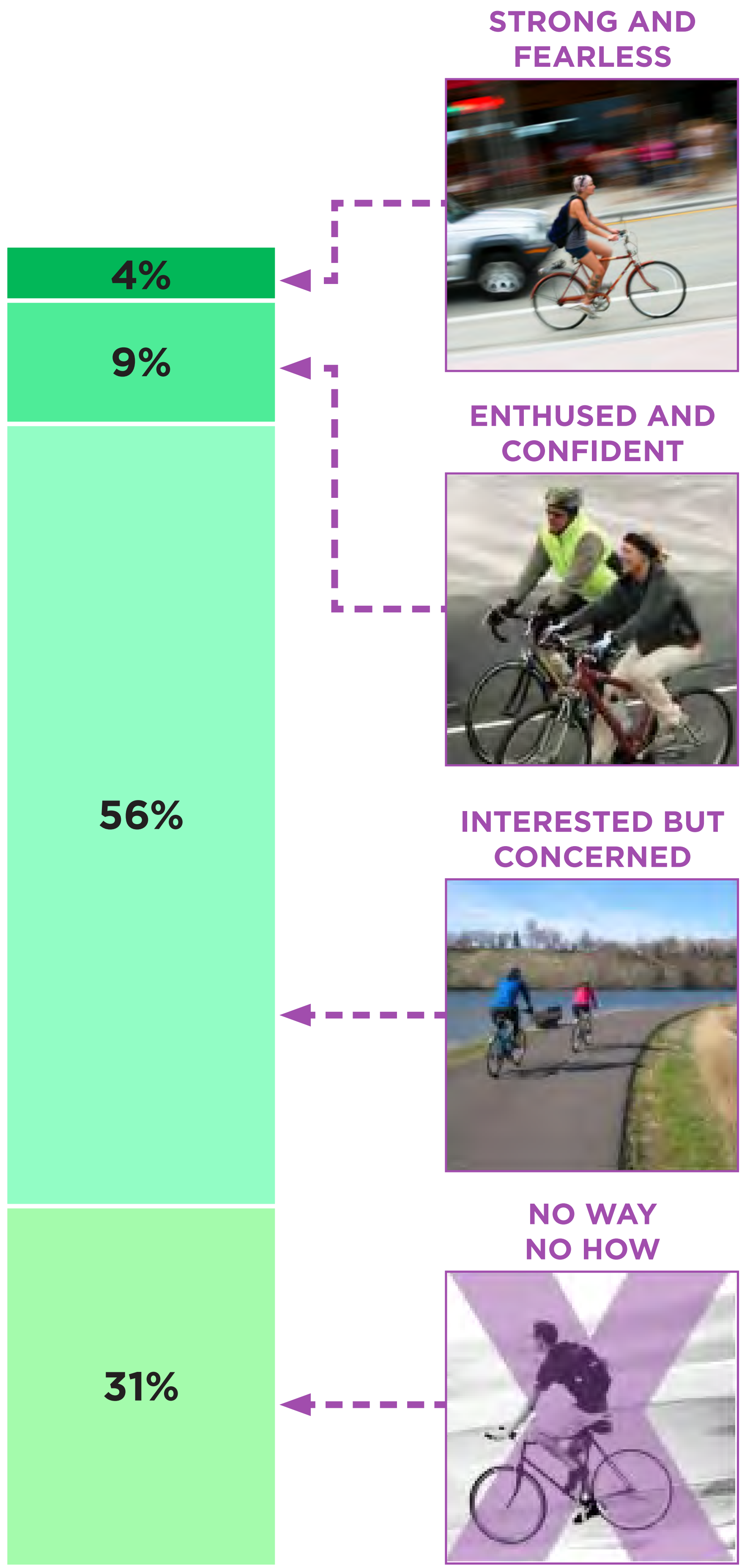
/ **Pedestrian Intersection Analysis**
Fifty intersections within the study area were selected to evaluate the comfort of each intersection for pedestrians. This was done by developing a methodology based on LTS principles and used parameters focused on crossing treatments, out-of-direction travel, delay and time to cross the street to evaluate how comfortable the intersection was for pedestrians. The intersection analysis did not incorporate ADA compliance into the score as ADA compliance is required by law.

The following sections provide a detailed overview of the methodologies above and documents the results.

Bicycle Level of Traffic Stress

Methodology

Research has identified that there are 4 types of bicyclist, Strong and fearless, Enthused and confident, Interested but Concerned and No way, No how.[1] Bicyclists categorized as Strong and Fearless are comfortable riding on busy roads with little physical separation from motorist through travel lanes. Enthused and Confident cyclists are generally recreational and utilitarian riders who will ride on busy streets if there are facilities provided, but may also deviate from the most direct route to ride on low-traffic or shared use paths. The No way no how group will not choose to bicycle for transportation or recreation, regardless of provided infrastructure.



1 *Dill, Jenifer and McNeil, Nathan, Four Types of Cyclists?: Testing a Typology to better Understand Bicycling Behavior and Potential. Portland State University, 2012.*

However, the majority of the population, fifty-six percent, falls in the Interested but Concerned category. This group includes a wide range of people of all ages who enjoy cycling, but may only ride on shared use paths, low traffic local streets, or protected on-street facilities. These bicyclists need to be connected via bike facilities/streets that are low stress for the entirety of their trip. This makes it crucial to create connected networks AND to select and build a well-designed facility that meets the needs of these riders. In general terms, this user group prefers:

/ Physically separated facilities such as bike lanes with vertical separation and trails

/ Wide, preferably-buffered bike lanes on medium to low speed and low volume streets, adjacent to the curb (not a parking lane)

/ Bike boulevard treatments on low-stress neighborhood streets

Least Separation **Most Separation**

Based on linear distance, significant portions of Coral Gables' roadway network are local streets that have low traffic speeds and volumes. These streets are already comfortable to bike on and do not need substantial infrastructure. However, most people will not bike unless they feel safe for their entire trip, creating a need for facilities on major roadways. Coral Gables' existing low-stress bike network consists of islands of accessibility in residential neighborhoods cut off from each other because of arterials and collector streets with no bike infrastructure.

The bicycle LTS methodology uses roadway characteristics to evaluate the perceived comfort of people riding a bicycle on the street or on a bicycle facility. Fundamentally, people will only travel around Coral Gables in a way that gets them where they need to go and feels safe to them. The way we traditionally plan bike facilities, however, often fails to meet one or both of these basic travel needs. Inevitably, a person on a bicycle encounters one of the two following situations:

1/ A lack of bicycle facilities, or gaps between bicycle facilities requires people on bikes to ride in mixed traffic on streets where that feels dangerous

2/ The bicycle facilities that do exist are designed in such a way that they don't feel safe, either because they're too close to fast-moving traffic, they're frequently obstructed, or the doors of parked cars open into them.

For Coral Gables, the network will be evaluated based on a "Weakest Link" threshold approach. This methodology uses (1) posted traffic speeds, (2) traffic volumes, (3) number of travel lanes, (4) level of separation from traffic and (5) level of incursion (based on context).

Links within the network will be evaluated based on the thresholds developed and explained in this methodology. If the link meets the threshold, it will be assigned an LTS score. If it does not, it will be evaluated based on the next set of thresholds. LTS 1-4 is generally defined using the following comfort level descriptions:

/ **LTS 1:** Except in low speed/low volume traffic situations, a separated bike facility that has physical separation from traffic is present. This is comfortable for the general population and is suitable for an 8-year old child.

/ **LTS 2:** Except in low speed/low volume traffic situations, cyclists have their own place to ride that keeps them from having to interact with traffic except at formal crossings. Stress that most adults can tolerate, particularly those sometimes classified as "interested but concerned."

/ **LTS 3:** Involves interaction with moderate speed or multilane traffic, or close proximity to higher speed traffic. Comfortable for "enthused and confident" riders.

/ **LTS 4:** Involves interaction with higher speed traffic or close proximity to high speed traffic. Uncomfortable for most bicycle riders, acceptable only to "strong and fearless" riders.

An approach was developed for network links where bicycles mix with traffic and a second approach was developed for network links with a bicycle facility.

Mixed Traffic Assessment

All facilities classified as sharrows or signed route will be assessed using the mixed traffic approach. The evaluation methodology, shown in Figure 1, will assign an LTS score to each mixed traffic segment. This results in only one score per segment and uses "Weakest Link" methodology to represent the highest level of stress encountered along that segment. Three main corridor characteristics influence LTS on Mixed Traffic segments – auto speed, number of lanes, and level of incursion/commercial activity.

Auto Speed

High auto speeds along a mixed traffic segment contribute to high levels of traffic stress for cyclists. In the absence of extensive spot speed data throughout the City, this characteristic will be reasonably quantified using speed limit data from the City's recent 25 mph Ordinance effort.

Streets with a speed limit of 35 mph or greater automatically receive an LTS 4 score. For streets with a speed limit of 30 mph or lower number of lanes and amount of anticipated commercial activity will be evaluated to assign an LTS of 1-4.

Number of Lanes

More lanes along a mixed traffic segment contribute to high levels of traffic stress for cyclists due to the potential for high automobile traffic volumes. In the absence of extensive lane count data throughout the City, these characteristics will be reasonably quantified using FDOT number of lanes data on arterials and collectors within the City, and local streets will be assumed to include 2 lanes. Google desk audit and supplement field study will be used for cross checking.

At the low stress end of the spectrum (low speed, low number of lanes), LTS 1 will be assigned to residential areas and LTS 2 will be assigned to commercial areas. At the high stress end of the spectrum (high speed, high number of lanes) LTS 4 will be assigned.

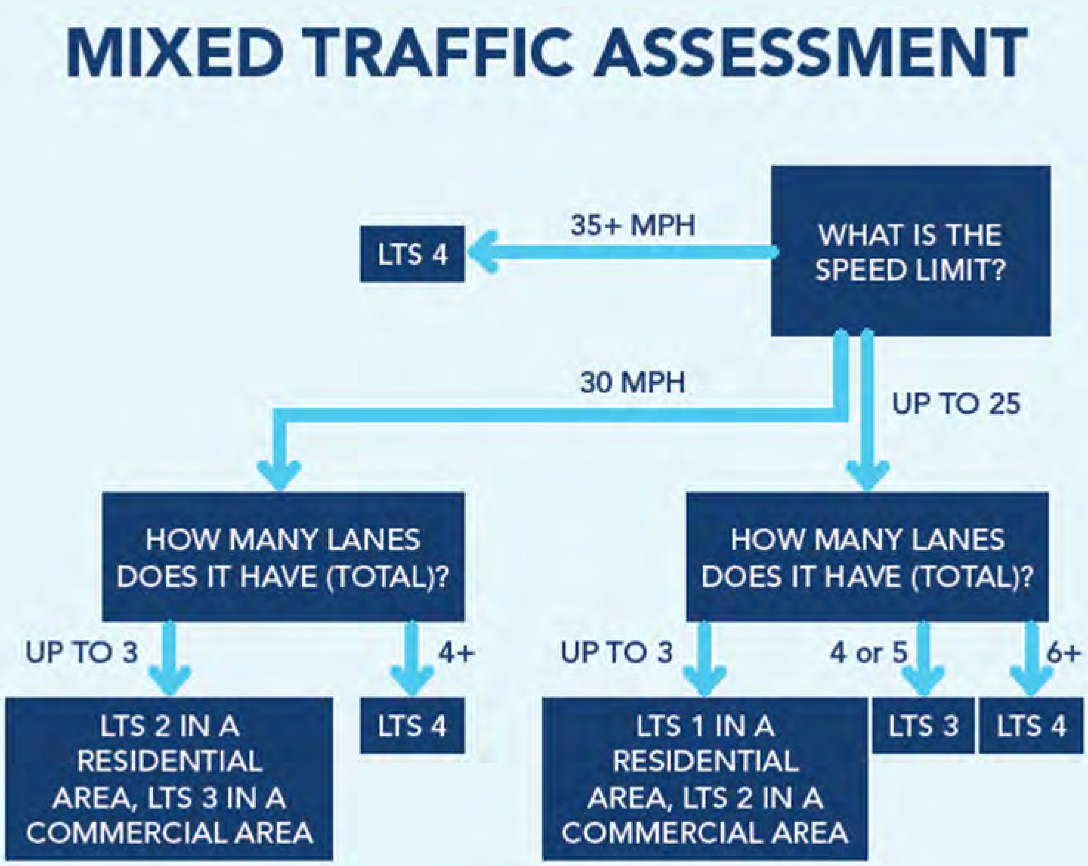
After an LTS score is assigned on Mixed Traffic segments, segments with Annual Average Daily Traffic (AADT) traffic volume of more than 8,000 will be re-evaluated. Segments with LTS 1 and 2 that have an AADT greater than 8,000 will be changed to LTS 3.

Level of Incursion/Commercial Activity

High on-street parking activity and driveway access to/from commercial land uses contribute to high levels of traffic stress for cyclists along mixed traffic segments, increasing the potential for bike/vehicle conflicts. Commercial land uses will be used to quantify this measure, using Coral Gables existing land use GIS layer.

For streets under 35 mph with up to 3 lanes, land use will be used to make final LTS determination. In these contexts, LTS will be one score higher (more stressful) if most of the street segment is located in a commercial area where potential for on-street parking activity and driveway access is high.

FIGURE 1 **MIXED TRAFFIC BICYCLE LTS METHODOLOGY**



Bicycle Facility Assessment

All trails and streets with bicycle facilities will be evaluated using the Bicycle Facility LTS Methodology. The evaluation methodology, shown in Figure 2, will assign an LTS score to each bicycle facility segment. This results in only one score per segment and uses "Weakest Link" methodology to represent the highest level of stress encountered along that segment. Three main elements influence level of traffic stress on bicycle facilities – type of bicycle facility, auto speed, and presence of on-street parking (and the width of the bike lane next to parking).

Type of Bicycle Facility

Bicycle facilities will be grouped into two general categories – separated facilities and bike lanes. For separated facilities (shared use paths and cycle tracks) that are completely separated from traffic, it is assumed that there are no known design flaws, and an LTS 1 is assigned. Separated facilities are considered two-way if they are 8' or wider and separated facilities are considered one-way if they are less than 8'.

A facility (including shoulders) will be classified as a bike lane if it is 4 feet or wider. For streets with bicycle facility on only one side, an LTS score will be assigned to each side of the street, and the segment score will be represented by the highest (most stressful) LTS.

Auto Speed

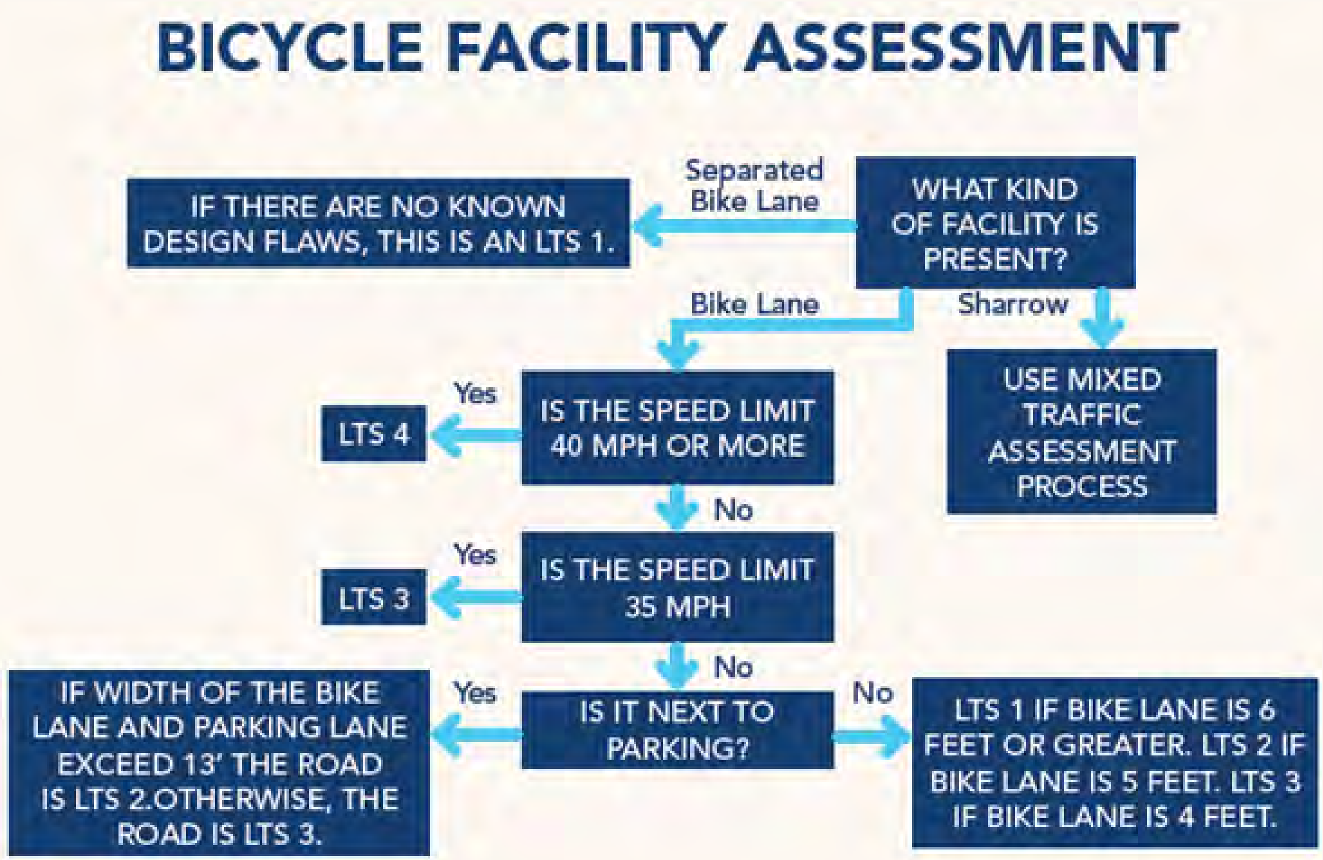
Although bikes may not share the same lane with autos on these segments, high auto speeds along bike lanes contribute to high levels of traffic stress for cyclists. In the absence of observed speed data throughout the City, this characteristic will be quantified using speed limit data from the City's recent 25 mph Ordinance effort.

Bike lanes with adjacent auto speeds of 40 mph or greater automatically receive an LTS 4 score. Bike lanes with adjacent auto speeds of 35 mph receive an LTS 3 score. For streets with speeds of 30 mph and lower, presence of parking and bike lane width will be evaluated to assign an LTS of 1-3.

Presence of On-Street Parking

For streets with a bike lane and speeds of 30 mph or lower, it is necessary to take the presence of a parking lane and its width into account. In these cases, a desk audit was conducted of the parking lane presence and width of parking lane and adjacent bike lanes. Google Earth measurements are adequate in order to streamline this process. If the bike lane is adjacent to parking, and the width of the bike lane plus parking exceeds 13', an LTS 2 will be assigned. If the width does not exceed 13', an LTS 3 will be assigned. For bike lanes that are not adjacent to parking, LTS 1-3 will be assigned depending on the width of the bike lane.

FIGURE 2 **BICYCLE FACILITY LTS METHODOLOGY**



Ground Truth the Results with the Study Advisory Committee (SAC)

Once the above methodologies were applied, a workshop with the SAC was leveraged to “ground- truth” the results with local knowledge from the SAC on the project. Stakeholder reviewed the LTS scores and recorded on maps in the workshop where they felt the scores were not reflective of real-world conditions. In many cases, stakeholders were recommending changing the scores from an LTS 1 to an LTS 2 or an LTS 2 to an LTS 3. This change was typically attributed to either stakeholders indicating where observed or perceived traffic speeds were higher than the posted speed in the methodology or streets where stakeholders indicated peak-hour traffic volumes created a much more stressful condition due to cut-through traffic between Red Road and Douglas Road on local neighborhood streets.

Results

The existing Bicycle LTS scores for the City of Coral Gables is provided in Figure 3 and Figure 4. These results incorporate the LTS score adjustments based on the feedback provided by Stakeholders and City staff. As indicated in the map, many of the arterials and collectors have an LTS score of 3 or 4, presenting barriers in the network and limiting the usefulness of the low stress network for the general population. The peak hour, cut-through traffic along east-west neighborhood streets north of Bird Road creates a stressful condition for people on bikes or who ride bikes in the peak hour that would otherwise be considered low stress throughout the rest of the day. In addition to barriers where streets are a score of LTS 3 or 4, the City of Coral Gables also presents geographic barriers, such as canals, golf courses and the University Miami. These present barriers to a connected grid network throughout the City and create pressure points on arterials, collectors and sometimes local roads that connect through neighborhoods.

Pedestrian Assessment

Pedestrian conditions (or level of traffic stress) were evaluated using three different methods – sidewalk gap analysis, intersection accommodation evaluation, and connectivity analysis. The sidewalk gap analysis and intersection accommodation evaluation have been completed and their methodology and results are described in the following sections.

Sidewalk Gap Analysis

The City’s pedestrian network face several challenges, including a lack of connected, dedicated pedestrian facilities. In order to map these challenges, the sidewalk gap analysis focused on identifying missing sidewalks within a 1/4-mile walkshed of key pedestrian generators and attractors - the areas of highest pedestrian need in Coral Gables.

Methodology

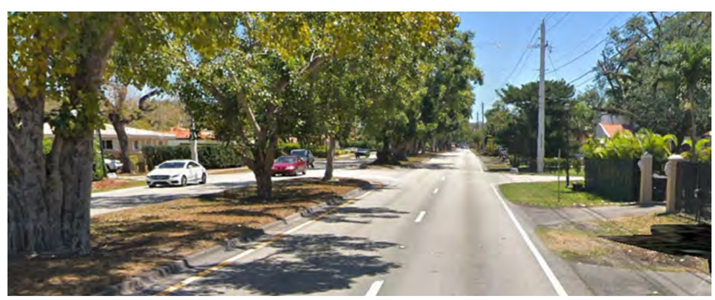
This sidewalk gap analysis methodology was applied using a 1/4-mile buffer surrounding pedestrian generators and attractors as identified by the City (schools, parks, and Metrorail stations). The sidewalk gap data, school and park locations were provided by the City of Coral Gables and a Google desk audit was used for cross checking. Sidewalks missing within a 1/4-mile of the major destinations were then identified and will be prioritized in future phases of the Assessment.

Results

These results showed significant sidewalk gaps within a 1/4-mile of major destinations. Of the 60 miles of roadway network within 1/4-mile of major pedestrian destinations, 3.1 miles (5 percent) of the network is missing sidewalk on one side and approximately 12.1 miles (20 percent) of the network is missing sidewalk on both sides of the street. These gaps exist on predominantly local roads and collector roads without curb and gutter, as shown in Figure 5.

Figure 5 show the results of the sidewalk gap analysis. This analysis mapped (1) sidewalk gap locations (2) major pedestrian destinations including schools, parks, and Metrorail stations; and (3) 1/4-mile walkshed buffer from the major destinations.

FIGURE 4 **SIDEWALK GAPS ON CORDOVA ST BETWEEN SEVILLA AVE AND ALMERIA AVE (TOP) AND ON BIRD RD BETWEEN MONSERRATE ST AND PALMERITO ST (BOTTOM)**



These conditions present unique challenges when planning for implementation, as many residents and business owners may consider their property to extend to the edge of pavement. These sidewalk gaps must be further prioritized based on feasibility and amount of increased connectivity and comfort the added sidewalk would provide. This will be done in later phases of the project.

