TPO
Miami-Dade Transportation Planning Organization

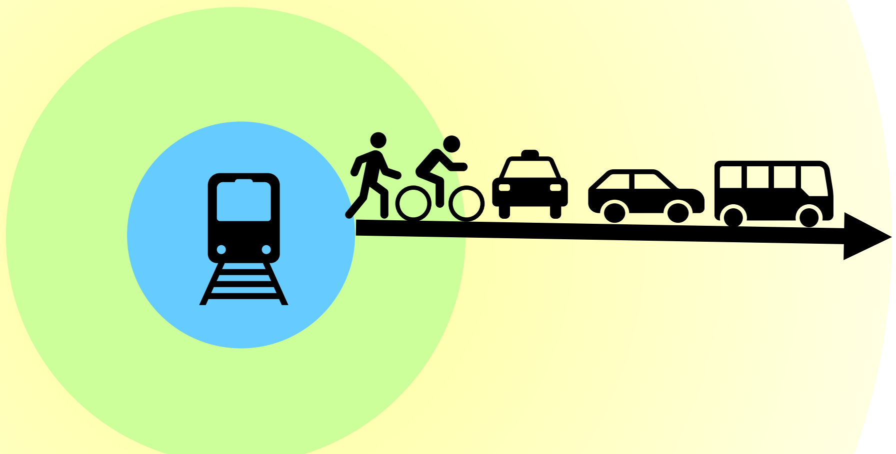
First Mile - Last Mile

Options with High Trip Generator Employers

DECEMBER 15, 2017









THE CORRADINO GROUP
Engineers • Planners • Program Managers • Environmental Scientists

FIRST MILE - LAST MILE

OPTIONS WITH HIGH TRIP GENERATOR EMPLOYERS

JANUARY 31, 2018

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FLM SUMMARY

The SMART Plan corridors will include stations that will have redevelopment plans to create transit oriented developments (TOD); however, the scope of TOD is limited by the walking time to and from the station. Many residential neighborhoods, workplaces, and other major destinations will be beyond an easy walk to a station. The purposes of developing First/Last Mile (FLM) mobility options are to:

- extend the service area for high capacity transit corridors;
- increase transit ridership potential;
- reduce single occupant vehicle miles;
- reduce roadway congestion;
- reduce greenhouse gas emission;
- improve the overall welfare of the community by reducing travel time;
- stress and cost to commute;
- and be more competitive for federal funding.

FLM mobility options include a wide range of modal options and delivery models (public and private). As much as FLM innovations leverage innovative vehicles, mobile communication technologies and sharing business models, the basics are also important: sidewalks with safe crossings, safe and convenient bicycle infrastructure. The Study looks at the wide range of these modal groups, infrastructure needs and policy needs, and identifies basic findings to address the needs of people, and develops a tool-kit of practical, context sensitive solutions to implement FLM mobility.

KEY FINDINGS

Key findings of the study include:

- The study begins with simple TOD scenario analysis to determine potential markets based on the number of people that are within range of the transit station as TOD residents and daytime visitors.
- While the focus of TOD has been the ¼ -mile walking distance, research implies that time is a more direct measure that is perceived by travelers, and motivates transit access decisions. The time is 5 to 10 minutes for any modal option, and includes delay time.
- Different FLM modes create different distances for transit access, and can vastly increase a transit shed for high-capacity transit.
- The primary mode is still walking, and the 5 to 10-minute walk corresponds to the traditional ¼ to ½ mile, but distance is greatly reduced by traffic signal time safety and delay including presence of protected crossings, granularity of development, perceived security, and accessibility.
- Bicycle travel is now augmented by a variety of new modes that are personal, often human powered (active) but increasingly battery-electric. It is also further supported by the increasing presence of bike sharing. The Bicycle Modal Group is the most efficient group and increases the transit shed distance to over 2 miles (an increase in area of 64 times)
- Vehicular travel to transit is also augmented by technology and the potential of battery electric vehicles. As an FLM modal group, it is also further supported by sharing business models, and will be further supported by the adaption of autonomous

vehicles. Careful development of strategies is needed to support vehicular FLM so as not to increase vehicular primary trips.

- Transit FLM transit is also augmented by autonomous technology and battery electric propulsion. As an FLM modal group, there is a strong direction toward private providers that can rapidly adapt to changing demand. Careful development of strategies is needed to support private transit FLM to integrate efficiently and equitably with public transit.

TOOL KIT PRACTICAL STRATEGIES

The Study includes 47 Tool Kit strategies for implementing FLM, depending on the urban context, primary transit mode, infrastructure in place, infrastructure needs, community economics, environmental impact, and implementation time horizon.