FIGURE 3 **EXISTING BICYCLE LEVEL OF TRAFFIC STRESS, CITY OF CORAL GABLES**

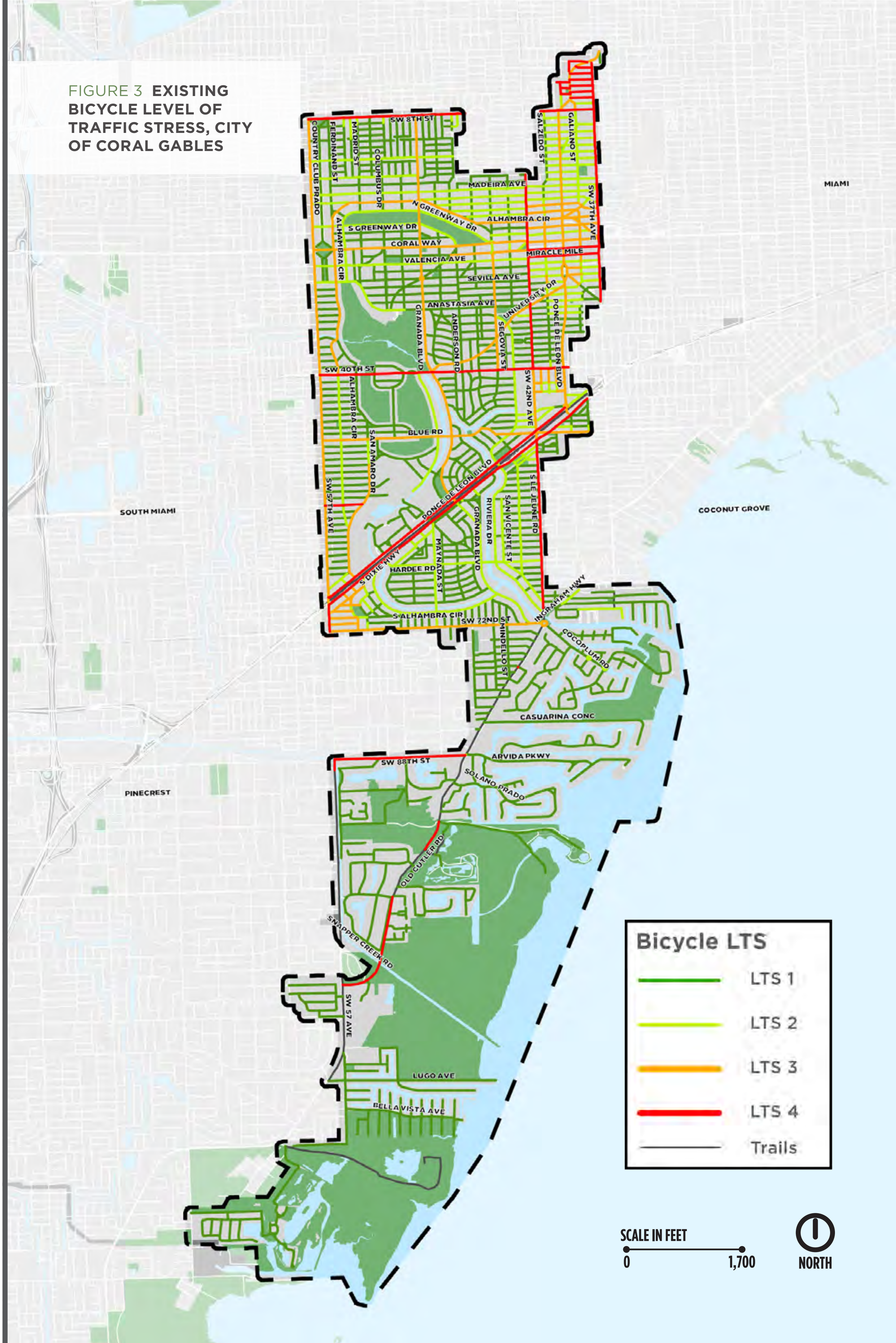
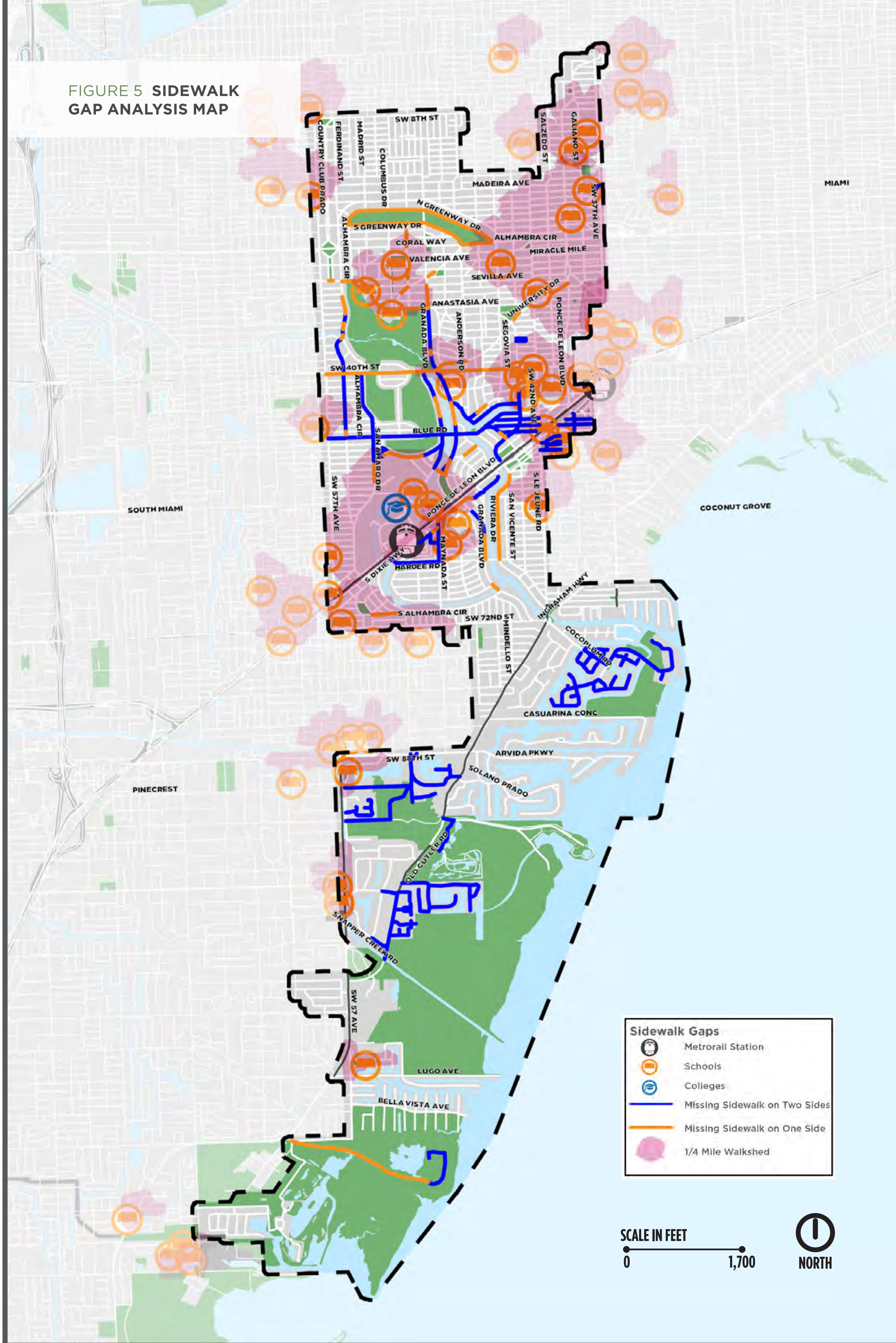


FIGURE 5 **SIDEWALK GAP ANALYSIS MAP**



Pedestrian Intersection Accommodation

Many times, intersections present the most stressful and inconvenient conditions for pedestrians of all age groups and skillsets. Several factors contribute to these pedestrian barriers including the amount of vehicle conflicts, pedestrian delay, lack of a pedestrian refuge, and lack of pedestrian-specific treatments, such as leading pedestrian intervals, no right turn on red restriction and audible push buttons. In order to evaluate and identify the largest of these barriers in the Coral Gables pedestrian network, a methodology was developed to qualitatively assess pedestrian intersection accommodations.

Methodology

Similar to the bicycle LTS methodology, the pedestrian intersection accommodation methodology follows the "Weakest Link" evaluation. In the pedestrian case, the evaluation focuses on mainline pedestrian crossings and includes factors that make an intersection feel safe and comfortable for pedestrians attempting to cross. More specifically, the factors considered were: (1) number of travel lanes, (2) pedestrian crossing distance, (3) existence of crossing conflicts, (4) pedestrian crossing delay, and (5) existence of pedestrian accommodation treatments.

Signalized intersections within a 1/4-mile walkshed of downtown Coral Gables (commercial land use designation used as downtown boundary) and the University of Miami were selected for evaluation. In addition, four mid-block crossings along Miracle Mile were evaluated due to increased pedestrian demand around downtown; the intersection of Bird Road/Granada Boulevard/University Drive was evaluated due to its strategic position along the route between University of Miami and downtown Coral Gables; and the intersection of Red Road/Sunset Drive was evaluated due to observed pedestrian demand near Sunset Place. The full list of signalized intersections and crossings evaluated is shown in Table 2.

TABLE 2 **INTERSECTIONS SELECTED FOR INTERSECTION ACCOMMODATION EVALUATION**

ID	NAME	TYPE
1	Ponce De Leon Blvd & Salamanca Av	Intersection
2	Douglas Rd & SW 17 St	Intersection
3	LeJeune Rd & Minorca Av	Intersection
4	Bird Rd & Granada Blvd & University Dr E	Intersection
5	Alcazar Av & Salzedo St	Intersection
6	Alcazar Av & Ponce De Leon Blvd	Intersection
7	Alhambra Cir & LeJeune Rd	Intersection
8	Alhambra Cir & Salzedo St	Intersection
9	Alhambra Cir & Ponce De Leon Blvd	Intersection
10	Alhambra Plz & Galiano St	Intersection
11	Alhambra Plz & Douglas Rd	Intersection
12	Giralda Av & Salzedo St	Intersection
13	Giralda Av & Ponce De Leon Blvd	Intersection
14	Galiano St & Giralda Av & Merick Way	Intersection
15	Ponce De Leon Blvd & San Amaro Dr	Intersection
16	Aragon Av & LeJeune Rd	Intersection
17	Aragon Av & Salzedo St	Intersection
18	Aragon Av & Ponce De Leon Blvd	Intersection
19	Coral Way & LeJeune Rd	Intersection
20	Coral Way & Salzedo St	Intersection
21	Coral Way & Ponce De Leon Blvd	Intersection
22	Coral Way & Galiano St	Intersection
23	Coral Way & Douglas Rd	Intersection
24	Biltmore Way & Hernando St	Intersection
25	Andalusia Av & LeJeune Rd	Intersection
26	Andalusia Av & Salzedo St	Intersection
27	Andalusia Av & Ponce De Leon Blvd	Intersection
28	Andalusia Av & Galiano St	Intersection
29	Andalusia Av & Douglas Rd & SW 22 Ter	Intersection
30	Red Rd & Sunset Dr	Intersection
31	LeJeune Rd & Valencia Av	Intersection
32	Salzedo St & Valencia Av	Intersection
33	Ponce De Leon Blvd & Valencia Av	Intersection
34	Galiano St & Valencia Av	Intersection
35	Almeria Av & Salzedo St	Intersection
36	Almeria Av & Ponce De Leon Blvd	Intersection
37	LeJeune Rd & Sevilla Av	Intersection
38	Malaga Av & Ponce De Leon Blvd	Intersection
39	Salzedo St & University Dr	Intersection
40	LeJeune Rd & University Dr	Intersection
41	Coral Way & Segovia St & N Greenway Dr	Roundabout

TABLE 3 INTERSECTIONS SELECTED FOR INTERSECTION ACCOMMODATION EVALUATION (CONTINUED)

ID	NAME	TYPE
42	Biltmore Way & Segovia St	**Roundabout**
43	Alhambra Cir S & Ponce De Leon Blvd	**Intersection**
44	Dickinson Dr & Ponce De Leon Blvd	**Intersection**
45	Ponce De Leon Blvd & Stanford Dr	**Intersection**
46	Granada Blvd & Ponce De Leon Blvd	**Intersection**
47	Coral Way/Salzedo St/LeJeune Rd	**Mid-block**
48	Coral Way/Galiano St/Ponce De Leon Blvd	**Mid-block**
49	Coral Way/Ponce De Leon Blvd/ Salzedo St	**Mid-block**
50	Coral Way/Douglas Rd/Galiano St	**Mid-block**

This evaluation resulted in one score for each intersection using the qualitative descriptions of:

/ Great
/ Good
/ Fair
/ Poor
/ Worst

Pedestrian Crossing Distance

Each intersection was checked for the presence of a marked crossing on each approach and if adequate crossing time is provided. The provided crossing time was determined by adding the walk and flash don't walk time provided, according to signal timing plans provided by Miami-Dade County.

Pedestrian crossing distance was measured using Google Earth satellite images. The entire crossing distance was measured at the center of the crosswalk, including any distances across channelized islands. Adequate crossing time was defined in two ways:

/ Time for a person to cross at 3.5 ft/s during the flash don't walk time, and

/ Time for a person to cross at 3.0 ft/s during the walk and flash don't walk time.

The limit of 3.5 feet per second represents a comfortable walking pace and is the value recommended in the Manual for Uniform Traffic Control Devices (MUTCD). The limit of 3 feet per second is to accommodate pedestrians with disabilities requiring more crossing time. The crossing must meet both requirements in order to be considered adequate.

In general, the methodology requires the presence of a crossing with adequate crossing time on all approaches to receive a score of Fair, Good, or Great. An exception is given when the mainline has four lanes or less and there is one crosswalk missing where the land use does not warrant the crossing. For example, if an intersection quadrant is taken up by an interstate pier and there is no destination, it may be appropriate to not mark the crossing. This causes some inconvenience for those crossing diagonally but has minimal effect on overall connectivity.

Existence of Crossing Conflicts

A pedestrian faces many potential vehicle conflict points when crossing at a signalized intersection as shown in Figure 6. Additionally, the SAC members expressed that right/left turning conflicts while pedestrians had the "walk" as a major concern. In this methodology, four turn conflicts were reviewed:

/ A yield controlled or free channelized right turn

/ Multiple (two or more) right-turn lanes with right-turn on red permitted

/ A permitted (or protected-permitted) left turn that has two or more conflicting through lanes, and

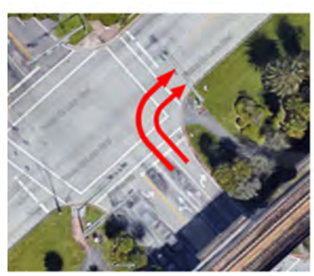
/ A permitted (or protected-permitted) left turn on the mainline without a turn lane.

Pedestrian crossing conflicts were captured using Google Earth. In keeping with Weakest Link approach, the existence of one or more of these crossing conflicts leads to an intersection receiving a score of Poor or Worst.

FIGURE 6 EXAMPLE OF CORAL GABLES CROSSING CONFLICTS

(a) Example of Approach w/ Channelized Right-Turn Lane

(c) Example of Approach with a Permitted Left-Turn and Multiple Conflicting Through Lanes



(b) Example of Approach with Multiple Right-Turn Lanes

(d) Example of Approach with a Permitted Left Turn on the Mainline Without a Turn Lane

Pedestrian Crossing Delay

The way signals are timed can impact the delay pedestrians experience when trying to cross the street. Pedestrian crossing delay was calculated using Highway Capacity Manual (HCM) 2010 equation 18-71:

$$delay=(C-g\_walk)^2/2C$$

where C is cycle length, g_walk is walk time plus 4 seconds, and delay is calculated in seconds. Various thresholds for pedestrian crossing delay were used based on number of lanes, type of crossing (signalized intersection or mid-block crossing), and user expectation when approaching the crossing.

Existence of Pedestrian Accommodation Treatments

The following extra accommodation features for pedestrians were considered in the evaluation:

1

All pedestrian phase (pedestrian scramble) with concurrent pedestrian phases – An all pedestrian phase adds a phase during a traffic signal cycle where all vehicle traffic is given a red light and all pedestrian movements are given a walk sign. Diagonal movements across the intersection may or may not be permitted during this phase. An all pedestrian phase included in addition to concurrent pedestrian/vehicle phases is an ideal condition to minimize delay and vehicle conflicts.

2

Pedestrian phase on recall on one or more legs – When the pedestrian phase is on recall, the walk sign to cross comes up during every cycle, without a pedestrian needing to push the pedestrian button every cycle. A pedestrian phase on recall allows shorter pedestrian delays, particularly if someone arrives during the walk interval.

3

Leading pedestrian interval on one or more legs – A leading pedestrian interval allows pedestrians to enter the intersection seconds before vehicles. This increases pedestrian safety by reducing conflicts with left and right-turning vehicles. LPI's are used in cities and downtown areas across the country and have become important tools to improve the comfort and safety of pedestrians crossing an intersection.

4

No right-turn on red on one or more legs – In Florida, right-turn on red is permitted unless otherwise signed. Vehicles turning on red conflicts with both the opposing through vehicles and the opposing pedestrian movement. Pedestrians traveling in the opposite direction of traffic will typically be out of the sight line of a driver looking for a gap to make a turn on red. Restricting right-turn on red eliminates this conflict.

5

Median refuge island on the mainline – A median refuge island is an area of at least six feet providing a place for pedestrians to stand and wait for traffic if unable to complete a crossing in one cycle.

The pedestrian treatments 1 through 3 were collected from signal timing plans and treatments 4 and 5 were captured from Google earth.

The evaluation methodology shown in Figure 7, 8, and 9 was used to assess the intersection accommodation level for 50 signalized intersections and mid-block crossings.