The Tool Kit is organized by modal groups:

1. Transit Oriented Development
2. Pedestrian
3. Bike Board and Skate
4. Vehicles
5. Transit

Within each modal group, are toolkits relating to a range of strategies to support development of FLM:

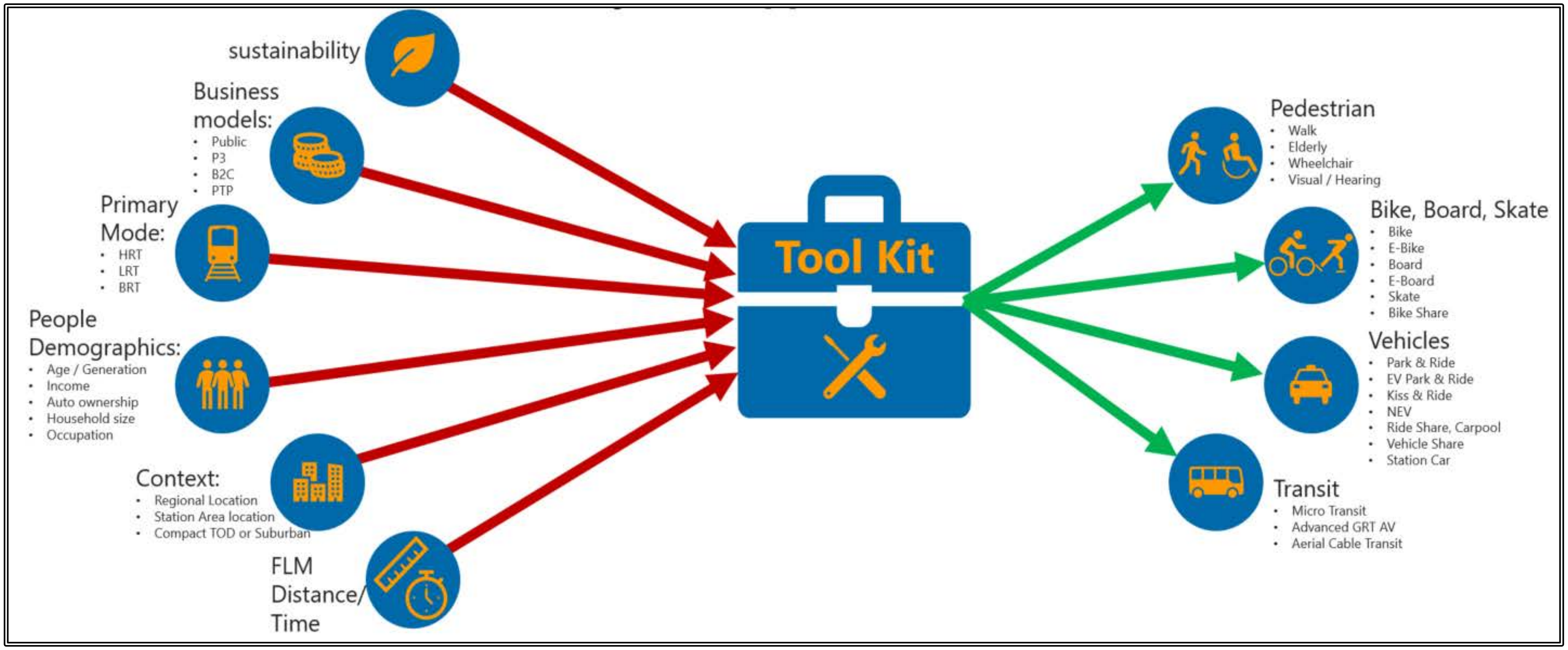
- Needs Assessment – Data Collection
- Land Use Policy
- Platting Policy
- Parking Policy
- Permitting Policy
- Public Realm Infrastructure Design
- Station Development and Design Considerations
- Roadway Operations
- Alternative Transit Modes, such as Micro Transit, AGT and ACT