FIGURE 7 **PEDESTRIAN SIGNALIZED INTERSECTION ACCOMMODATION – FOUR OR LESS LANES ON THE MAINLINE**

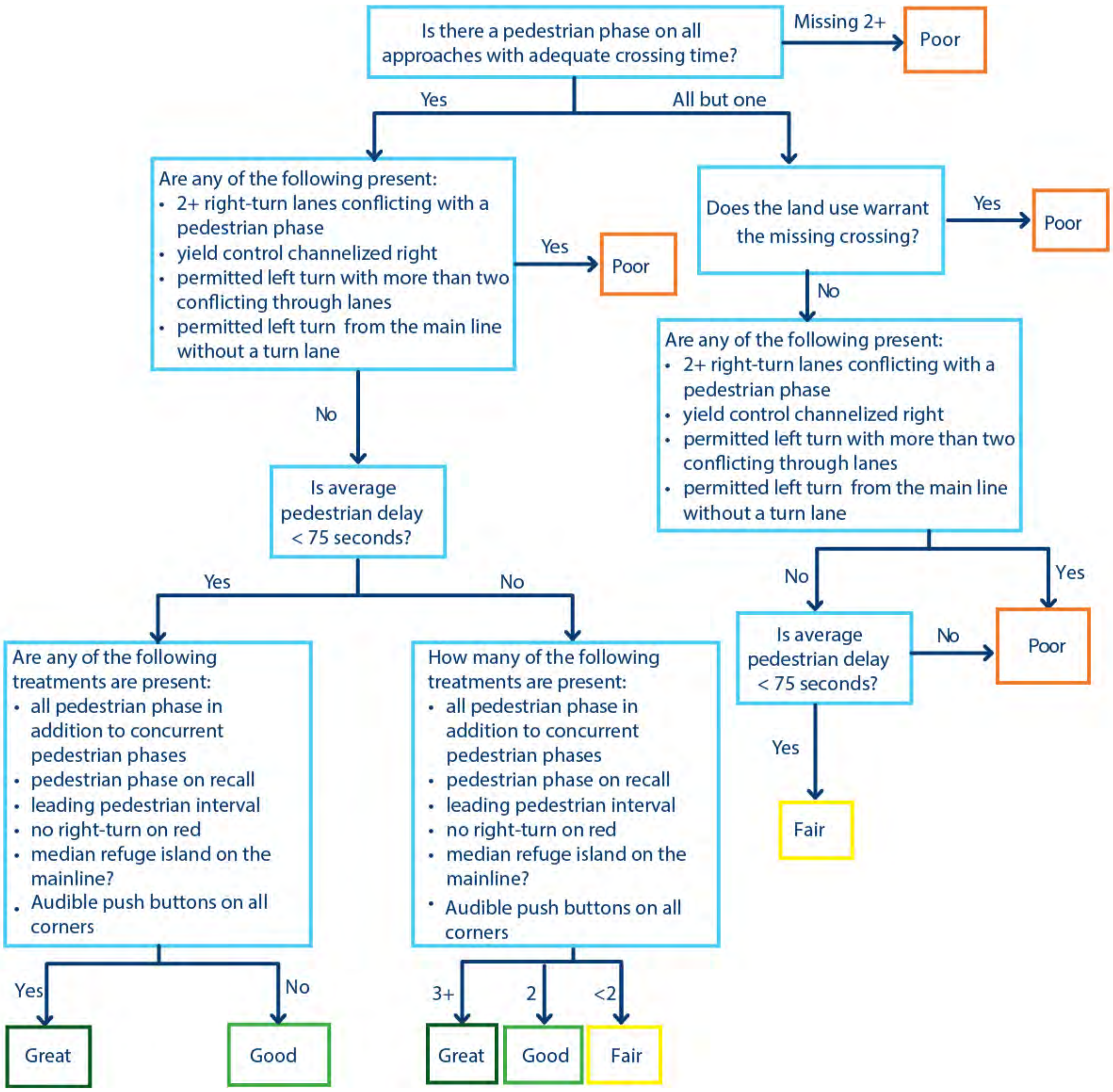


FIGURE 8 **PEDESTRIAN SIGNALIZED INTERSECTION ACCOMMODATION – FIVE TO SEVEN LANES ON THE MAINLINE**

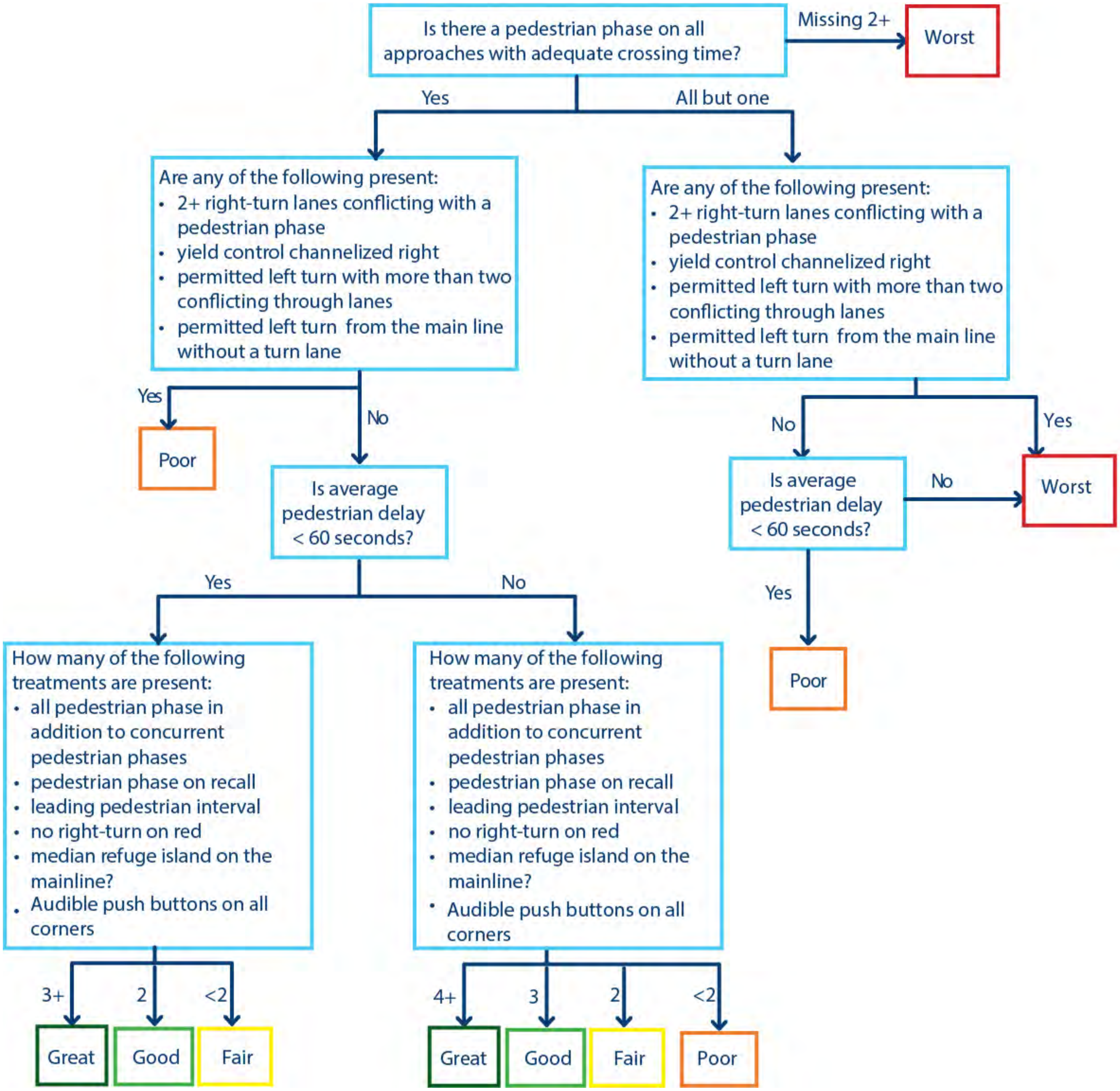
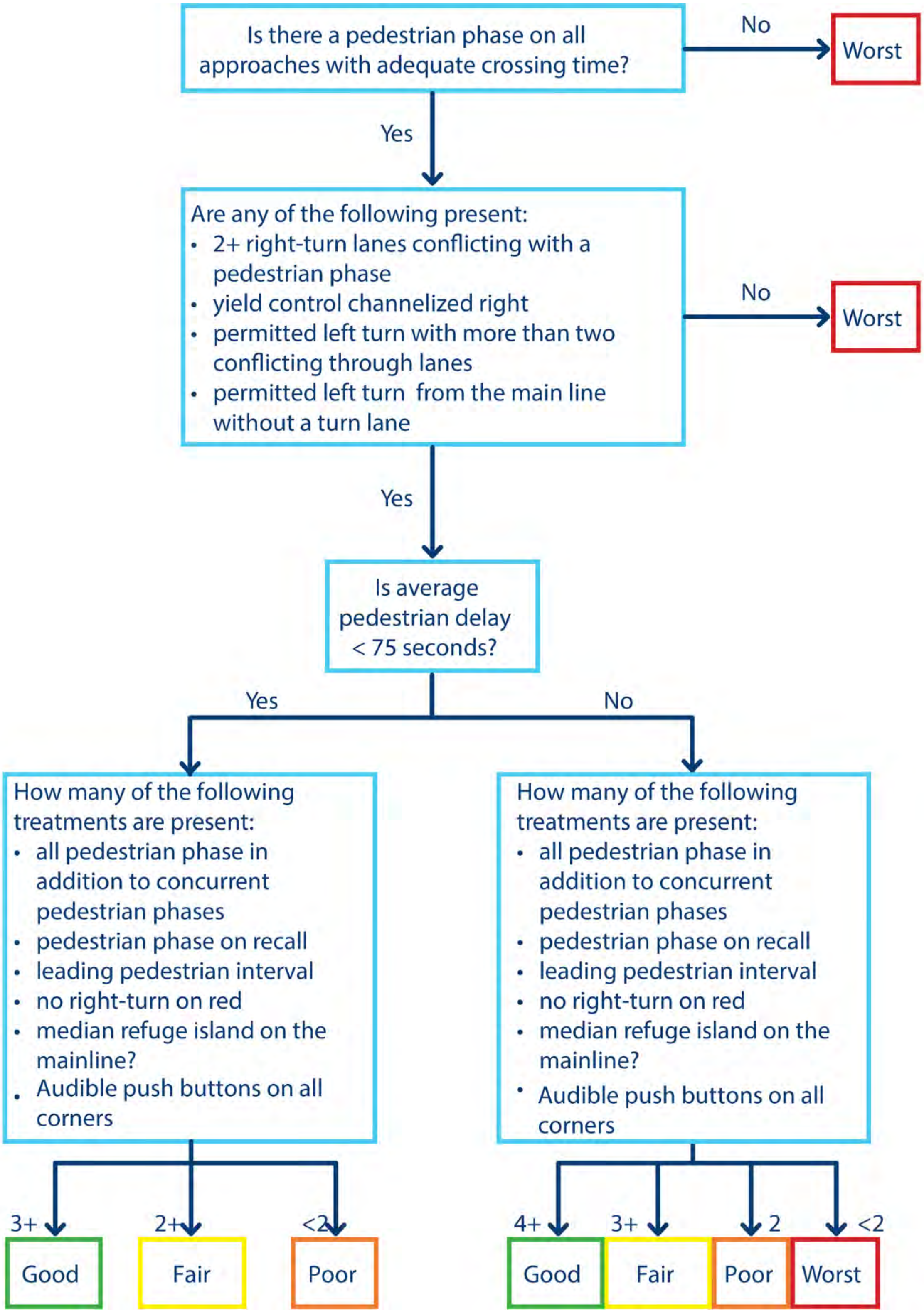


FIGURE 9 **PEDESTRIAN SIGNALIZED INTERSECTION ACCOMMODATION – EIGHT OR MORE LANES ON THE MAINLINE**



Five-Legged Intersections

Due to limitations in the methodology, five-legged intersections were considered on a case-by-case basis. Usually, five-legged intersections have relatively long walking distance and thus inadequate crossing time and uncomfortable experience for pedestrian. When evaluating five-legged intersections, the data was collected based on the four main legs. If these intersections did not score as a "Worst" when evaluating based on only four legs, adjustments to the crossing distances and number of lanes were made to accurately reflect pedestrian experience at these intersections.

Roundabouts

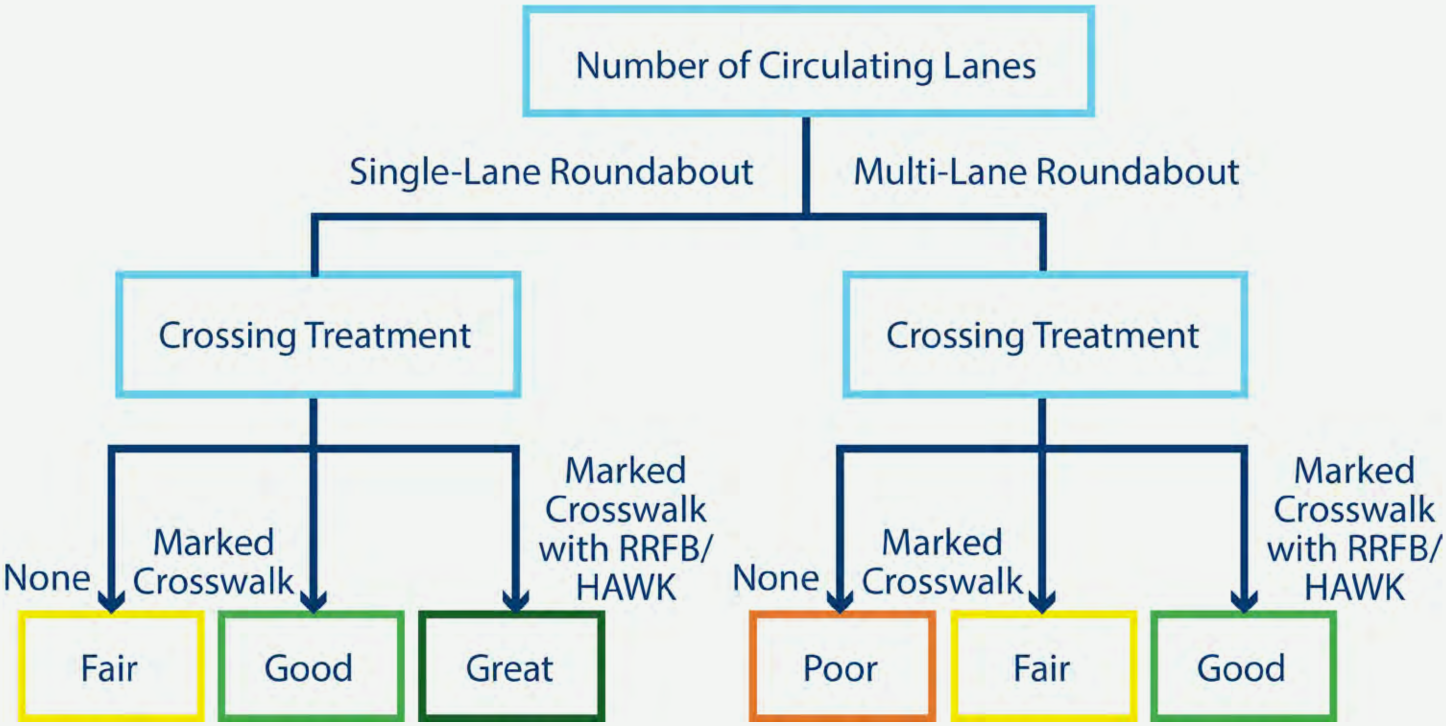
Several roundabouts were analyzed during the intersection accommodation evaluation. A separate weakest link methodology was developed to evaluate how roundabouts are accommodating pedestrians. The methodology incorporated two simple elements:

/ Number of circulating lanes; and

/ Type of crossing treatment.

The methodology for the pedestrian accommodation at a roundabout is summarized in Figure 10.

FIGURE 10 **PEDESTRIAN ACCOMMODATION FOR A ROUNDABOUT**



Mid-block Crossings

Due to pedestrian demand around downtown/Miracle Mile and corridors with longer block lengths, there are several mid-block crossings throughout Coral Gables. A separate weakest link methodology was developed to evaluate how the mid-block crossings are accommodating pedestrians. The methodology incorporated the following elements:

/ Whether the crossing is signalized or not,

/ Number of lanes of traffic to cross,

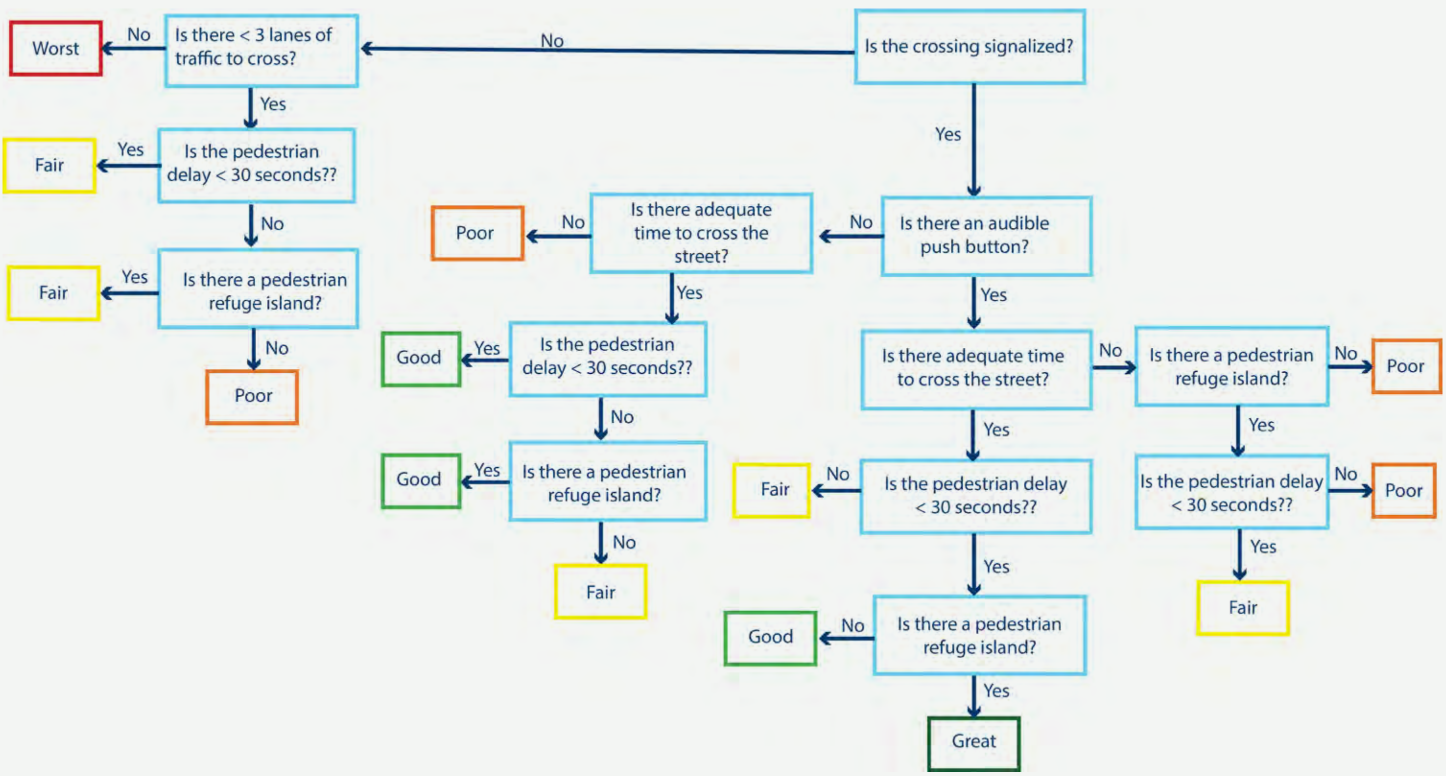
/ Pedestrian crossing delay,

/ Presence of a pedestrian refuge island; and,

/ Presence of an audible push button.

The methodology for the pedestrian accommodation at a midblock crossing is summarized in Figure 11.

FIGURE 11 **PEDESTRIAN ACCOMMODATION FOR A MIDBLOCK CROSSING**



Results

The results of the pedestrian intersection accommodation evaluation are shown in Figure 12 and Figure 13. Almost all (88 percent) of the evaluated intersections received a “Worst” or “Poor” score. In general, many of these intersections did not include adequate crossing time - where pedestrian crossing distances are long, flash ‘don’t walk’ intervals are short, or a combination of the two. In addition, many of these intersections showed a high number of vehicles crossing conflicts and a general lack of pedestrian-specific treatments such as leading pedestrian intervals.

For example, consider the intersection of Ponce de Leon Blvd and Aragon Ave. While it does include pedestrian phase recall on each approach, it includes a permitted left-turn with 2 lanes of conflicting through traffic, high pedestrian delay (average of 84.3 seconds), and does not include adequate flash don’t walk time for a pedestrian at a comfortable walking pace or pedestrians with disabilities. In fact, 41 of the 44 signalized intersections (93 percent) did not include adequate flash ‘don’t walk’ time. This indicates that Miami-Dade County designs its signal timing plans so that both the walk and the flash ‘don’t walk’ intervals combined meet the clearance interval required. This is not uncommon; however, it does not represent the pedestrian best practice of including adequate time to cross during flash ‘don’t walk’ with a comfortable walking pace or pedestrians with disabilities.

While generally there is a higher pedestrian quality of service due to the pedestrian only phases and good lighting conditions, the mid-block crossings along Miracle Mile received “Fair” scores. This is mainly due to the high average pedestrian crossing delay (84.3 seconds) and the lack of audible pedestrian push buttons. These high delays are problematic as they typically encourage frustrated pedestrians to cross unprotected after long wait times.

The roundabouts in the evaluation (Coral Way/Segovia Street/N Greenway Drive; Biltmore Way & Segovia Street) are the only intersections that received a score greater than “Poor”. These scores are solely based on the number of lanes and marked crosswalks at each approach. For single lane roundabouts (such as the Coral Way/Segovia Street/N Greenway Drive roundabout), pedestrians need only cross one lane of traffic at a time. Traffic is generally traveling slower here and can more easily spot a pedestrian attempting to cross in the crosswalk. At a multi-lane roundabout (such as the Biltmore Way & Segovia Street roundabout), traffic is generally slower, but at some approaches, pedestrians must cross 2 lanes of traffic at a time.

Overall, modifying signal timing in Coral Gables’ downtown area is an effective, low cost way to improve pedestrian safety and comfort. The City should work with Miami-Dade County in developing a formal signal timing study to address the safety issues described in this plan.

Pedestrian Connectivity Assessment

A pedestrian connectivity analysis was completed to evaluate linear barriers in the pedestrian network. This analysis evaluated the ability for pedestrians to cross major roads in the network (pedestrian permeability). The analysis included evaluating the crossing frequency, opportunities to add additional crossings, and opportunities to upgrade existing crossings along the following collector corridors, as identified in discussion with City staff:

/ Bird Road (Ponce de Leon to SW 57th Avenue)

/ Coral Way (Douglas Road to SW 57th Avenue)

/ Anderson Road (Jeronimo Drive to Coral Way)

In addition to corridor assessments, a focused assessment within the areas evaluated for sidewalk gaps was also be completed. This included identifying new crossings and upgrades to existing crossings within a 1/4-mile of the following areas:

/ Schools

/ Parks

/ Major transit stops

/ Future transit hubs (from the SMART Plan)

The recommendations identified in this assessment were reviewed and refined with stakeholders during the second Study Advisory Committee (SAC) Meeting. The final recommendations are outlined in Chapter 4.

Pedestrian Connectivity Analysis

This analysis evaluated the ability for pedestrians to cross major roads in the network (pedestrian permeability). The analysis examined crossing frequencies, opportunities to add additional crossings, and opportunities to upgrade existing crossings along Bird Road, Coral Way, and Anderson Road. Through discussions with the City, the study corridors grew to include Ponce de Leon Boulevard and Granada Boulevard.

In addition, access and connectivity to schools, parks, major transit stops, and University of Miami were evaluated for sidewalk and crosswalk gaps. Walksheds were built around schools and major transit stops to better understand potential gaps in the pedestrian network for these destinations.

The recommendations identified in this assessment were reviewed and refined with stakeholders during the second SAC Meeting. The final recommendations are outlined in Chapter 4.

FIGURE 12 **PEDESTRIAN INTERSECTION ACCOMMODATION RESULTS (NORTH)**

FIGURE 13 **PEDESTRIAN INTERSECTION ACCOMMODATION RESULTS (SOUTH)**

STAKEHOLDER ENGAGEMENT

STAKEHOLDER ENGAGEMENT

Stakeholder feedback is necessary to obtain a true picture of real-world conditions in the pedestrian and bicycle network. A Study Advisory Committee (SAC) was assembled to serve as a guide to the Study and provide real-world feedback at strategic input points. The SAC is composed of the following City of Coral Gables staff, agency partners, and advocacy organizations:

/ Business Improvement District (BID) of Coral Gables

/ Bike-Walk Coral Gables

/ University of Miami Walk Safe/Bike Safe

/ Miami-Dade County

/ FDOT District 6

/ Miami-Dade Transportation Planning Organization (TPO)

/ City of Coral Gables Development Services

/ City of Coral Gables City Manager's Office

/ City of Coral Gables Public Works

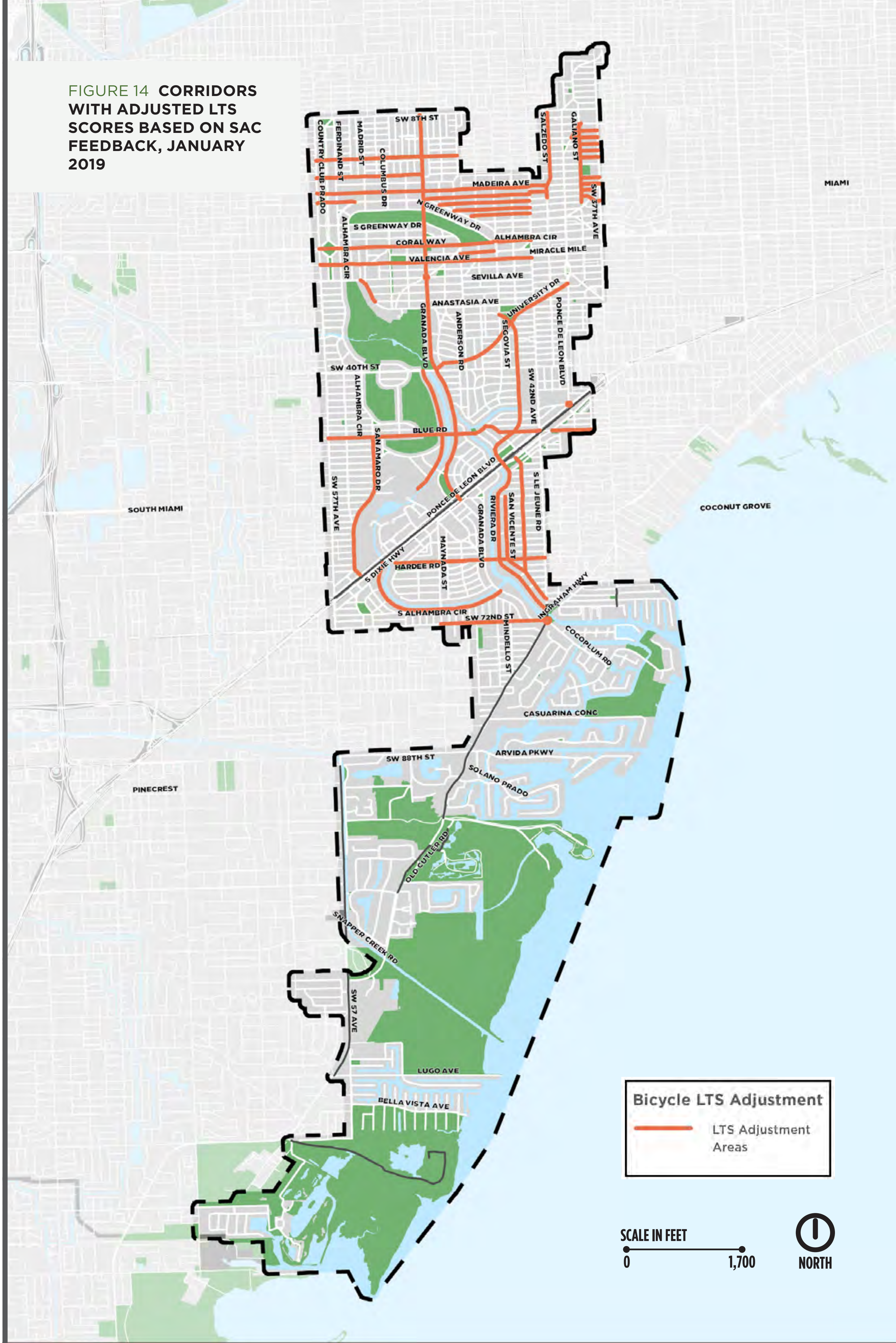
/ City of Coral Gables Historical Resources and Cultural Arts

/ City of Coral Gables Parks and Recreation

The first SAC meeting was held on January 14th, 2019 to kick off the project, review the scope of work and project schedule, and truth-vet the analyses to date. The SAC completed a detailed review of the Bicycle LTS results and refined the LTS scores based on local knowledge of the area. Several east-west corridors in northern Coral Gables were originally scored as LTS 1 due to the low ADT and posted speed limit. However, many people described these corridors as comfortable in the off—peak but that the streets experienced heavy traffic volumes in the peak hours as they served as cut-through routes for traffic trying to access US 1. Several other streets were also perceived to be more stressful than the LTS score indicated. The LTS score for all of the corridors identified in the group was increased by 1 (so a score of LTS 1 was revised to LTS 2, LTS 2 to 3 and so on). A map of the corridors adjusted based on the SAC's feedback is provided in Figure 14.

The second SAC was held on March 21st to review the proposed recommendations and provide input on prioritization. The SAC completed a "String Exercise" for the proposed bicycle recommendations. This allowed SAC members to test the connectivity of the recommendations and whether the network would serve likely trips. It also provided an opportunity for the SAC to identify specific challenges the implementation of the proposed facilities may encounter. The SAC also walked through each of the crossing recommendation and provided input on the location and proposed crossing treatment. The recommendations were refined based on the SAC input.

FIGURE 14 **CORRIDORS WITH ADJUSTED LTS SCORES BASED ON SAC FEEDBACK, JANUARY 2019**



RECOMMENDATIONS

RECOMMENDATIONS

Bicycle Facility Recommendations

The 2014 Plan outlines preliminary facility recommendations on each of the corridors. In order to evaluate whether these recommendations would create a low stress facility the following metrics were collected and reviewed:

/ **Identified bike corridors in Bicycle Master Plan:** 23 routes were evaluated and identified as suitable for a bicycle facility. In the assessment, only identified bike corridors in the 2014 Bicycle Master Plan were reviewed. Other bicycle corridor information would be obtained from stakeholder experience.

/ **LTS score:** Each roadway segment is assigned with its LTS score, ranging from 1 to 4. The LTS score were used in the bicycle recommendation assessment process.

/ **Street road right-of-way:**[1] By evaluating the right-of-way, the recommendation implementation feasibility and needs would be identified.

The facility recommendations development focused on refining the recommendations in the 2014 Bicycle Master Plan based on the LTS score to identify whether the proposed recommendation would create a low stress, all-age bicycle facility. The basic required facilities designed for general population are listed below:

/ **LTS 1:** shared use arrows (sharrows)/wayfinding recommended but not required

/ **LTS 2:** minimum 5 feet bike lane or bike boulevard with traffic calming

/ **LTS 3:** separated bike lane, buffered bike lane, or bike boulevard with substantial traffic calming

/ **LTS 4:** physically separated bike lane, shared use path

Each corridor recommendation was also evaluated against the available right-of-way to determine the feasibility of implementation. The evaluation used minimum design width provided in the NACTO Urban Bikeway Design Guide to assess the feasibility. Bike boulevards recommendations are predicated on implementing traffic calming projects through the City's traffic calming program criteria (https://www.coralgables.com/traffic-calming).

For example, if a bike lane is suggested on an LTS 2 street, the recommendation is appropriate. The total right-of-way is 20 feet, with two-lane through traffic. Thus, there is not enough right-of-way for 5 feet bike lane on both sides of the road. A bike boulevard with traffic calming would be suggested instead.

The final recommendations are shown in Figure 16. In total, five different bike facilities are included, i.e. bike lane, bicycle boulevard, shared use path, buffered bike lane, separated bike lane and physically separated bike lane. A general description of each bikeway type, including typical application, relevant dimensional details, land use context can be found in Chapter 6.

1 *A right-of-way (ROW) is a right to make a way over a piece of land, usually to and from another piece of land. A right of way is a type of easement granted or reserved over the land for transportation purposes, such as a highway, public footpath, rail transport, canal, as well as electrical transmission lines, oil and gas pipelines. [1]*

[1] Henry Campbell Black: Right-of-way. In: A law dictionary containing definitions of the terms and phrases of American and English jurisprudence, ancient and modern: and including the principal terms of international, constitutional, ecclesiastical, and commercial law, and medical jurisprudence, with a collection of legal maxims ... (West Publishing Co., 1910), pg. 1040.

FIGURE 15 **EXAMPLES OF DEDICATED BICYCLE FACILITIES**

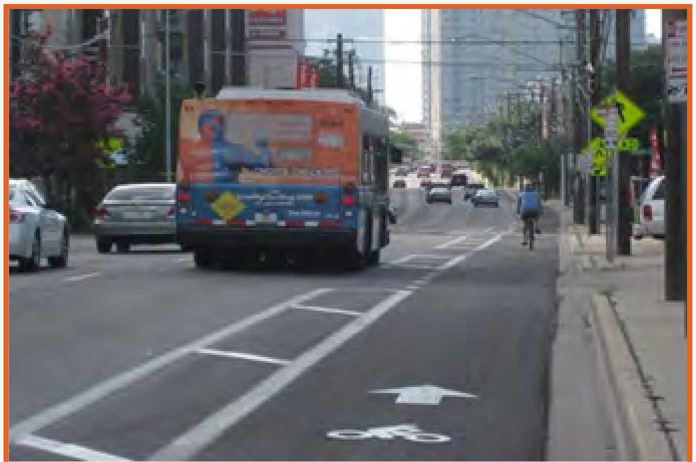
Separated Facilities

Physically separated bike lane

Shared Use Path/Multi-Use Trail

On-street, Unprotected Facilities

Conventional Bike Lane



Buffered Bike Lane

FIGURE 16 **2019 BICYCLE FACILITY RECOMMENDATIONS**

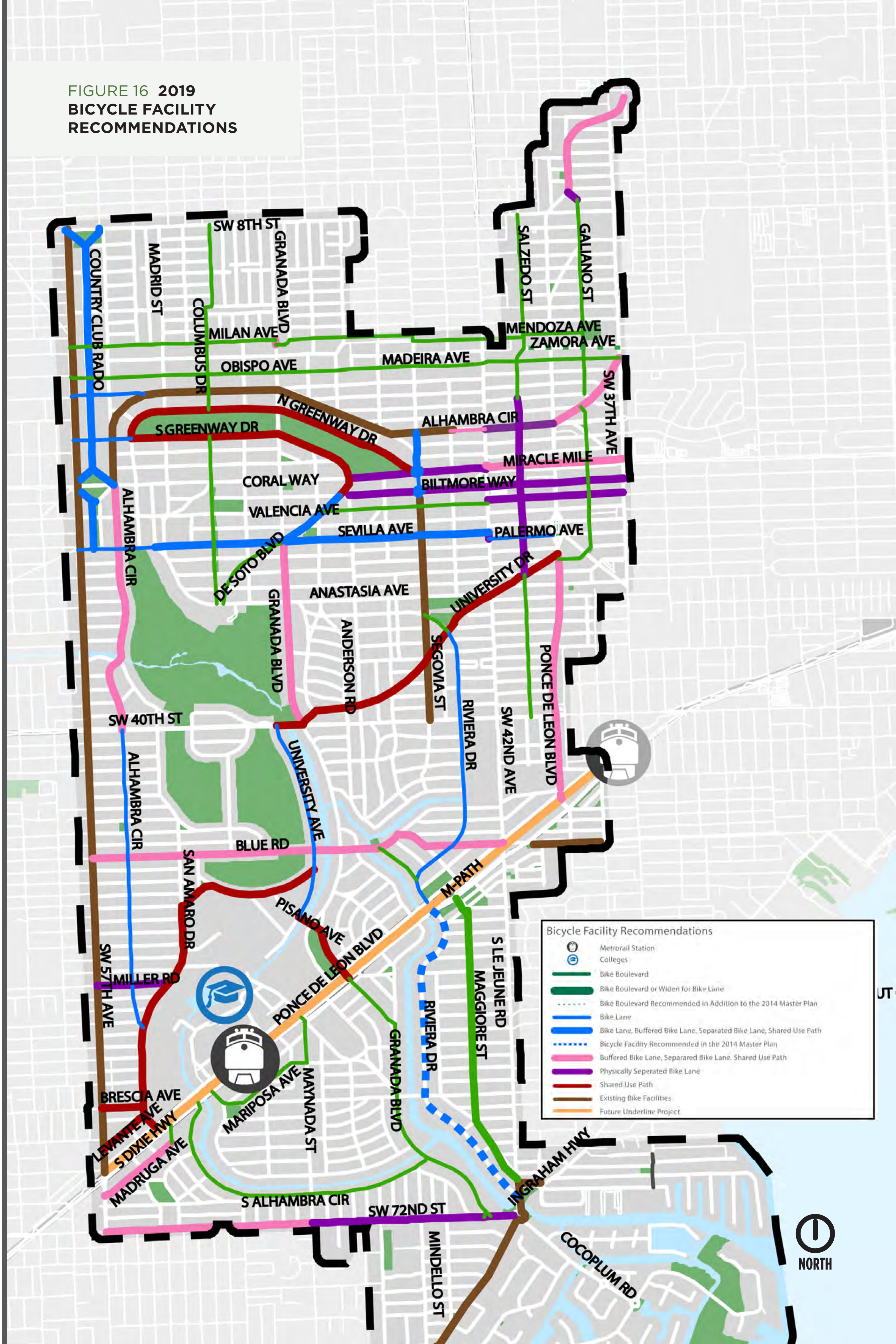


FIGURE 16 (CONTINUED)
2019 BICYCLE FACILITY RECOMMENDATIONS

Key Projects

University Drive

University Drive is one of the most important connections between downtown Coral Gables and the University of Miami. The heavy through traffic along University Drive makes it LTS 3 between Ponce de Leon Boulevard and Bird Road, and LTS 2 between Bird Road and Pisano Avenue. In the Bicycle Master Plan, bike lanes are recommended along University Drive. However, for an LTS 3 road, bike lanes are not suitable for the Interested but Concerned group of bicyclists. Instead, a shared use path is recommended. The right-of-way between Ponce de Leon Boulevard and Bird Road is about 90 feet, while 60 feet between Bird Road and Pisano Avenue. For a two-lane road with a shared use path, the total width shall be no less than 38 feet. For a three-lane with a shared use path, the total width shall be no less than 50 feet. Thus, with enough right-of-way, a shared use path is recommended along University Drive between Ponce de Leon and Bird Road.

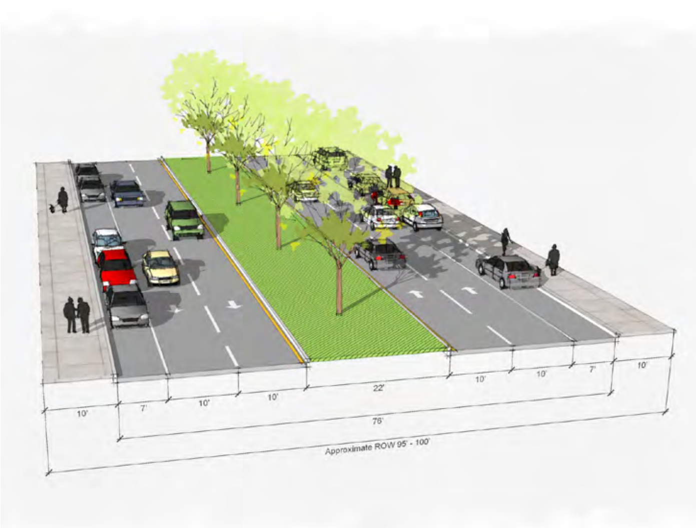
The shared use path facility would connect downtown Coral Gables with the University of Miami, which leads to much less detour compared to the current situation.

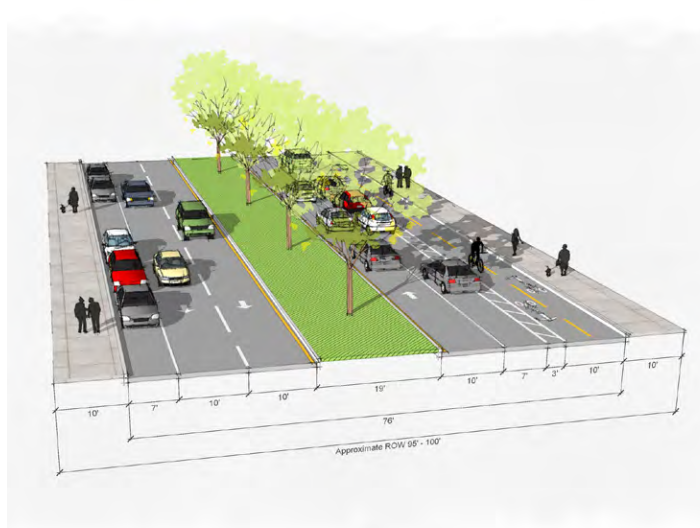
FIGURE 17 **CURRENT AND FUTURE CONDITIONS (UNIVERSITY DRIVE)**

Ponce De Leon Boulevard

Ponce de Leon Boulevard is a main arterial that runs north-south and connects many of Coral Gables residential neighborhoods and businesses to the downtown area. The speed and friction the turnover of parking creates results in an LTS score of 3. Separated bike lanes would create an all-age, comfortable connection through the busiest part of the corridor.

FIGURE 18 **CURRENT AND FUTURE CONDITIONS (PONCE DE LEON BOULEVARD)**

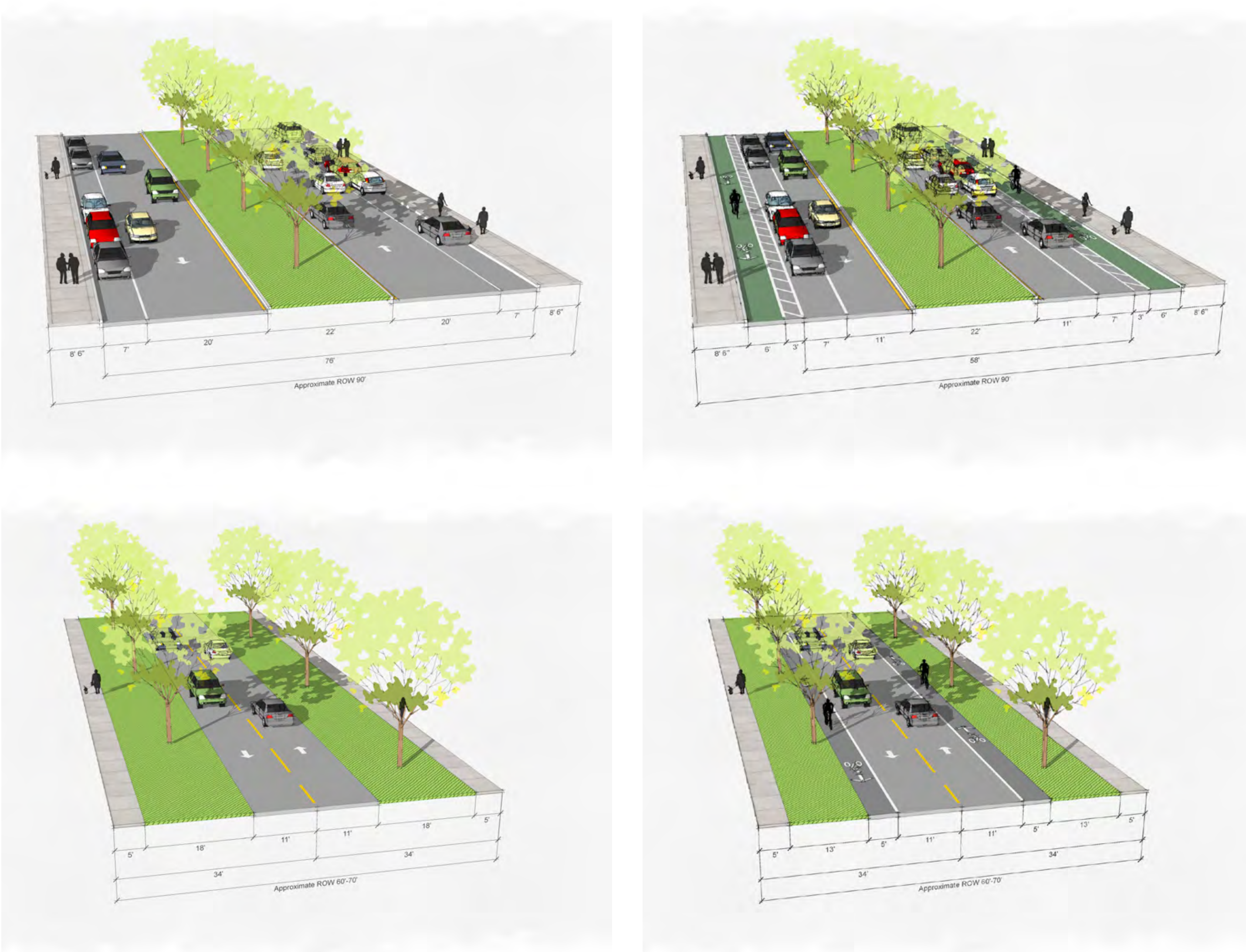




Alhambra Circle

The context along Alhambra Circle changes drastically. South of Bird road, the street is low speed, but has narrow traffic lanes, creating the potential for consistent conflict with vehicles in teh same lane. This section is only an LTS 2, and the edge of the road could be widened slightly to install a bike lane. North of Bird Road, the higher traffic volumes and turnover of parking creates an LTS 3 environment. However, the overly-wide single travel can be narrowed to maintain parking, a single travel lane in each direction and install a one-way separated bike lane in each direction.

FIGURE 19 **CURRENT AND FUTURE CONDITIONS (ALHAMBRA CIRCLE)**



University Drive/Granada Boulevard/Bird Road Intersection

While the recommendations focused on the bicycle facility along a roadway, there are several intersections within the City that are particularly complex and create a barrier to the low stress network. The intersection of University Drive/Granada Boulevard/Bird Road is a 5-legged intersection where multiple proposed facilities are expected to intersect. The intersection design will be key to maximizing the effectiveness of the adjacent facilities. It is recommended that the City, Miami-Dade County and Florida Department of Transportation coordinate to re-design the intersection to comfortably accommodate pedestrians and bicyclist. This should be completed as a high priority prior to the implementation of the shared use path on University Drive.

Pedestrian Recommendations

Sidewalk Gap Recommendations

The sidewalk gap analysis identified where sidewalks are missing on one or both sides of the road within a 1/4-mile walkshed of key pedestrian generators and attractors - the areas of highest pedestrian need in Coral Gables.

For many of the local roads, a 6 foot to 8-foot sidewalk is recommended. For collectors and arterials, however, additional buffer and sidewalk width improves pedestrian comfort along the street. Figure 17 provides examples of what these facilities may look like. Each facility should be assessed on a project-by-project basis for feasibility given the street right-of-way constraints. A minimum 5-foot sidewalk should be accommodated, but where possible additional sidewalk width and amenities should be considered.

Pedestrian Intersection & Connectivity Recommendations

An examination of Coral Way, Bird Road, and Anderson Road found several trends. First, each roadway had several intersections where pedestrian infrastructure was inadequate or missing, which would make it challenging for a pedestrian to safely cross the street. Second, each roadway had stretches of greater than 1,200 feet between marked crosswalks to access the other side of the street. Third, sidewalks and crosswalks were often missing around bus stops and other local destinations.

Key Intersection Opportunities

Anderson Road/Coral Way Intersection

This intersection, which includes two of the three study streets, has no crosswalks, no sidewalk on the northeast corner of the intersection, and channelized right turns for every intersection approach. As a result, pedestrians must cross at three different points to cross one side of the intersection, and two of those three approaches will be across cars making a higher-speed channelized right-turn.

FIGURE 20 **ANDERSON ROAD/CORAL WAY INTERSECTION IN CORAL GABLES**

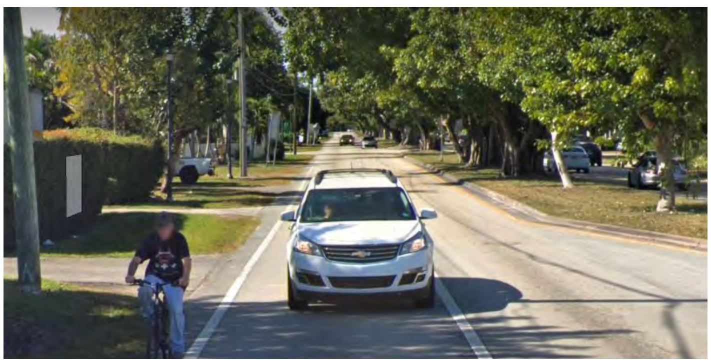
Adding crosswalks across all legs of the intersection and constructing a sidewalk along the northern side of Coral Way to the east of the intersection, will provide more visibility to pedestrians. A longer-term solution to remove the channelized right turns, or to add stop bars at each right turn lane, would limit pedestrian exposure and improve safety and accessibility.

Bird Road between Red Road and Riviera Drive

Currently, there are no marked crosswalks across Bird Road between Red Road and Riviera Drive, a distance of 1.4 miles. There are no sidewalks along the south side of Bird Road at any point along this 1.4 mile stretch of roadway. Bird Road is a four-lane state highway with a landscape median with a 40 MPH speed limit.

A lack of sidewalk and crosswalk infrastructure presents several challenges. Coral Gables High School, located by the Riviera Drive/Bird Road intersection, provides an opportunity for students to cross Bird Road at that intersection. If a student doesn't cross there, they have no marked crosswalk for 1.4 miles. Miami-Dade Transit bus 40 runs along Bird Road, so passengers who travel both ways on the bus will need to cross Bird Road by foot at least once. Additionally, the roadway crosses a canal and does not provide pedestrians with a crosswalk to reach the pedestrian bridge on the road's north side.

FIGURE 21 **PEDESTRIANS ON THE SOUTH SIDE OF BIRD ROAD HAVE NO SIDEWALK OR SHOULDER – AND NO MARKED CROSSWALK TO REACH THE PEDESTRIAN BRIDGE ON THE OTHER SIDE OF THE STREET**

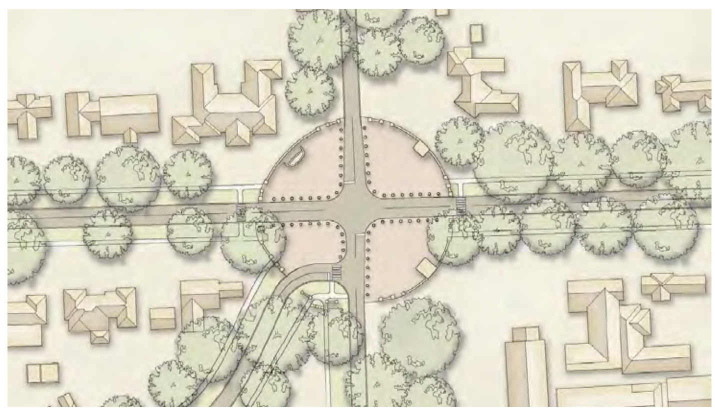


The recommended improvements include adding five marked crosswalks across Bird Road, including crossings at existing signalized intersections and spaced along the corridor to reduce the distance between crossings to approximately 1,500 feet.

Columbus Boulevard/Coral Way Intersection

The Columbus Boulevard/Coral Way intersection does not provide crosswalks across the arterial Coral Way, yet there are bus stops at each side of the intersection that pedestrians on the opposite side of the street cannot access. The east-west crosswalks that do exist are 160 feet long with exposure from channelized right turns.

FIGURE 22 **THE COLUMBUS BOULEVARD/CORAL WAY INTERSECTION LIMITS PEDESTRIAN ACCESS TO TRANSIT**



Solutions include signalizing the intersection to allow for pedestrian signals and adding north-south crosswalks, as well as removing the channelized right turn lanes.

Additional Analysis

The City of Coral Gables requested that the pedestrian connectivity analysis include new street segments (such as portions of Ponce de Leon Boulevard and Granada Boulevard). This expanded analysis uncovered similar themes: missing sidewalk and crosswalks, long stretches without a crosswalk across an arterial roadway, and limited access to transit.

Destinations and Walksheds

Finally, the analysis scope included a focused pedestrian connectivity assessment within walksheds for schools, parks, major transit stops, and future transit hubs. While a majority of schools in Coral Gables had immediate crosswalk access, many parks (especially small, neighborhood parks without a parking lot) had no crosswalks that allowed access on foot. Other regional destinations, including the University of Miami campus and the two closest Metrorail stations (one of which is just across the city boundary in Miami), have adequate pedestrian accessibility.

Recommendations

Several types of recommendations emerged from the pedestrian connectivity analysis:

Install Missing Crosswalks

At numerous locations across Coral Gables, adding a crosswalk is recommended for improvement pedestrian access. The reasons include access to local destinations, connecting housing to businesses, adding crosswalks at existing signalized intersections, and providing a marked crosswalk at a school. In general, these are located on lower volume, lower speed, two-lane streets where a crosswalk provides enough visibility and protection for pedestrians.

Construct a Roundabout

Roundabouts allow traffic to flow continuously while providing relatively high comfort levels for pedestrians trying to navigate across an intersection. Pedestrians only cross one lane of traffic at a time, and vehicles approaching or inside a roundabout are traveling at slow speeds. These conditions are conducive to safe pedestrian movement. Roundabouts also need a considerably more space than a typical four-way intersection, so their use is more appropriate at intersections with a large existing footprint.

Intersections that are conducive to roundabouts include Granada Boulevard at North Greenway Drive and South Greenway Drive, and Blue Road at University Drive and Granada Boulevard.

FIGURE 23 **EXISTING ROUNDABOUT AT SEGOVIA STREET AND CORAL WAY PROVIDES A COMFORTABLE PLACE FOR PEDESTRIANS TO WALK**

Change Roadway Design

Roadways can be designed to encourage motorists to slow down and allow safer pedestrian movement. At the Anderson Road/Biltmore Way intersection, for example, Biltmore Way is a two-lane road west of the intersection that turns into a four-lane road with head-in parking on the east side of the intersection. Narrowing the roadway here will reduce the pedestrian crossing distance and should encourage slower vehicle speeds. In other places, constructing a median refuge island provides pedestrians with a safe place to wait for traffic while increasing their visibility to drivers.

Add Pedestrian Signals

Some locations need full signalization for motorists to allow safe pedestrian crossing conditions. These are typically located on the busiest streets in a city or at midblock locations where a motorist would not typically expect to see a pedestrian. At other locations, a signalized intersection already exists but a crosswalk or a pedestrian signal does not. At another location, adding a pedestrian-only signal phase allows safe pedestrian movement away from turning vehicles. The locations under this recommendation include Coral Way, Bird Road, Le Jeune Road, Douglas Road, and South Dixie Highway.

In some cases, there are crossings that do not meet warrants for a full signal, but a crosswalk only is not sufficient to support the pedestrian activity and traffic conditions. In these cases a HAWK signal or Rectangular Rapid Flashing Beacon (RRFB) may be used. The HAWK signals are generally preferred based on the City's past experience with safety and maintenance challenges with the RRFBs.

Improve Existing Signals

Members of the SAC also wanted improved pedestrian operations at locations with signals and crosswalks. These improvements should include:

/ Adding Pedestrian countdown signals with push buttons.

/ Pedestrian call buttons that provide an audible cue to cross a street.

/ Retiming traffic signals to avoid long pedestrian crossing delays.

/ Adding bump outs or other geometric design elements to slow traffic speeds at the intersection.

/ Eliminate right and left vehicle turn conflicts during walk phases.

/ In dense downtown areas and neighborhoods, phase out the push buttons to accommodate a pedestrian phase every cycle

A summary map of the pedestrian connectivity recommendations is provided in Figure 23.

FIGURE 25 **PEDESTRIAN CONNECTIVITY RECOMMENDATIONS**

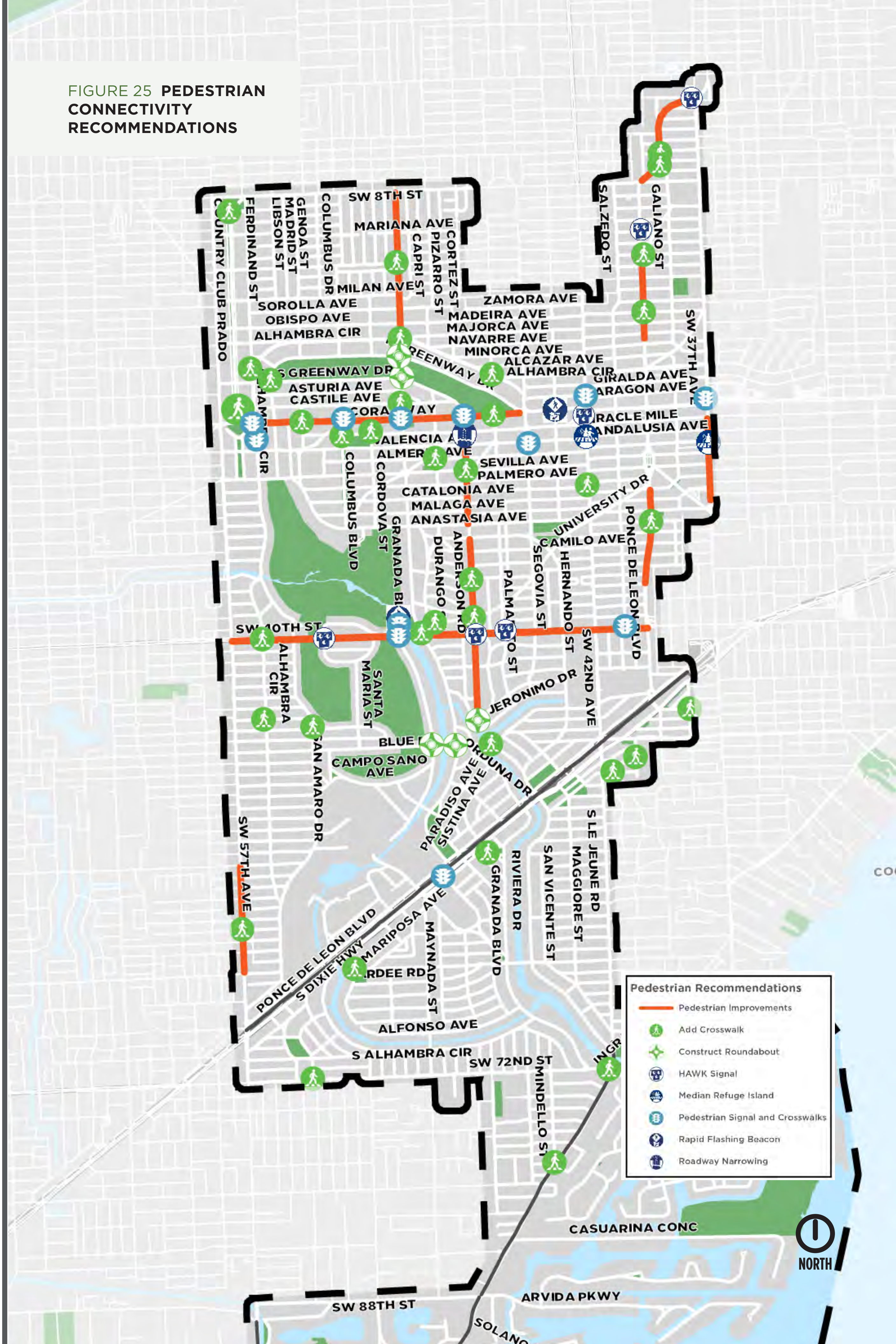
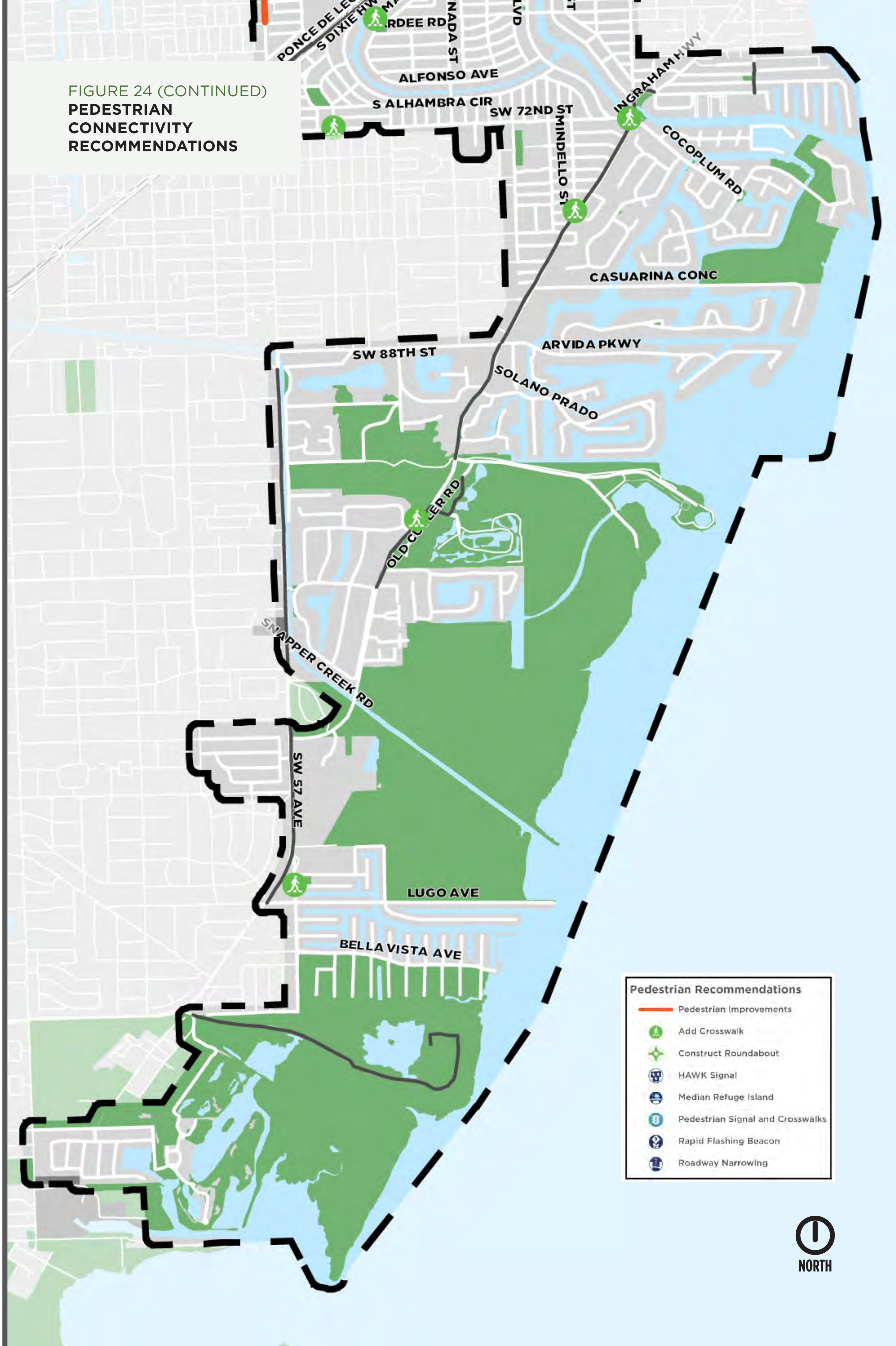


FIGURE 24 (CONTINUED)
PEDESTRIAN CONNECTIVITY RECOMMENDATIONS



IMPLEMENTATION PLAN

IMPLEMENTATION PLAN

Prioritization

A key part of implementation for bicycle and pedestrian projects, is to prioritize the implementation in a way that addresses the highest needs first, while also implementing projects that systematically builds a connected network. The highest return projects will be ones that build off existing infrastructure or make connections to pedestrian and bicycle-oriented destinations. The SAC also heavily identified safety and connectivity as the top 2 priorities for project implementation. This chapter outlines the prioritization of recommended projects for implementation.

Pedestrian Projects

Sidewalk Gap Prioritization

Pedestrians are vulnerable users of the transportation network and are extremely sensitive to detour and distance. The network needs to be fully useful so that they can take the most direct route. The sidewalk gap analysis identified missing sidewalks within a 1/4-mile buffer surrounding pedestrian generators and attractors as identified by the City. These sidewalks were prioritized as Tier 1, 2, and 3 priorities based on the following metrics:

/ **Tier 1:** Sidewalks missing on both sides of the street of an arterial or collector street.

/ **Tier 2:** Sidewalks missing on one side of the street of an arterial or collector street.

/ **Tier 3:** All other missing sidewalks within 1/4-mile of a park or school, on one or both sides of the street.

The City has a Neighborhood Enhancement Program where residents can request sidewalks on their street. The City will fully fund sidewalk installation on collector roadways and 50 percent of sidewalk installation on local residential streets. There is currently a sidewalk program underway on University Boulevard between Bird Road and Blue Road. The Tiered sidewalk project priorities are mapped in Figure 24 and the sidewalks that qualify for full funding from the City through the NEP are noted.

Bike Projects

The Level of Traffic Stress methodology and resulting mapping are useful for determining the appropriate facility for each of the bicycle corridors, but each of the resulting projects must be designed, funded, and constructed. Selecting which projects to advance through this process is based on a combination of factors:

/ **Connectivity.** Connecting to the wider low stress facility network is critically important in prioritizing projects. It is also important to connect major origins and destinations.

/ **Safety.** Providing continuous facilities that have logical termini is key part of network planning and, consequently, implementation execution, that contributes to safety.

/ **Demand.** Good implementation execution prioritizes connecting high demand places, such as premium transit stops, Miracle Mile and Parks.

/ **Equity.** It is key that the network is accessible across the City and provides connections to key amenities such as transit stops, grocery stores, health care centers and schools. This provides safe choices for residents without a car.

The prioritization of the bicycle facilities was broken into three phases:

/ **Phase 1:** This phase identifies a “backbone” network that focuses on connecting the most existing low stress streets to downtown Coral Gables (Miracle Mile) as well as leverage connections to the Underline linear park beneath the Metrorail. This phase also identifies bike corridors that also have Tier 1 sidewalk gap priorities.

/ **Phase 2:** This phase identifies opportunities to build off of the Phase 1 network to provide supporting connections to the facilities built in Phase 1.

/ **Phase 3:** This Phase focuses on building the final supporting connections as well as completing major east-west connections that may require more resources for the engineering phase and require a longer design phase.

The proposed phasing for each of the bicycle corridors is identified in Figure 25.

FIGURE 26 **PRIORITIZED SIDEWALKS GAP PROJECTS, 2019**

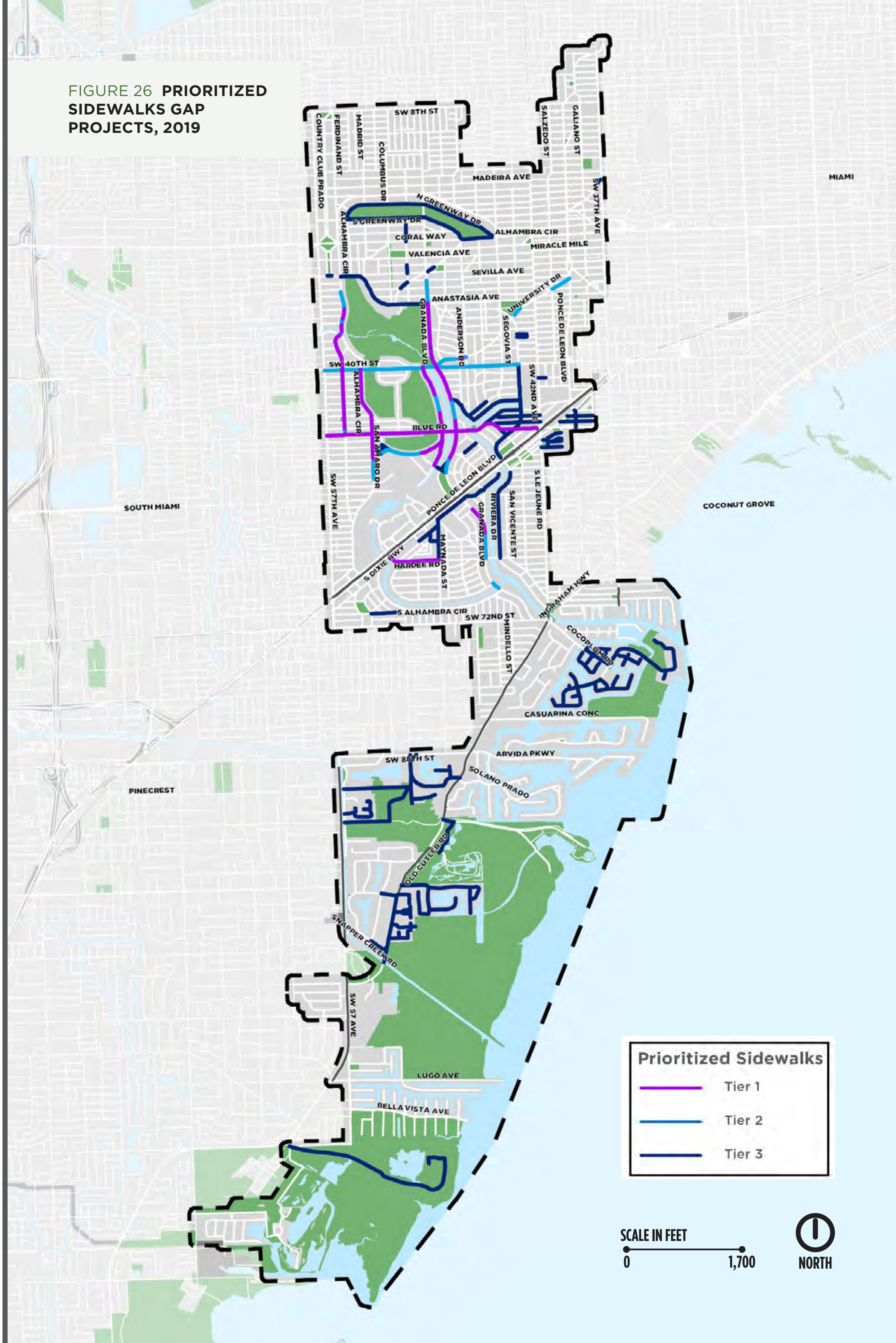
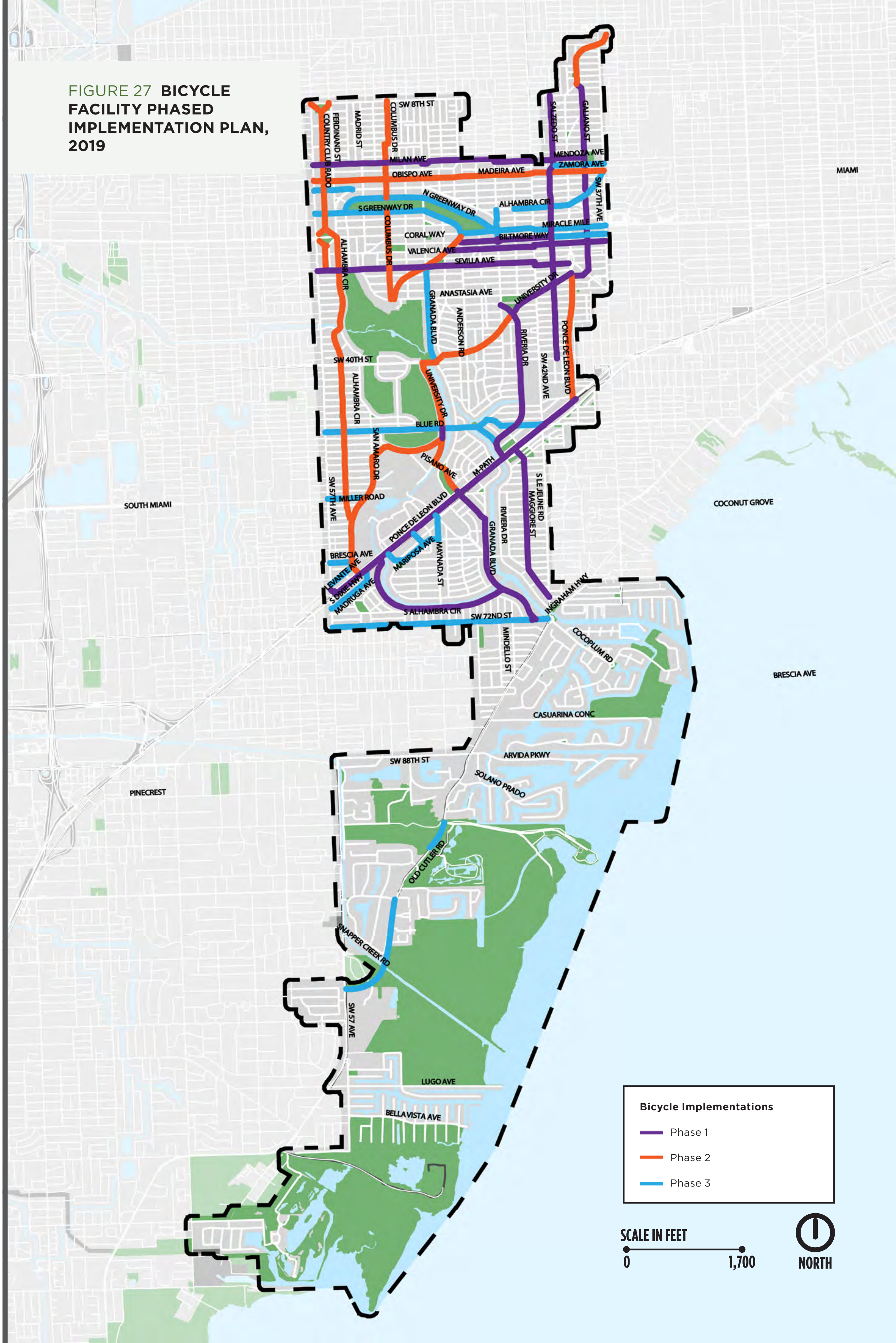


FIGURE 27 **BICYCLE FACILITY PHASED IMPLEMENTATION PLAN, 2019**



BICYCLE FACILITY SELECTION TOOLKIT

BICYCLE FACILITY SELECTION TOOLKIT

Mission Statement

To provide flexible design guidance for the implementation of appropriate bicycle facilities on the City of Coral Gables' Street network.

Purpose

This toolkit is will aid in Coral Gables planning and implementation staff making well-informed decisions about bikeway design. Selecting the right facility for a given roadway can be challenging due to the range of factors that influence bicycle users' safety and comfort level. One of the most important factors is to determine what type of bicyclist the facility is meant to attract. Section III outlines the differing levels of comfort and skill bicyclists have.

How to Use the Toolkit

This toolkit has taken design best practices and compiled them in a framework that is intended to be useful for staff undertaking high-level planning efforts as well as implementation staff seeking to advance projects through their design and construction phases.

The guidance in this toolkit are broken down into subcategories:

"For Planning Staff"

&

"For Implementation Staff"

callouts to tailor the application of the facility guidance to the user's need.

What is Level of Traffic Stress?

For Planning Staff: The primary goal is to select a bicycle facility that will provide the greatest amount of safety and protection within the existing roadway design for the expected user group. During the planning phase, the expected user group should be determined based on the surrounding environment. For example, a high-speed arterial with a high volume of traffic will not attract 'low skill' bicyclists who ride recreationally, but rather determined commuters who make routine trips. A breakdown of the various user groups is provided in Section III.

This section provides a high-level look at how bicyclists are likely to experience each roadway in Coral Gables. This can be used to show a project's usefulness in (1) connecting important destinations and places that are already bike-suitable to one another and (2) extending bike travel as a viable option into more of Coral Gables neighborhoods. Relying on how comfortable one is with riding a bike is in direct correlation to how safe the person(s) feels doing so on a Coral Gables' roadway during their entire trip. It can also be used to select which facility type is appropriate in a given location depending on who it is purported to serve.

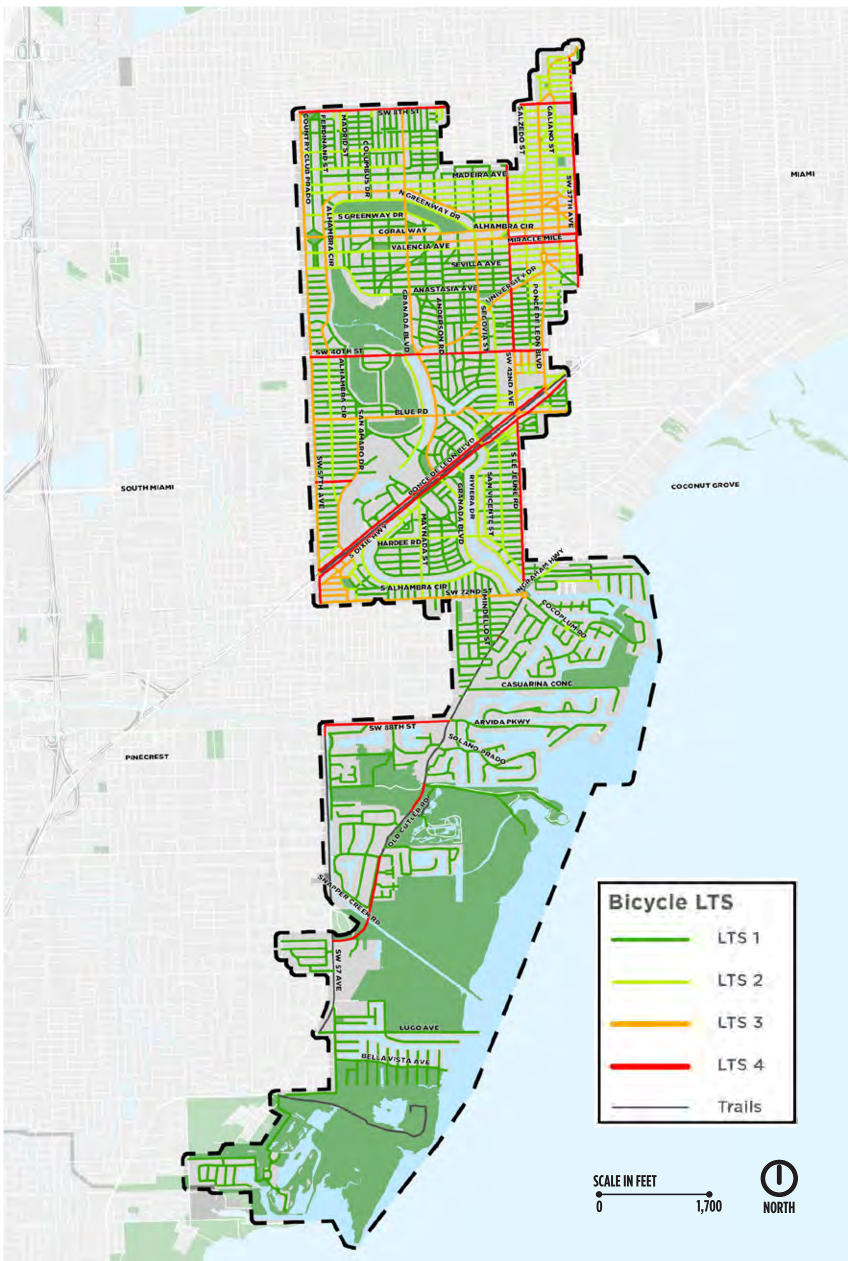
A data-driven process to plan a bicycle facility system based on comfort

The LTS analysis uses a "weakest link" methodology of assigning stress level; this reflects the reality that people on bikes experience various types of traffic stress (speed of traffic, volume of traffic, degree of separation from traffic, incursions into their space) simultaneously. For example, if even one of these factors is excessive, the whole street segment is a high stress experience for most potential riders.

A roadway stress level can depend on as few as one factor. Thus, roadways are first evaluated based on whether they have existing bike facilities. The methodology has two assessment processes, one for roadways with a bicycle facility and one for mixed traffic conditions. The following five factors are considered in both: (1) traffic speed; (2) surrounding land use; (3) traffic volume (as assumed from the number of travel lanes); (4) the level of separation from traffic; and, (5) incursions into the space used by people on bikes (e.g. high turnover parking).

The LTS scores range from an LTS 1, which is comfortable for most of the general population, to an LTS 4, which is uncomfortable for even experienced bicyclists. The LTS scores can help plan a complete bicycle network that is useful to the general population, leverage low-stress streets that are already comfortable for most people, and help identify the appropriate bicycle facility based on key characteristics of the street.

With the goal assessing every roadway segment in Coral Gables for true comfort level by bicycle, the City applied LTS to the entire County and state roadway network. This is depicted in the map to the right.



LTS for Network Planning

Once LTS scores are identified for all roads in the Network, LTS can be used to identify the ideal location(s) for adding or upgrading bike facilities. This is thought of as "unlocking" or "interconnecting" the low-stress system by identifying and overcoming the barriers to a complete network of facilities. This section provides important context as to how the application of LTS in-network planning is applicable for planning and implementation staff as defined below:

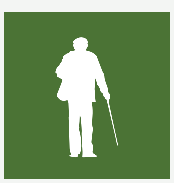
For Planning Staff: LTS provides a network-wide assessment of the locations where different user groups feel comfortable, enabling network planners to identify strategic corridors, sub-networks, and spot-improvements that will achieve maximum value, thus, enabling safe and comfortable bike travel in more parts of Coral Gables. Strategic interventions should be organized into projects of one or more corridors or spot improvements and undertaken in a way to maximize the area around the project that can reach it via low-stress streets/trails. Each individual project should be thoughtfully linked to its catchment area.

LTS for Facility Selection Process

Bicyclists categorized in **User Group A (Strong and Fearless)** are comfortable riding on busy roads with little physical separation from motorist through travel lanes.

User Group B (Enthused and Confident) cyclists are generally recreational and utilitarian riders who will ride on busy streets if there are facilities provided but may also deviate from the most direct route to ride on low-traffic or shared use paths.

Most of the population is categorized into **User Group C (Interested but Concerned)**. This group includes a wide range of people of all ages who enjoy cycling, but may only ride on shared use paths, low traffic local streets, or protected on-street facilities.



User Group D (No way no how) will not choose to bicycle for transportation or recreation, regardless of provided infrastructure.

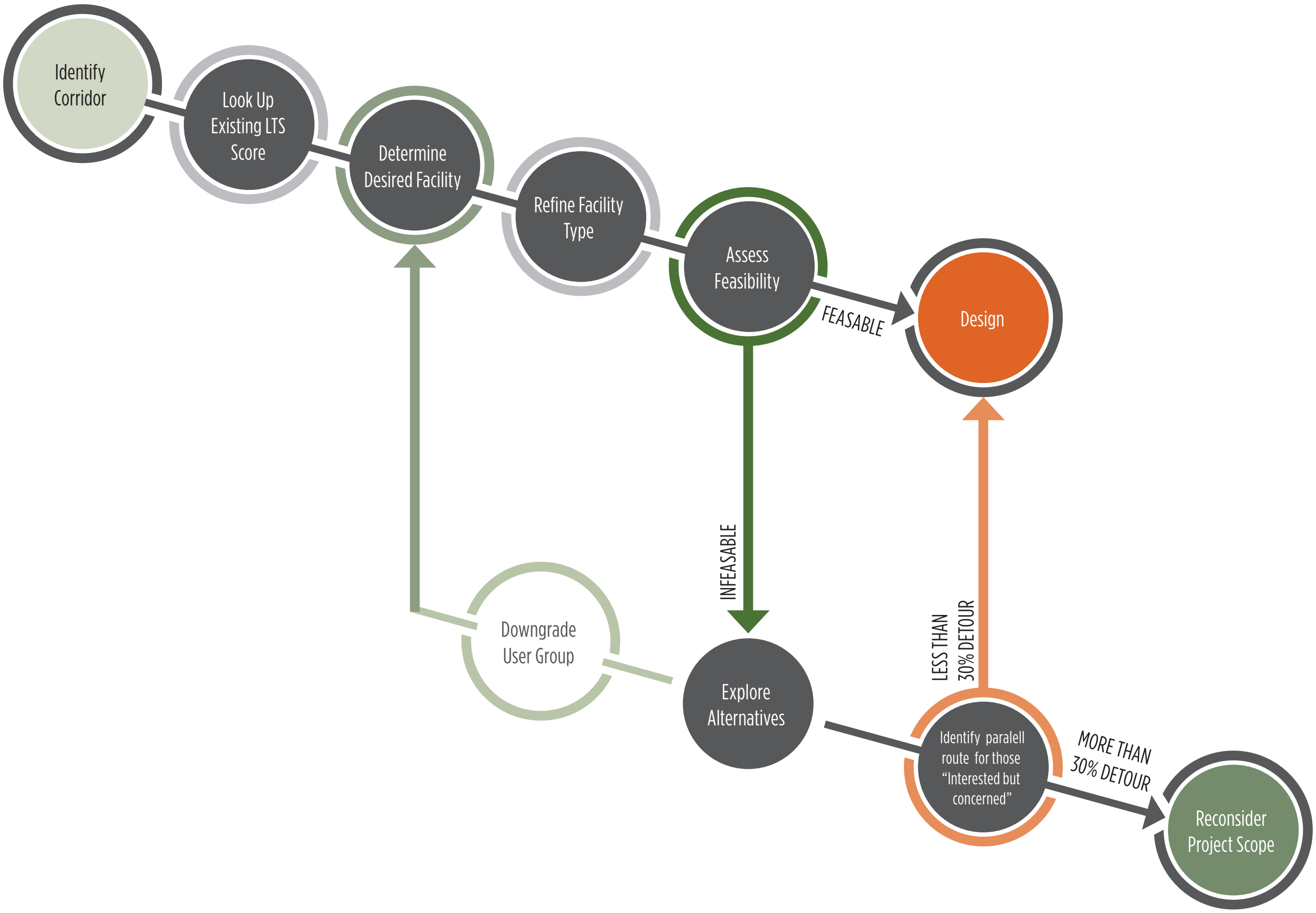
Less-experienced and risk-averse bicyclists in User Group C account for most of the population. These bicyclists need to be connected via bike facilities and/or streets that are LTS 1 or 2 for the duration of their trip. This makes it crucial to create connected networks, as shown above, AND to select and build a well-designed facility that meets the needs of these riders. In general terms, this user group prefers:

- Physically separated facilities such as protected bike lanes and trails
- Wide, preferably-buffered bike lanes on medium to low speed and low volume streets, adjacent to the curb (not a parking lane)
- Bike boulevard treatments on low-stress neighborhood streets

This indelibly explains the rationale of how facility types impact whether most people choose to bike or not to bike through “Types of Bicyclist” research categorizations - further breaking down how facility selection, based on LTS, is applied for planning and implementation staff:

For Planning Staff: The use of the existing LTS map and field visit (if applicable) should be enough to determine the general existing stress level of a street or road, which can be used to select the appropriate general facility type for a corridor. It may be satisfactory to simply designate the level of physical separation from traffic that these general population riders would need to feel comfortable and leave more detailed assessment to design and implementation staff. The flow chart below provides a planning-level process that helps determine the level of separation necessary for the corridor.

Facility Selection Process



For Implementation Staff: A project will likely reach its implementation phase as a concept, at best, or a drawing as a line on a map with a general level of required separation. Additionally, it will depend on the implementation and design team to refine this into a plan that:

- Fits within the space that is available (determined in the planning phase)
  - If planning assumptions cannot be realized it may be necessary to choose a parallel, nearby route that can perform a similar bike network function.
- Achieves a low-stress bicycling condition
  - This is to be determined at each specific segment of the corridor, and at each intersection, bus stop, and other special-case locations.
- Is this acceptable to community members and stakeholders
  - It may be necessary to develop several alternatives to achieve a low-stress condition and engage in a public engagement process to choose a preferred alternative.

Implementation staff typically encounter irregularities in the corridor cross section in the design phase that is not found or realized at the planning stage. In these cases, the below table can be used to identify possible mitigations. To build on to the below table, we can add a column that references best practice resources (the City's Manual, NACTO Guidance, AASHTO etc.).

CONSIDERATION	MITIGATION
Bus stops along bike route	Bike lanes: Minimize and clearly mark conflict areas to alert bicyclists and buses Physically seperate facilities: Provide pedestrian queuing, landing, and shelter (if preseent) between bike facility and roadway, if feasible.
Bikeway adjacent to on-street parking with low occupancy	Consider removal or consolidation of parking
Bikeway adjacent to on-street parking with high turnover	Wide or buffered bike lanes preferred to reduce risk from opening car doors
Head-in 90 degree angled parking	The use of back-in angled parking preferred
Bikeways along streets with numerous commercial driveways and/or unsignalized intersections	Clearly sign and mark conflict areas with colored pavement to warn motorists and bicyclists. Design high-volume driveways as intersections
Bikeways crossing a major signalized intersection	Consider bike boxes, turn-queue boxes, warning signs and markings, bicycle signals (especially at separated bicycle facility)
New bicycle route connecting existing facilities	Provide continuity with adjacent facilities, where possible. Provide bicycle facility at same or higher level of protection compared to adjacent facilities.
Bikeway on a truck route or road with greater than 10% heavy vehicles	Step up to next level of protection recommended by the chart (i.e. from mixed traffic to bike lanes, from buffered bike lanes to separated bicycle facility). Generally, separated bicycle facilities preferred, bike lane with buffer optional, depending on speed & volume characteristics of the roadway.

Public Engagement Strategies for Bike Lanes

Public perception versus reality with respect to bike lanes is a very real issue. Many people equate the change in road/street configurations to accommodate bike lanes to mean that there will be a negative impact to cars, traffic, parking, and businesses. Combatting negative public perceptions starts with community engagement around the actual impacts that this project and projects like it can have in the community.

Utilizing guiding principles to engage the public to foster a robust and honest community discussion about the impacts of a bike lane. Starting with hearing what the fears and worries of aw community are and what they are trying to accomplish in the community as a whole

1/ Foster an environment where the community can tell you about where they live; no one knows what is happening everyday better than them

2/ Being cognizant of the condition of the community by familiarizing yourself with land use, economic growth/development, major population increases/decreases, and the community demographics

3/ Educate the community about the options associated with the installation of bike lane(s) in their neighborhood by providing them relevant examples of similar projects, utilizing a 'toolbox' approach and the understanding that different issues have different solutions – this allows for informed feedback from community members

4/ Providing a vision to accompany the purpose of a bike lane project allows for the community to circle back to see the broader goals of bicycle infrastructure

Interaction at community meetings/gatherings/ fairs...etc. via charette exercises allow for the community to visually engage in the project by seeing the actual design options and cross sections. Pop-up, pilot, and tactical design projects allow for communities to experience the impact of a bike lane for a short-term to see what impacts occur and gives way to necessary modifications. These are all ways to build a positive, strong base of community support by engaging all members of the community.

Myths vs. Facts: Misconceptions of Bike Projects and Community Impacts

Many communities make assumptions and fear the 'unknown' when they are propositioned with the possibility of bike infrastructure in their direct neighborhood or indirect neighborhood that they frequent. There are facts and statistics that combat common misconceptions of bike projects to override the myths that can mar even the idea of a bike project before it even gets going. Below are a few 'myths vs. facts':

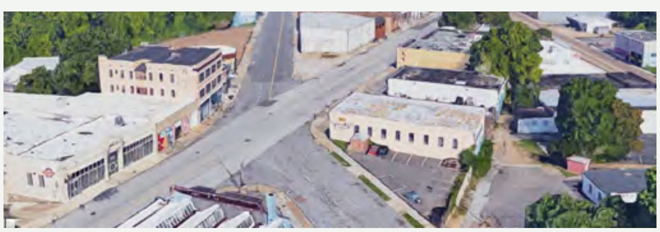
Myth	Fact
People do not cycle even if the infrastructure is available: "Even if we build bike lanes, no one will use them!"	Research from Portland State University shows that the availability of cycling infrastructure encourages cycling. Routes with high quality of service have a significant positive effect on the desirability of cycling to users. In other words, "If you build it, they will come." (https://pdxscholar.library.pdx.edu/open_access_etds/2702/)
Cycling is purely a leisure activity, so an on-street network is unnecessary: "We already have plenty of greenways for people to bike on, why should we put bike lanes on our roads?"	Dr. Jennifer Dill of Portland State University monitored the travel patterns of 166 people who cycle regularly and found that recreation constituted only 5% of time spent on a bicycle for her sample group. (https://www.jstor.org/stable/40207254?seq=1&cid=pdf-reference#references_tab_contents)
Cycling infrastructure is expensive: "Wouldn't our tax dollars go farther being used for something else?"	The City of Portland conducted an audit of its cycling infrastructure and determined that the entirety of its 300-mile-long network could be rebuilt for $60 million. For comparison, only one mile of urban freeway could be built for the same cost. (https://activelivingresearch.org/sites/activelivingresearch.sdsc.edu/files/Dill_Bicycle_Facility_Cost_June2013.pdf)
Cycling infrastructure will not fit in the right-of-way: "There's no shoulder on that street, how are we going to fit a bike lane on it?"	Travel lanes are typically between 11 and 13 feet wide, with 12 feet being the historical standard. However, urban streets will operate safely and efficiently with 10-foot lanes. In addition, corridors with excess capacity should be considered for a road diet, which will lead to smoother operation and frees up right-of-way for other uses, such as cycling infrastructure. (https://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/)
Cycling infrastructure will prevent smooth operation of emergency vehicles: "Fire trucks won't have enough space to get through that street with the new bike lanes."	Cycling infrastructure generally does not have a negative impact on emergency operations. Some treatments, such as a two-way turn lane road diet, improve emergency operations. (https://safety.fhwa.dot.gov/road_diets/resources/pdf/fhwasa17020.pdf)
Cycling infrastructure will kill business: "I run a retail business and depend on parking for people to be able to access my store."	People who bike, while they spend less per a trip spend more over the course of a month. In Portland, OR, people who traveled to a shopping area by bike spent 24% more per month than those who traveled by car. Studies found similar trends in Toronto and three cities in New Zealand. (Peopleforbikes, Protected Bike Lanes Mean Business)

Parking vs. Bike Lanes

Strategies to manage public conversations around parking should include various sections of the community. More specifically, those associated with the installation of a bike lane that will impact parking should be included in the conversation before the work is done. There are several stakeholder groups to consider: residents, business owners, commuters, local government, community associations/ organizations, and consumer groups…etc. When considering affected groups for parking impacts associated with the installation of bike lanes, it is critical to provide fact-based and statistical data that shows the impact in similar projects (locally or nationally).

Parking and small business case study demonstrates that there can be a positive impact and relationship between bicycle infrastructure and small businesses. Although it is possible for local business owners to push back against having a street reconfigured to include a bike lane in lieu of or in addition to parking, education about the positive effects to revenue that a bike lane and slower traffic have on business can change their minds.

When Ingersoll Avenue in Des Moines, Iowa, was reconfigured from a four-lane road to a two-lane road with a two-way left turn lane in the center and bike lanes at the edges, businesses strongly opposed the change. However, they soon saw a twenty-three (23) percent increase in revenues and warmed up to the new configuration. The revenue increase can be attributed to the slower speeds and higher bicycle and pedestrian traffic on the street as a direct result of the street reconfiguration. Subsequent bicycle projects in Des Moines have been met with greater enthusiasm from area business owners because of education about the initial success on Ingersoll Avenue. (https://peopleforbikes.org/blog/business-leading-charge-des-moines-33m-street-overhaul/)



Before and after photos of the Memphis Intersection Pilot project (Source: https://mdcollaborative.squarespace.com/streetscape-projects)

Demonstration/ Pilot Projects

Demonstration projects are rudimentary implementations of key project elements using inexpensive and temporary treatments. For example, a bike lane demonstration could consist of spray-painted lane markings and temporary signs to demarcate the lane. By physically interacting with the project elements, the public can better understand what the impacts and benefits of the full-build implementation will be. Through this process, the public can make informed comments that will help the planners and engineers identify potential challenges. A thoughtfully executed demonstration is an inexpensive and effective way to gain community support for a project and can lead to new partnerships and funding vehicles. Below are a few examples of successful demonstration/pilot projects:

Protected bike lane in Des Moines, Iowa

The City of Des Moines piloted its first separated bike lane on a block of E. Grand Avenue. The project quickly drew support from the area businesses and local advocates, and new funding sources became available to add colorful paint and whimsical street furniture. In addition, the new funding allowed the demonstration to continue into the next year. https://static.spokanecity.org/documents/projects/riverside-ave-division-to-monroe/riverside-avenue-parking-protected-bike-lane-case-studies.pdf)

Key project elements:

/ Separated bike lane
/ Shortened crosswalks
/ Narrower travel lanes
/ Transit stops
/ Improved sight lines
/ Placemaking features

Intersection reconfiguration in Memphis, Tennessee

MEMFix, a business district's experimental street design-turned city-wide tactical urbanist movement, reconfigured a large intersection in a neighborhood known as the Edge District. They turned what was a large swath of asphalt and concrete into space oriented towards bicycles and pedestrians, while making the intersection safer for automobiles. The demonstration also features a large piece of public art harkening back to the area's days as a neighborhood full of car dealerships. (https://usa.streetsblog.org/2017/04/04/memphiss-spectacular-street-experiments-moving-toward-permanence/)

Key project elements:

/ Separated bike lanes
/ Shortened crosswalks
/ Elimination of oblique angles at intersection
/ Improved sight lines
/ Placemaking features

Pilot Project Best Practices

There are necessary steps in how to move forward in the development of a demonstration/pilot project that successfully exemplifies the positive and real-life impacts on installing bike infrastructure that affects parking and roadways. Below are criteria to utilize in the process:

Site selection

Critical to a successful demonstration project is a suitable site. When selecting a site, consider whether *an area...*

...is a gap in a larger cycling network

...is part of city or regional bike plans

...has existing cycling infrastructure that does not meet the needs of its users

...has roads that are too wide

...has issues with road safety, such as speeding

...already has local support for cycling infrastructure projects

...has high foot traffic or has the potential to

...is a candidate for revitalization efforts

The confluence of these factors indicates a good site for a demonstration. Beyond these high-level factors, the constructability and other logistical concerns of the demonstration must also be considered.

Funding

There are several sources of funding for pilot and demonstration projects. The table below summarizes some of these options from various sources. Note, Florida does not have a dedicated funding source for bicycle projects.

Federal	US Department of Transportation Transit, Highway, and https://www.fhwa.dot.gov/environment/bicycle_pedestrian/funding/funding_opportunities.cfm
Advocacy Group	Local advocacy groups PlacesForBikes by PeopleForBikes (https://peopleforbikes.org/our-work/community-grants/)
Private-Public Partnerships	Local businesses Hospitals Universities Philanthropic organizations and foundations

Analysis

Collect data before, during, and after the demonstration. These data will inform decisionmakers, stakeholders, and planners and engineers. Consider collecting data about...

/ Public opinion
/ Actual safety
/ Perceived safety
/ Community support
/ Mode share
/ Bicycle volume

Collect other data according to context and project needs.

Documentation

Thoroughly document all aspects of the demonstration such that the process can be repeated, and best practices can be developed over time.

Facilities

Once a facility type is selected, the appropriate design practices must be applied to design a useful facility based on the street context. The following toolkit provides a summary of design best practices for each facility type as well as additional design resources available to reference in further detail.

CONVENTIONAL BIKE LANE

BUFFERED BIKE LANE

BICYCLE BOULEVARD

ONE-WAY SEPARATED BIKE LANE

TWO-WAY SEPARATED BIKE LANE

SHARED-USE PATHS

- **WAYFINDING/SIGNAGE**
- **MEDIAN REFUGE ISLANDS**
- **THROUGH BIKE LANES**
- **BIKE BOXES**
- **TWO-STAGE TURN QUEUE BOXES**
- **BIKE SIGNALS**

CONVENTIONAL BIKE LANE

DESIGN SUMMARY

Shoulder bike lanes provide spaces for bicyclists to ride, separate from motor vehicle traffic. They are generally used on arterial and collector streets, where higher traffic volumes and higher speeds warrant more separation. Bike lanes increase safety, while reducing wrong-way riding.

DIMENSIONS

/ 6’ recommended

/ 5’ if no on-street parking is present

/ 4’ minimum in constrained locations

/ If on-street parking or buffer, total width 14.5’ – minimum 12’

TYPICAL APPLICATION

/ Low traffic volumes (≥ 3,000 AADT)

/

/ Posted travel speed ≥ 25 mph

LAND USE CONTEXT

/ Urban and suburban

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9C

/ NACTOUrbanBikewayDesign Guide: Pages 7-11

/ FDOTCompleteStreetsDesign Handbook: Chapter 4

EXPECTED COST

$

CONSIDERATIONS FOR LTS

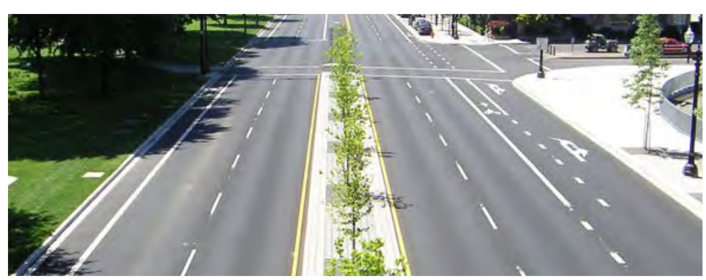
Interested but Concerned

/ Conventional bike lanes are only appropriate for inexperienced riders if the street is low-volume or low-stress. Typically, try to not place parking next to the bike lane, as inexperienced riders can find the car turnover and doors opening to be an unsafe environment (or add a buffer between parking and bike lane).

/ Standard bike lanes should be used in conjunction with traffic calming measures (bottlenecks, chicanes, neckdowns, etc.) for LTS 2 roadways. More separation is required for an LTS 2 street to ensure the comfort of the range of riders.

Enthusiastic and Confident

/ More experienced riders are comfortable with bike lanes next to parking lanes.



Images (Source: NACTO)

BUFFERED BIKE LANE

DESIGN SUMMARY

Buffered bike lanes are designed to increase space between bike lanes and the travel lane(s). They work best on high-volume or high-speed roadways or spaces where cars are parked too close to bike traffic. These conditions can be dangerous or uncomfortable for bicyclists.

DIMENSIONS

/ Same as conventional bike lane (5' – 6'), plus 2' – 3' painted buffer

- Typically, paint buffer with diagonal lines to increase visibility
- Buffer may be on the travel lane or parking lane side

/ Together, the bike lane and buffer should be at least 7'

TYPICAL APPLICATION

/ High traffic volume (≥ 10,000 AADT)

/ Travel Speed ≥ 25 mph

LAND USE CONTEXT

/ Urban, suburban, rural

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9C

/ *NACTO Urban Bikeway Design Guide*: Pages 21-25

/ FDOT Complete Streets Design Handbook: Chapter 4

EXPECTED COST

$$

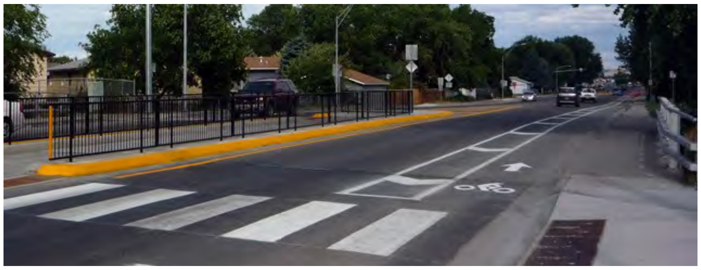
CONSIDERATIONS FOR LTS

Interested but Concerned

/ For inexperienced riders, a painted buffer between parked cars and the bike lane is helpful. It protects bicyclists from car doors opening and adds to their overall safety. The buffer should be painted with diagonal lines to make it clear to drivers to keep out of the designated bike space.

Enthusiastic and Confident

/ More experienced and confident riders require buffered bike lanes when traffic volumes or speeds are high. Consider adding flex posts or a traffic calming device (daylighting, chicanes, narrowing roads, etc.) to ensure the bicyclist feels comfortable and is a safe distance from high speed traffic on through streets.



Images (Source: NACTO)

BICYCLE BOULEVARD

DESIGN SUMMARY

Bicycle boulevards are used on low-volume streets where motorists and bicyclists share the same space. Through traffic calming measures, they generally travel at the same speed, which creates a more comfortable environment for all users. Bike boulevards incorporate cost-effective and less physically-intrusive treatments compared to other bicycle facilities. Residents who live on bicycle boulevards benefit from reduced vehicle speeds, creating a safer environment.

DIMENSIONS

/ Use Wayfinding signs, standard traffic calming measures (choker, chicane, neckdown, etc.)

TYPICAL APPLICATION

/ Low traffic volumes (≤3,000 AADT)

/ Posted travel speed ≤ 25 mph

LAND USE CONTEXT

/ Urban and suburban

- Avoid major streets

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9C

/ NACTOUrbanBikewayDesign Guide: https://nacto.org/publication/urban-bikeway-design-guide/bicycle-boulevards/, and Page 240

EXPECTED COST

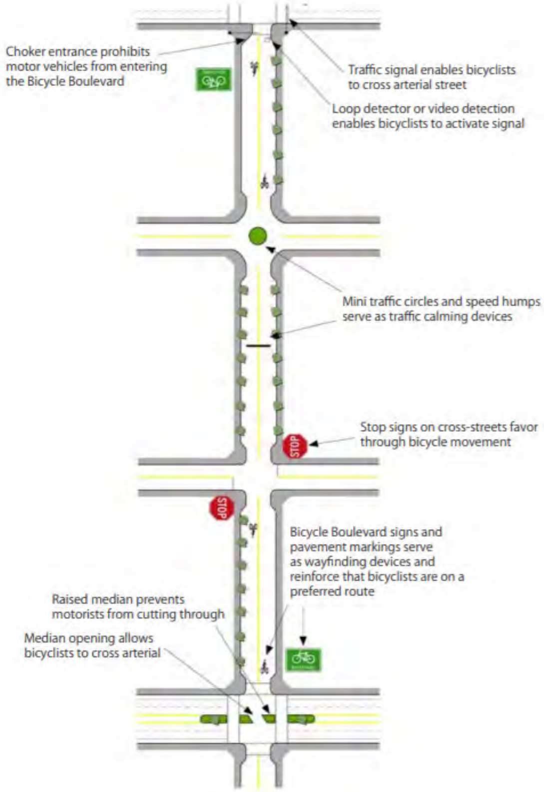
$

CONSIDERATIONS FOR LTS

Interested but Concerned

/ Bicycle boulevards are perfect for low-stress streets, because little mitigation needs to be done. Residential streets or roads to public parks/schools work best due to their slower speeds. Inexperienced riders can easily ride on these streets, as they generally have lower motor speeds or volumes. Ideally, bicycle boulevards should be used as parallel/alternative routes in comparison with higher stress streets.

/ /Note, sharrows are not considered a bicycle facility in itself. They are part of a design toolbox for creating safe and comfortable bicycle boulevards. Sharrows should be used in combination with traffic calming infrastructure. Sharrows are not advised on streets over 25 mph or streets that do not have adequate traffic calming.



Images (Source: NACTO)

ONE-WAY SEPARATED BIKE LANE

DESIGN SUMMARY

Also called 'protected cycle tracks,' separated bike lanes are on-street facilities that provide the comfort and safety of multi-use paths within the road right-of-way. This is done by combining a painted buffer with a physical barrier, such as flex posts, a parking lane, or a landscaped buffer. The added protection separates bicyclists from high-speed or high-volume motor traffic.

DIMENSIONS

/ 5' – 7' bike lane

/ 2' – 3' painted buffer (see buffered bike lane standards)

TYPICAL APPLICATION

/ High traffic volumes (≥ 10,000 AADT)

/ Travel speeds ≥ 40 mph

/ Multi-lane streets with few intersections and driveway access points

LAND USE CONTEXT

/ Urban and suburban

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9C

/ NACTO Urban Bikeway Design Guide: Pages 62-70

/ FDOT Complete Streets Handbook: Chapter 4

EXPECTED COST

$$$

CONSIDERATIONS FOR LTS

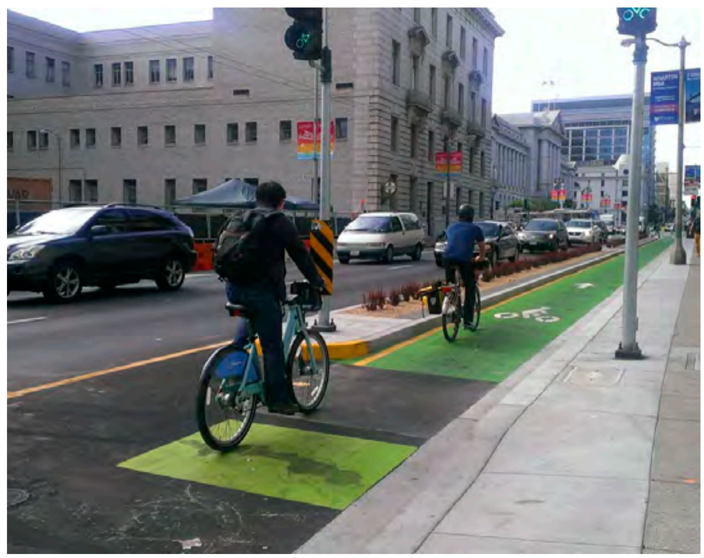
Interested but Concerned

/ Arterials are not safe or comfortable for inexperienced riders and therefore demand more separation for interested but concerned riders to be able to bike on or near the road. A physical barrier helps motorists stay in their space, away from bicyclists – giving even inexperienced riders a comfortable and safe environment, despite higher speeds and volumes.

/ Typically, avoid a separated facility for a lower stress corridor, as it is more expensive and often conventional or buffered bike lanes will work. However, implementation of separated facilities is still important, as the raised buffer or flex posts give riders a sense of security due to the physical separation.

Enthusiastic and Confident

/ Confident riders tend to ride faster than inexperienced riders, and thus the geometry of the facility should allow room for them to pass slower riders, space permitting.



Images (Source: NACTO)

TWO-WAY SEPARATED BIKE LANE

DESIGN SUMMARY

Also called “two-way cycle tracks,” separated bike lanes allow bicycle travel in two directions on the same side of the road. Additional safety design is required because bicyclists travelling in the opposite direction of traffic is often unexpected and can cause confusion for drivers. Two-way cycle tracks are preferred when cyclists are already riding the “wrong” way on corridors where alternate routes are unsafe or have no bike facilities, or where there is not room for a one-way separated bike lane on both sides of the street.

DIMENSIONS

/ At least 9’ bike lane (total width)

/ 2’ – 3’ painted buffer (see buffered bike lane standards)

TYPICAL APPLICATION

/ High traffic volumes (≥ 10,000 AADT)

/ Travel speeds ≥ 40 mph

/ Multi-lane streets with few intersections and driveway access points

LAND USE CONTEXT

/ Urban and suburban

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9C

/ NACTOUrbanBikewayDesign Guide: Pages 62-70

/ FDOT Complete Streets Handbook: Chapter 4

EXPECTED COST

$$$

CONSIDERATIONS FOR LTS

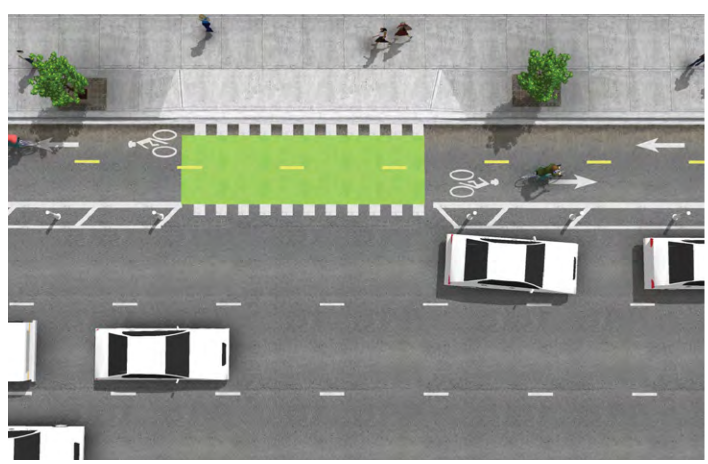
Interested but Concerned

/ Arterials are not safe or comfortable for inexperienced riders, and therefore demand more separation for interested riders to be able to bike on or near the road. A physical barrier helps motorists stay in their space, away from bicyclists – giving even inexperienced riders a comfortable and safe environment, despite higher speeds and volumes.

/ Typically, avoid a separated facility for a lower stress corridor, as it is more expensive and often conventional or buffered bike lanes will work. However, implementation of separated facilities is still important, as the raised buffer or flex posts give riders a sense of security due to the physical separation.

Enthusiastic and Confident

/ Confident riders tend to ride faster than inexperienced riders, and thus the design of the facility should allow room for them to pass slower riders, if space permits.



Images (Source: NACTO)

SHARED-USE PATHS

DESIGN SUMMARY

Shared-use paths, also called "multi-use paths," provide additional width for pedestrians and bicyclists, over a standard sidewalk. Paths next to roadways must have some sort of vertical or horizontal buffer – for example, a curb or landscaped barrier, respectively. Off-street paths are commonly found in urban and rural settings across the country.

DIMENSIONS

/ 10' minimum in low traffic conditions

/ 12' for high-use areas, or in areas where multiple users such as pedestrians, bicyclists and rollerbladers share the same space. In that context, pavement markings may be appropriate to separate them.

TYPICAL APPLICATION

/ High volume, high speed roads with constricted right-of-way

/ Few at-grade crossings, like driveways or alleyways

LAND USE CONTEXT

/ Urban, suburban, and rural

ADDITIONAL GUIDANCE

/ NACTO Urban Bikeway Design Guide: http://www.fdot.gov/design/training/DesignExpo/2016/Presentations/Multi-UseTrails-obinBirdsongAndMaryAnneKoos.pdf

/ FDOTCompleteStreetsHandbook:Chapter 4

/ AASHTOGuideforDevelopmentofBicycle Facilities: Chapter 5

EXPECTED COST

$$$$

CONSIDERATIONS FOR LTS

Interested but Concerned

/ In high-volume and high-speed conditions, additional separation from drivers can make bicyclists feel more comfortable. The extra pavement also gives the cyclist more space to ride.

/ In areas with very high motorist traffic, shared-use paths grant cyclists and pedestrians a safe space away from drivers. The raised separation between motor traffic and bicycles also adds to the overall environment, making it more comfortable for all users of the space.

Enthusiastic and Confident

/ In areas where shared use paths are provided, usually bicyclists are mandated to ride them. Because of this, enthusiastic riders may want extra space to overtake slower pedestrians or cyclists. Appropriate sight distance should also be integrated accordingly, as experienced riders tend to travel faster.

WAYFINDING/SIGNAGE

DESIGN SUMMARY

Wayfinding signs are typically placed at key locations leading to and along bicycle boulevards. They are also helpful where multiple routes intersect, and at key bicyclist "decision points." Wayfinding signs displaying destinations, distances, and approximate riding time can dispel common misperceptions about time and distance, while simultaneously increasing comfort and accessibility to destinations. Aside from signage, wayfinding can also exist in the pavement, in the form of shared arrow markings (sharrows), pavement markings, etc.

DIMENSIONS

/ Too many signs clutter the right-of-way, so signs should be posted at a level most visible to bicyclists and pedestrians rather than following the per vehicle signage standards

/ Should be placed consistently along designated bike routes to be most effective

TYPICAL APPLICATION

/ Designated bicycle routes (conventional bike lane, buffered, cycle tracks, etc.)

/ Bicycle boulevards

LAND USE CONTEXT

/ Urban, suburban, rural

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9B

/ NACTOUrbanBikewayDesign Guide: Pages 246-252

EXPECTED COST

$

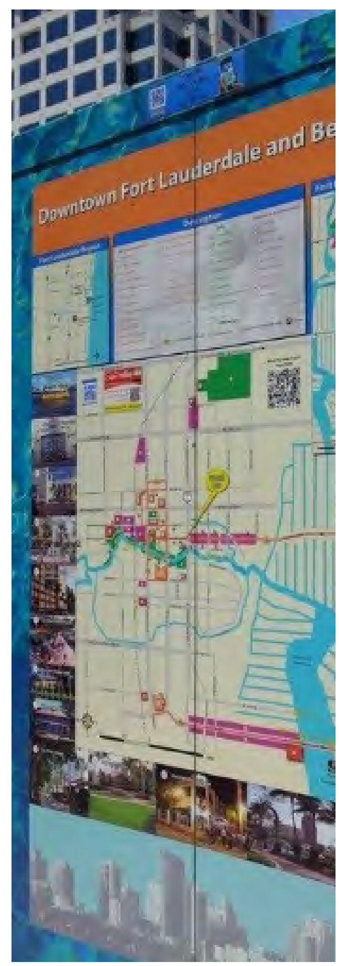
CONSIDERATIONS FOR LTS

Interested but Concerned

/ Wayfinding and signage are only appropriate on low-stress streets because they do not improve physical separation between traffic and bicyclists, but rather improve the environment for the rider. Wayfinding and signage are strictly communication tools. Make sure the signs are at an appropriate eye level and are spaced at consistent intervals, to increase efficiency and visibility.

Enthusiastic and Confident

/ Since these riders tend to bike at higher speeds, it is important to place the signs in a way that they can read it and gather the important information quickly as they pass it by.



Images (Source: NACTO)

MEDIAN REFUGE ISLANDS

DESIGN SUMMARY

Median refuge islands provide a space for pedestrians and bicyclists to wait to cross populated or long intersections. They help facilitate crossing one direction of traffic at a time and can be used in conjunction with bike boxes or cycle track crossings for additional safety. Median refuge islands provide a protected space for bicyclists to take advantage of gaps in traffic while simultaneously reducing delays to cross. They can also act as a traffic calming device, by narrowing the roadway and restricting turning movements.

DIMENSIONS

/ Want 10' wide with an absolute minimum of 6'

/ Place the median in the middle of the right-of-way

/ Want the height to be curb level (6" typically

TYPICAL APPLICATION

/ Where a bikeway crosses high-volume, high-speed traffic

/ Signalized or unsignalized intersections

/ Where cycle tracks end or intersect with motor traffic

LAND USE CONTEXT

/ Urban and suburban

ADDITIONAL GUIDANCE

/ NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/median-refuge-island/, page 157-160

/ FDOT Complete Streets Handbook: Chapter 4

EXPECTED COST

$$

CONSIDERATIONS FOR LTS

Interested but Concerned

/ A median refuge island shields bicyclists from incoming traffic and gives them a protected area to wait to cross an intersection.

/ On higher volume and higher speed roadways, the full design suite (longer widths, reflective markers the approach to the island, angled cut-through, etc.) should be used to make inexperienced riders feel more comfortable crossing busy intersections. The raised median provides them with more visibility and allows them to wait until an appropriate gap in traffic before they cross.

/ They work well in conjunction with raised cycle tracks, to give structure to the floating parking lane. Medians also provide shelter to bicycles making a two-stage turn.

Enthusiastic and Confident

/ Confident riders can take advantage of an angled-cut through across the median, to position them to face traffic and judge when the best time to cross would be. Medians should be wide enough to allow for two-way traffic, or for these cyclists to pass the less experienced ones.

Images (Source: NACTO Design Guide pg 159)

THROUGH BIKE LANES

DESIGN SUMMARY

Through bike lanes are design approaches to intersections that allow bicyclists to correctly position themselves in anticipation of upcoming intersections. They typically work well in areas where a bike lane merges into a turning lane or parking lane, or on streets with right-turn only lanes.

DIMENSIONS

/ Dashed white lines, 6" wide, 2' long

/ Right-turn only lanes should be as short as possible

TYPICAL APPLICATION

/ In context with right-turn only lanes

/ Areas where the bike lane merges with a parking lane

LAND USE CONTEXT

/ Urban and suburban

ADDITIONAL GUIDANCE

/ MUTCD: Chapter 9C

/ NACTO Urban Bikeway Design Guide: Pages 173-176

EXPECTED COST

$

CONSIDERATIONS FOR LTS

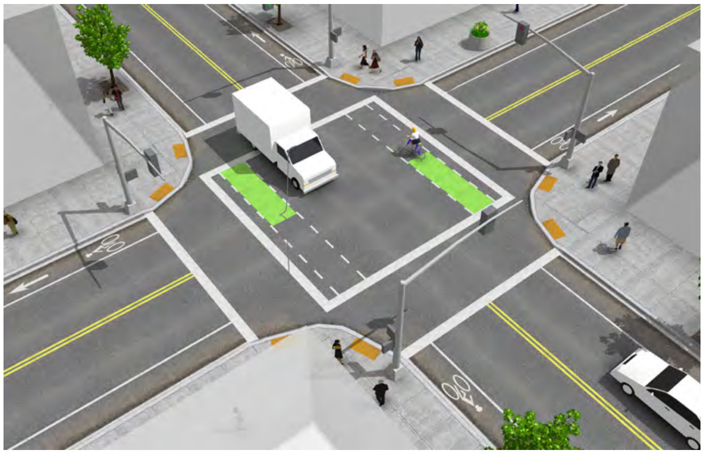
Interested but Concerned

/ A through bike lane does not provide any additional separation from motorists, but instead keeps the same bike lane intact throughout the intersection. This can be helpful for inexperienced riders to stay in their lane, but traffic often uses the lane to merge into a turning lane, therefore creating a difficult environment for them.

Enthusiastic and Confident

/ More experienced riders should be able to navigate around turning traffic. Painting the through lane green will help bicyclists and motorist both identify conflict areas to help maintain awareness.

/ This intersection treatment works well in conjunction with conventional or buffered bike lanes, as it acts as a continuation to the lane.



Images (Source: NACTO page 175)

BIKE BOXES

DESIGN SUMMARY

Bike boxes move the stop bar back for vehicles at signalized intersections. This creates a designated area for cyclists to wait during the red light phase. Bike boxes create a comfortable environment for riders by making them more visible and providing them a way to get ahead of queued traffic.

DIMENSIONS

/ Use transverse lines to create a box 10’ – 16’ deep, and indicate where motorists are required to stop

/ Center a bike symbol in the ox, between the crosswalk like and stop line

/ Can also dye the pavement green for extra visibility

TYPICAL APPLICATION

/ Signalized intersections on streets with bike lanes or cycle tracks

/ Intersections with high-volume traffic, or a high number of right-turn movements

LAND USE CONTEXT

/ Urban and suburban

ADDITIONAL GUIDANCE

/ MUTCD: Chapters 3B, 9C

/ NACTOUrbanBikewayDesign Guide: Pages 110-116

EXPECTED COST

$$

CONSIDERATIONS FOR LTS

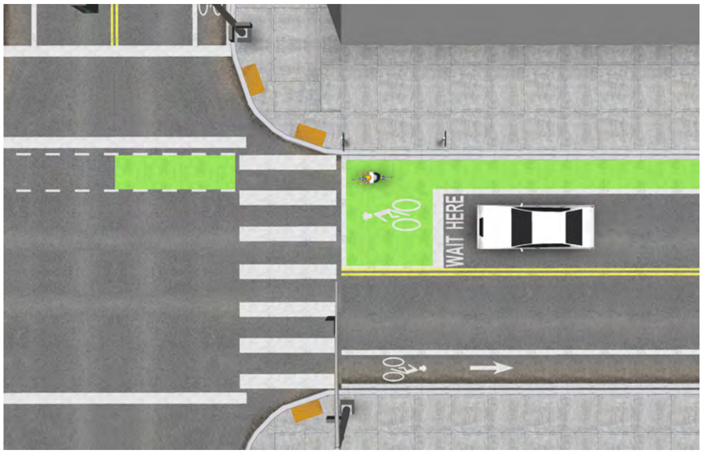
Interested but Concerned

/ Bike boxes give cyclists an area to wait in front of drivers, to improve their visibility and give them additional space to wait ahead of queued traffic. They work best at signalized intersections, when the light is already red, as it gives the cyclist time to position themselves before the green light. If a cyclist arrives at a green light, see Two-Stage Queue Boxes.

Enthusiastic and Confident

/ In higher volume or higher-turning-movement areas, green-colored bike boxes increase visibility and safety of the cyclist. By putting the cyclist ahead of motorists, the bike box allows cyclists to get a head start through the intersection and safely merge into their own lane once they cross it.

/ If the bicycle box spans across multiple lanes, and is sufficiently deep, experienced cyclists have a chance to move in front of slower riders, without having to weave through traffic at an intersection.



TWO-STAGE TURN QUEUE BOXES

DESIGN SUMMARY

Two-stage turn queue boxes are treatments for intersections with a high-volume of left-turning cyclists or where bike facilities merge onto the main road. In a two-stage left-turn, cyclists proceed through the intersection on a green light, and wait in a marked queue box on the cross street to proceed through the intersection on the next green phase. Whereas a bike box works well for riders arriving during the red phase, a two-stage box gives riders the opportunity to be equally safe arriving during the green phase.

DIMENSIONS

/ The queue box needs to be in a protected area (within on-street parking, or between the bike lane and pedestrian crosswalk, for example)

/ Include pavement makings to indicate bicycle direction and positioning

/ Can dye the pavement green for increased visibility

TYPICAL APPLICATION

/ Signalized intersections with high volumes or speeds

/ Streets with a significant amount of bike riders making left turns

LAND USE CONTEXT

/ Urban, suburban, and rural

ADDITIONAL GUIDANCE

/ MUTCD: Chapters 3B, 9C

/ NACTOUrbanBikewayDesign Guide: Pages 146-149

EXPECTED COST

$$

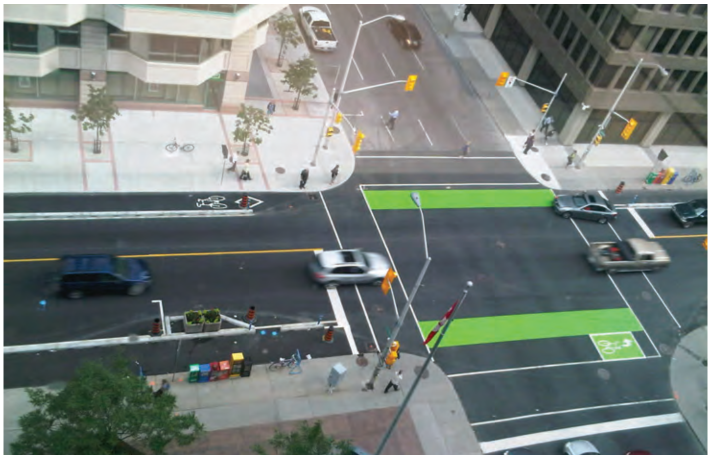
CONSIDERATIONS FOR LTS

Interested but Concerned

/ For intersections with high speeds or volumes, a painted two-stage queue box gives inexperienced riders a designated safe area to wait before crossing. This treatment reduces conflict with motorists, as the cyclists will always travel parallel to through traffic.

Enthusiastic and Confident

/ Two-stage queue boxes also separate turning cyclists from through bicyclists and works well in conjunction with cycle tracks or conventional and buffered bike lanes. More experienced riders can use the space to navigate the intersection at their own speed, with the additional room in the intersection.



Images (Source: NACTO)

BIKE SIGNALS

DESIGN SUMMARY

At intersections with conflicting movements, such as areas with high pedestrian or cyclist volumes, transit movements, or high motorist traffic, bicycle signal heads can be used to provide additional guidance to bicyclists and other users. Bike signals are used in conjunction with conventional traffic signals, and have the same standard green, yellow, and red light phases. They also prioritize bike movements and separate the traffic from conflicting movements.

DIMENSIONS

- Signal head should be clearly visible to cyclists and motorists
- Bicycle-only phase should provide adequate clearance time and actuation detection if it's not pretimed

TYPICAL APPLICATION

- Intersections with high volumes of bicyclists
- Transitions from trails or shared-use paths to on-street facilities

LAND USE CONTEXT

- Urban, suburban, and rural

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: Pages 206-213

EXPECTED COST

$$

CONSIDERATIONS FOR LTS

Interested but Concerned

- Bike signals can help slower riders pace themselves through the intersection during the bike-only phase. During this phase, they do not have to compete with motorists for the right of way.

Enthusiastic and Confident

- In areas with high car and bicycle ridership, a bike-only phase is helpful in separating cyclists from motor traffic. The bicycle signal head allows cyclists to move safely through crowded intersections, and their protected phase also gives them an accurate sense of how much time they have to cross an intersection.
- For high stress areas, a bike box may also be used in conjunction with a signal head for increased separation.

Images (Source: NACTO)

Appendix 1- Recommended Projects

Sidewalk Infrastructure & Implementation Recommendations

Street Name	Start	End	Missing Sidewalk?	Priority Tier
Alhambra Circle	Alhambra Court	Alegriano Avenue	Both Sides	1
Alhambra Circle	South of Salvatierra Drive	North of Taragona Drive	Both Sides	1
Alhambra Circle	San Rafael Avenue	South of Trevino Avenue	Both Sides	1
Blue Road	Red Road	Ponce de Leon Boulevard	Both Sides	1
Caballero Boulevard	Dixie Highway	Hardee Road	Both Sides	1
Campo Sano Ave	University Avenue	Pisano Avenue	Both Sides	1
Granada Boulevard	Viera Avenue	Marmore Avenue	Both Sides	1
Granada Boulevard	Orduna Drive	South of Donatello Street	Both Sides	1
Granada Boulevard	South of Algaringo Avenue	Jeronimo Drive	Both Sides	1
Granada Boulevard	Anastasia Avenue	Algargingo Avenue	Both Sides	1
Hardee Road	Caballero Boulevard	Maynada Street	Both Sides	1
San Amaro Drive	Bird Road	North of Certosa Avenue	Both Sides	1
University Drive	North of Blue Road	Pisano Avenue	Both Sides	1
University Drive	Bird Road	South of Bird Road	Both Sides	1
University Drive	Toledo Street	West of Anderson Road	Both Sides	1
Alhambra Circle	Alegriano Avenue	North of Blue Road	One Side	2
Alhambra Circle	South of Catalonia Avenue	San Rafael Avenue	One Side	2
Alhambra Circle	South of Trevino Avenue	South of Salvatierra Drive	One Side	2
Alhambra Circle	North of Taragona Drive	South of Taragona Drive	One Side	2
Bird Road	Red Road	Riviera Drive	One Side	2
Campo Sano Avenue	Campo Sano Court	Pisano Avenue	One Side	2
Granada Boulevard	Marmore Avenue	Hardee Road	One Side	2
Granada Boulevard	South of Donatella Street	Pisano Avenue	One Side	2
Granada Boulevard	Jeronimo Drive	Orduna Drive	One Side	2
Granada Boulevard	Palermo Avenue	Anastasia Avenue	One Side	2
Granada Boulevard	Alfonso Avenue	North of S Alhambra Circle	One Side	2
San Amaro Drive	South of Certosa Avenue	Ancona Avenue	One Side	2
University Drive	South of Bird Road	North of Blue Road	One Side	2
University Drive	Bird Road	West of Toledo Street	One Side	2
University Drive	West of Anderson Road	Anderson Road	One Side	2
University Drive	Camilo Avenue	Sarto Avenue	One Side	2
University Drive	Salzedo Street	Ponce de Leon Boulevard	One Side	2
Alhambra Circle	North of Majorca Avenue	Douglas Road	Both Sides	3
Alminar Avenue	Vilabella Avenue	Le Jeune Road	Both Sides	3
Altara Avenue	Le Jeune Road	Laguna Road	One Side	3
Anastasia Avenue	San Domingo Street	Granada Boulevard	One Side	3
Bahia Vista Terrace	Isla Dorada Boulevard	End of Road	Both Sides	3
Cadagua Avenue	Suarez Street	Le Jeune Road	Both Sides	3
Campana Avenue	Old Cutler Road	Tanya Street	Both Sides	3
Campo Sano Avenue	Campo Sano Court	Campo Sano Avenue (east)	Both Sides	3
Campo Sano Court	Campo Sano Avenue (north)	Campo Sano Avenue (south)	Both Sides	3
Caoba Court	Paloma Drive	End of Road	Both Sides	3
Carillo Street	Granada Boulevard	Pisano Avenue	Both Sides	3
Cocoplum Road	Vera Court	Isla Dorada Boulevard	Both Sides	3
Conde Avenue	Old Cutler Road	End of Road	Both Sides	3

Street Name	Start	End	Missing Sidewalk?	Priority Tier
Coral Way	S Greenway Drive	Segovia Street	One Side	3
Cordova Street	Almeria Avenue	Sevilla Avenue	One Side	3
Cordova Street	Asturia Avenue	Coral Way	One Side	3
Costa Brava Court	Costanera Road	End of Road	Both Sides	3
Costanera Road	End of Road (north)	End of Road (south)	Both Sides	3
De Soto Boulevard	Catalonia Avenue	Cordova Street	One Side	3
De Soto Boulevard	East of Granada Boulevard	South of Almeria Avenue	One Side	3
Destacada Avenue	Old Cutler Road	End of Road	Both Sides	3
Distacada Cirlce	Destacada Avenue	End of Road	Both Sides	3
Dolias Court	Isla Dorada Boulevard	End of Road	Both Sides	3
E Lago Drive	W Lago Drive	End of Road	Both Sides	3
Florida Avenue	Dixie Highway	Brooker Street	Both Sides	3
Frow Avenue	Dixie Highway	Brooker Street	Both Sides	3
Gavilan Avenue	Paloma Drive	End of Road	Both Sides	3
Girasol Avenue	Old Cutler Road	End of Road	Both Sides	3
Granada Boulevard	North of Algaringo Avenue	South of Algaringo Avenue	One Side	3
Grant Drive	Le Jeune Road	Lincoln Drive	Both Sides	3
Guadalajara Street	Old Cutler Road	Chapman Trail Parking	One Side	3
Guadalajara Street	Chapman Trail Parking	End of Road	Both Sides	3
Hammock Drive	Banyan Drive	School House Road	Both Sides	3
Hammock Lakes Court	Hammock Lakes Drive	Lake Lane	Both Sides	3
Hammock Lakes Drive	School House Road	End of Road	Both Sides	3
Hammock Park Drive	School House Road	End of Road	Both Sides	3
Isla Dorada Boulevard	Cocoplum Road	Tahiti Beach Island Drive	Both Sides	3
Isla Dorada Boulevard	Sinsonte Avenue	Costanera Road (south)	Both Sides	3
Jefferson Drive	Washington Drive	Lincoln Drive	Both Sides	3
Jefferson Street	Grand Avenue	Dixie Highway	Both Sides	3
Jeronimo Drive	Granada Boulevard	Riviera Drive	Both Sides	3
Kerwood Count	Kerwood Oaks Drive	End of Road	Both Sides	3
Kerwood Oaks Drive	SW 55th Court	Kerwood Court	Both Sides	3
Lake Lane	Hammock Lakes Court	End of Road	Both Sides	3
Madison Lane	Washington Drive	End of Road	Both Sides	3
Madruga Avenue	East of Turin Street	Maynada Street	One Side	3
Madruga Avenue	Mariposa Court	East of Turin Street	Both Sides	3
Malvas Court	Orquidea Avenue	End of Road	Both Sides	3
Marin Street	Campana Avenue	End of Road	Both Sides	3
Mariposa Avenue	Turin Street	Maynada Street	Both Sides	3
Matheson Park	Old Cutler Road	Matheson Park Path	Both Sides	3
Matheson Park Path	Matheson Park	Fairchild Tropical Botanic Garden	Both Sides	3
Maynada Street	Augusto Stree	Hardee Road	Both Sides	3
Miami Homestead Avenue	Maynada Street	Granada Boulevard	One Side	3
Miller Road	University Concourse	Sardinia Street	One Side	3
Miller Road	Sardinia Street	Orduna Drive	Both Sides	3
Mira Flores Avenue	Lago Drive	End of Road	Both Sides	3
Monfero Street	Campana Avenue	Neda Ave	Both Sides	3
N Greenway Drive	S Greenway Drive	Segovia Street	One Side	3
Neda Avenue	Monfero Street	Paradela Street	Both Sides	3

Street Name	Start	End	Missing Sidewalk?	Priority Tier
Nogales Street (Conde Avenue)	North End of Road	South End of Road	Both Sides	3
Nogales Street (Sierra Circle)	North End of Road	South End of Road	Both Sides	3
Old Cutler Road	Snapper Creek Road (north)	South of Snapper Creek Road (south)	Both Sides	3
Orduna Drive	Miller Road (north)	Miller Road (south)	Both Sides	3
Orquidea Avenue	Isla Dorada Boulevard	Malvas Court	Both Sides	3
Paloma Drive	Caoba Court	End of Road	Both Sides	3
Paradela Street	Neda Avenue	End of Road	Both Sides	3
Paradiso Avenue	Orduna Drive	Paradiso Avenue Cutoff	One Side	3
Pisano Avenue	East of University Drive	Granada Boulevard	One Side	3
Riviera Court	Riviera Drive (north)	Riviera Drive (south)	Both Sides	3
Riviera Drive	Castania Avenue	Hardee Road	One Side	3
Riviera Drive	Bird Road	San Lorenzo Avenue	One Side	3
Riviera Drive	Ponce de Leon Boulevard	San Lorenzo Avenue	Both Sides	3
Rosales Court	End of Road (north)	End of Road (south)	Both Sides	3
Rovino Avenue	Monfero Street	End of Road	Both Sides	3
S Greenway Drive	N Greenway Drive	Coral Way	One Side	3
San Amaro Court	San Amaro Drive	Campo Sano Avenue	Both Sides	3
San Estaban Avenue	Monserrate Street	Palmarito Street	One Side	3
San Estaban Avenue	Anderson Road	Monserrate Street	Both Sides	3
San Remo Avenue	Nervia Street	Santona Street	One Side	3
School House Road	SW 88th Street	Hammock Park Drive	Both Sides	3
Sevilla Avenue	Country Club Prado (west)	County Club Prado (east)	One Side	3
Sevilla Avenue	Alhambra Circle	San Domingo Street	One Side	3
Sierra Circle	Old Cutler Road	Nogales Street	Both Sides	3
Sinsonte Avenue	Isla Dorada Boulevard	Paloma Drive	Both Sides	3
Snapper Creek Road	Lakeside Drive (south)	East of Lakeside Drive	Both Sides	3
Snapper Creek Road	Lakeside Drive (north)	Old Cutler Road	Both Sides	3
Suarez Street	Blue Road	Riviera Drive	One Side	3
SW 55th Court	Kerwood Oaks Drive	End of Road	Both Sides	3
SW 95th Street	Banyan Drive	SW 55th Court	Both Sides	3
Tahiti Beach Island Drive	Isla Dorada Boulevard	End of Road	Both Sides	3
Tanya Street	Campana Avenue	Marin Street	Both Sides	3
Tulipan Court	Mira Flores Avenue	End of Road	Both Sides	3
Turin Street	Madruga Avenue	Mariposa Avenue	Both Sides	3
University Concourse	Granada Boulevard	Miller Road (west)	One Side	3
Vera Court	Cocoplum Road	End of Road	Both Sides	3
Vilabella Avenue	Ronda Street	Riviera Drive	Both Sides	3
W Lago Drive	E Lago Drive	End of Road	Both Sides	3
Washington Drive	Grant Drive	Lincoln Drive	Both Sides	3

Intersection Infrastructure & Implementation Recommendations

Location	Treatment	Description	**Priority Tier**
Ponce De Leon Boulevard/Madeira Avenue	Add Crosswalk	Add crosswalk across Ponce De Leon Boulevard	1
Ponce De Leon Boulevard/Romano Avenue	Add Crosswalk	Add crosswalk across Ponce De Leon Boulevard	1
Cardena Street/Coral Way	Add Crosswalk	Add crosswalk across Coral Way	1
Granada Boulevard/N Greenway Drive	Construct Roundabout	Construct a mini-roundabout	1
Granada Boulevard/S Greenway Drive	Construct Roundabout	Construct a mini-roundabout	1
Douglas Road/Merrick Way	Pedestrian Signals and Crosswalks	Add signalized pedestrian crossing for northwest leg of the intersection	1
Hernando Street/Coral Way	Rapid Flashing Beacon	RRFB, potential early merge with bulb outs	1
Salzedo Street- Between Catalonia Avenue and Sevilla Avenue	Pedestrian Signals and Crosswalks	Add midblock crossing (near a school, major commercial center, mix of land uses)	1
Le Jeune Road/Valencia Avenue	Median Refuge Island	Ideas include: pedestrian refuge island on north side of intersection, crosswalk south side of intersection, no right turn on red, leading pedestrian intervals	1
Douglas Road/Almeria Avenue	Median Refuge Island	Offset crosswalk, median island, etc.	1
Anderson Road/Coral Way	Pedestrian Signals and Crosswalks	Add crosswalks, figure out how to safely add crossings with channelized right turns	1
Anderson Road/Biltmore Way	Roadway Narrowing	Ideas: add crosswalks, remove merge lane, one lane each for EB and WB traffic	1
Le Jeune/Catalonia Crossing	Add Crosswalk	Add crosswalk to connect housing with businesses and school	1
Le Jeune/Aragorn Ave	Pedestrian Signals and Crosswalks	Add pedestrian-only signal phase and prevent EB/WB right turn on red	1
Granada Boulevard/Alhambra Circle	Add Crosswalk	Add crosswalks for all intersection legs	2
Alhambra Circle/Bird Road	Add Crosswalk	Add crosswalks across Bird Road	2
Anderson Road/Sevilla Avenue Traffic Circle	Add Crosswalk	Add missing crosswalks	2
Anderson Road/University Drive	Add Crosswalk	Add crosswalks across University Drive	2
Madrid Street/Coral Way	Add Crosswalk	Add crosswalks across Coral Way	2
Anderson Road/Escobar Avenue Traffic Circle	Add Crosswalk	Add crosswalks around traffic circle	2
Ponce De Leon Boulevard/Campina Ct	HAWK Signal	Install crossing and HAWK Signal across Ponce de Leon Boulevard	2
Ponce De Leon Boulevard/Boabadilla St	Add Crosswalk	Install crosswalk across Ponce de Leon Boulevard	2
Ponce De Leon Boulevard/Oviedo Ave	Add Crosswalk	Install crosswalk across Ponce de Leon Boulevard	2
Granada Boulevard/Venetia Terrace	Add Crosswalk	Add crosswalks	2
Columbus Boulevard/Coral Way	Pedestrian Signals and Crosswalks	Remove channelized turning movements and add pedestrian signals	2
Granada Boulevard/Coral Way	Pedestrian Signals and Crosswalks	Signalize intersection and remove channelized turning movements	2
Ponce de Leon Blvd/Phoenetia Ave	HAWK Signal	Install crossing and HAWK Signal across Ponce de Leon Boulevard	2
Bird Road/University Drive	Pedestrian Signals and Crosswalks	Add pedestrian crossing at existing signal	2

Location	Treatment	Description	Priority Tier
Blue Road/University Drive	Construct Roundabout	Construct roundabout with pedestrian infrastructure	2
Blue Road/Granada Blvd	Construct Roundabout	Construct roundabout with pedestrian infrastructure	2
University Dr/Durango St	Add Crosswalk	Add crosswalk to access school	2
57th Avenue/Corniche Avenue	Add Crosswalk	Add crosswalk	3
Granada Boulevard/Bird Road	Add Crosswalk	Add pedestrians crossing to all legs of intersection	3
Anderson Road/Jeronimo Drive	Construct Roundabout	Construct a mini-traffic circle or roundabout	3
Alhambra Circle/Coral Way	Pedestrian Signals and Crosswalks	Improve pedestrian crossing conditions, add crosswalk across northwest leg of intersection	3
Anderson Road/Bird Road	HAWK Signal	Install crossing and HAWK Signal across Bird road	3
Pinta Court/Bird Road	HAWK Signal	Install crossing and HAWK Signal across Bird road	3
Palmarito Street/Bird Road	HAWK Signal	Install crossing and HAWK Signal across Bird road	3
Tiziano Park	Add Crosswalk	Access to Tiziano Park	3
Andalusia Avenue/Cordovia Street	Add Crosswalk	Access to Salvadore Park	3
Andalusia Avenue/Columbus Boulevard	Add Crosswalk	Access to Salvadore Park	3
Pierce Park	Add Crosswalk	Access to Pierce Park	3
Rotary Centennial Park	Add Crosswalk	Access to Rotary Centennial Park	3
Venetial Pool- Almeria Avenue/Toledo Street	Add Crosswalk	Access to Venetial Pool	3
Ponce de Leon Park	Add Crosswalk	Access to Ponce de Leon Park	3
William A Cooper Park	Add Crosswalk	Access to Cooper Park	3
Young Park	Add Crosswalk	Access to Young Park	3
Country Club Prado (N)	Add Crosswalk	Access to Country Club Prado	3
Country Club Prado (S)	Add Crosswalk	Access to Country Club Prado	3
Granada Golf Course	Add Crosswalk	Access to Granada Golf Course	3
Cerepo Memorial Park	Add Crosswalk	Access to Cerepo Memorial Park	3
Betsy Adams Park	Add Crosswalk	Access to Betsy Adams Park	3
Nellie B. Moore Park	Add Crosswalk	Access to Nellie B. Moore Park	3
Jaycee Park	Add Crosswalk	Access to Jaycee Park	3
Orduna Drive/Miller Road Triangle	Add Crosswalk	Access to Orduna Drive/Miller Road Triangle	3
Blue Road Open Space	Add Crosswalk	Access to Blue Road Open Space	3
Alcazar Plaza	Add Crosswalk	Access to Alcazar Plaza	3
Coral Bay Park	Add Crosswalk	Access to Coral Bay Park	3
Loretta Sheehy Park	Add Crosswalk	Access to Loretta Sheehy Park	3
Alhambra Water Tower Park	Add Crosswalk	Access to Alhambra Water Tower Park	3
Fairchild Tropical Botanic Gardens	Add Crosswalk	Access to Fairchild Tropical Botanic Gardens	3
Dixie Highway/Marius St	Pedestrian Signals and Crosswalks	Add pedestrian signal for access to middle school (and access to M Path)	3
72nd St/Nervia St	Add Crosswalk	Add crosswalk to access school	3

Bicycle Infrastructure & Implementation Recommendations

Implementation Phase	Street Name	Start	End	Bicycle Facility Recommendation
1	Augusto Street	Miami-Homestead	US 1	Bike Boulevard
	Caballero Boulevard	Madruga Avenue	US 1	
	Galiano Street	Coconut Grove Drive	Alhambra Circle	
	Granada Boulevard	Sunset Drive	US 1	
	Hardee Road	Caballero Boulevard	Mariposa Court	
	Mendoza Avenue	Segovia Street	Galiano Street	
	Milan Avenue	S Red Road	Segovia Street	
	Maggiore Street	San Vincente	US1	
	Riviera Drive	University Drive	Segovia Street	
	Salzedo Street	Miracle Mile	Minorca Ave	
	SW 15th Terrace	Casilla Street	Segovia Street	
	SW 16th Street	Segovia Street	Salzedo Street	
	Valencia Avenue	De Soto Boulevard	S Le Jeune Road	
	Palermo Avenue	S Le Jeune Road	Ponce de Leon Boulevard	Bike Lane, Buffered Bike lane, Separated Bike Lane or Shared Use Path
	Riviera Drive	US 1	University Drive	
	Sevilla Avenue	S Red Road	Ponce de Leon Boulevard	
	S Alhambra Circle	Hernando Street	S Douglas Road	Buffered Bike lane, Separated Bike Lane or Shared Use Path
	University Drive	Granada Boulevard	Ponce de Leon Boulevard	
	Biltmore Way	Cardena Street	Coral Way	Separated Bike Lane
	Oviedo Avenue	Galiano Street	Ponce de Leon Boulevard	
	Salzedo Street	University Drive	Miracle Mile	
	Salzedo Street	Minorca Ave	Tammiami Trail/US 41	
	Valencia Avenue	S Le Jeune Road	S Douglas Road	
	M-PATH (Future Underline	S Red Road	Ponce de Leon Boulevard	Shared Use Path
	Bird Avenue	University Drive	Granada Boulevard	
2	Columbus Boulevard	N Greenway Drive	Tammiami Trail/US 41	Bike Boulevard
	De Soto Boulevard	Anastasia Avenue	Granada Boulevard	
	Maderia Avenue	Cortez Street	Douglas Road	
	Obispo Avenue	S Red Road	Cortez Street	
	Venetia Terrace	Columbus Boulevard	Columbus Boulevard	
	Alhambra Circle	Bird Road	Coral Way	Bike Lane, Buffered Bike Lane, Separated Bike Lane or Shared Use Path
	Country Club Prada	Sevilla Avenue	Tammiami Trail/US 41	
	De Soto Boulevard	Granada Boulevard	Andalusia Avenue	
	Granada Boulevard	Pisano Avenue	Bird Rad	
	University Drive	Pisano Avenue	Bird Avenue	
	Alhambra Circle	San Amaro Drive	Bird Road	Buffered Bike Lane,
	Campo Sano Avenue	San Amaro Drive	University Drive	Shared Use Path
	De Soto Boulevard	Andalusia Avenue	Anderson Road	
	Granada Boulevard	US 1	Pisano Avenue	
	Pisano Avenue	University Drive	Granada Boulevard	
	San Amaro Drive	Ponce De Leon	Campo Sano Avenue	

Implementation Phase	Street Name	Start	End	Bicycle Facility Recommendation
3	S Biltmore Drive	Riviera Drive	Blue Road	Bike Boulevard
	Madruga Avenue	S Red Road	Madruga Avenue	
	Mariposa Avenue	Hardee Road	Maynada Street	
	Mariposa Court	Mariposa Avenue	US 1	
	Maynada Street	Mariposa Avenue	Augusto Street	
	Zamora Avenue	Salzedo Street	Douglas Road	
	SW 22th Avenue	SW 16th Street	SW 15th Terrace	
	Cadiz Avenue	S Red Road	Alhambra Circle	Bike Lane, Buffered Bike lane, Separated Bike Lane or Shared Use Path
	Santona Street	Madruga Avenue	US 1	
	Segovia Street	Andalusia Avenue	Alhambra Circle	
	Blue Road	S Red Road	US 1	Buffered Bike lane, Separated Bike Lane or Shared Use Path
	Sunset Drive	US 1	Maynada Street	
	Granada Boulevard	Bird Road	Sevilla Avenue	
	Andalusia Avenue	S Le Jeune Road	Douglas Road	Separated Bike Lane
	Coral Way	S Greenway Drive	S Douglas Road	
	Milan Street	Milan Avenue	Milan Avenue	
	Sunset Drive	Maynada Street	Old Cutler Road	
	Anderson Road	De Soto Boulevard	Coral Way	Shared Use Path
	Brescia Avenue	S Red Road	San Amaro Drive	
	Levanta Avenue	S Red Road	San Amaro Drive	
	Miller Road	S Red Road	San Amaro Drive	
	Miracle Mile	S Le Jeune Road	S Douglas Road	
	N Greenway Drive	S Greenway Drive	Coral Way	
	S Greenway Drive	N Greenway Drive	Coral Way	
	Old Cutler Road	Matheson Park	Fairchild Tropical Gardens Entrance	
	Old Cutler Road	Snapper Creek Road	Red Road	

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