LIST OF TOOL KIT STRATEGIES & TIMEFRAME

Transit Oriented Development FLM Tool Kit Strategies		
D1.	Land Use Planning	Short Term
D2.	Land Development Regulation	Short Term
D3.	Re-platting Decisions	Midterm/On-going
Pedestrian FLM Tool Kit Strategies		
P1.	Transit Access Pedestrian Survey	Short Term
P2.	Transit Access Pedestrian Audit	Short Term
P3.	Adequate Sidewalks	Short Term/Ongoing
P4.	Enhanced Crosswalks	Short Term/Ongoing
P5.	Diagonal Crossings	Short Term/Ongoing
P6.	Midblock Crosswalks	Short and Midterm
P7.	Signal Operations	Short Term/Ongoing
P8.	Pedestrian Lighting	Midterm/On-going
P9.	Pedestrian Path Network	Short Term
P10.	Barrier Bridges	Short Term/Ongoing
P11.	Pedestrian Amenities	Midterm/On-going
P12.	Way Finding	Midterm/On-going
Bike Board & Skate FLM Tool Kit Strategies		
B1.	Transit Access Bike & Skate Survey	Short Term
B2.	Bike & Skate Transit Access Audit	Short Term
B3.	Bike, Board & Skate Continuous Path	Short Term
B4.	Vehicular Travel Lane Width	Midterm/On-going
B5.	Bicycle & Rolling Lanes	Short Term/Ongoing
B6.	Shared ROW & Bicycle Boulevards	Short Term/Ongoing
B7.	Signal Operations	Short Term/Ongoing
B8.	Barrier Overpasses & Underpasses	Short Term/Ongoing
B9.	Carriage on Transit Vehicles – Bikes	Short Term
B10.	Transit Station Bicycle Storage	Midterm/On-going
B11.	Transit Station Bicycle Sharing	Midterm/On-going

B12.	Transit Station Bicycle Station	Midterm/On-going
B13.	Station Area Short-Term Bicycle Parking	Midterm
B14.	Board & Skate Access	Short Term/Ongoing
Vehicular FLM Tool Kit Strategies		
V1.	Person Trip Capacity Methodology	Short Term
V2.	Transit Station Pick-Up & Drop Off	Long Term
V3.	Station Area Pick-Up & Drop-Off	Midterm/Ongoing
V4.	Station Cars	Midterm/On-going
V5.	Plug-In Electric Station Cars	Midterm/On-going
V6.	NEV Station Cars	Midterm/On-going
V7.	Car Share Parking Policies and Fees	Short Term
V8.	NEV Prioritization	Midterm/On-going
V9.	AV Infrastructure	Long Term
V10.	Transit Station Parking	Midterm/On-going
Transit FLM Tool Kit Strategies		
T1.	Transit Signal Priority	Short Term/On-going
T2.	Queue Jumps and Bottleneck By-Passes	Midterm/On-going
T3.	Exclusive Bus Lanes	Midterm/On-going
T4.	Level-Boarding Transit Area Bus Stops	Midterm/On-going
T5.	Level-Boarding Transit Station Bus Stop	Midterm/On-going
T6.	Micro Transit	Short Term/On-going
T7.	Advanced Group Rapid Transit	Long Term
T8.	Aerial Cable Transit (ACT)	Long Term

Tool Kit Inputs and Outputs



IMPLEMENTATION

Implementation of the FLM will be through the toolbox strategies which range from short-term, before corridor transit development in preparation to support transit forecasts; to mid-term and long-term, during the construction of SMART Corridor high-capacity transit facilities and/or land development of transit station areas.

Future mechanisms for the Miami-Dade Transportation Planning Organization (TPO), Miami-Dade Department of Transportation and Public Works (DTPW), and Miami-Dade Planning to implement Tool Kit strategies, after acceptance of the Study include:

- SMART Plan Land Use Studies
- SMART Plan Economic Mobility Analyses
- Miami-Dade 2045 Long Range Transportation Plan (LRTP)
- Miami-Dade Transportation Improvement Program (TIP), 2018-2023
- Transportation demand modelling for SMART Plan Corridor
- Miami Dade Transit Development Program (TDP)
- Miami-Dade Comprehensive Development Master Plan (CDMP) transportation and future land use policy amendments

Many other Tool Kit strategies involve coordination of Miami-Dade County with the private sector providers of FLM Mobility.

Current Actions:
Dynamic Route On-Demand Micro Transit Demonstration Projects

The final draft of the Study was used in December 2017 to support the application by DTPW toward seeking funding to implement two Dynamic Routed On-Demand Micro Transit Demonstration Projects along the existing Metro Rail lines as FLM strategies. The demonstration programs are:

- North Corridor Dynamic Routed On-Demand Micro Transit Demonstration for MetroRail FLM in the Earlington Heights Area;
- South Corridor Dynamic Routed On-Demand Micro Transit Demonstration for MetroRail FLM in the Dadeland Area.

Current Actions:
GIS-based Accessibility Model Test Coordination

The study was also used to test an Accessibility GIS-based model for one of the two case studies. In its current state of development, the Accessibility model efficiently identified pedestrian FLM infrastructure improvements.

1 INTRODUCTION

For an urban traveler that is not driving their own car from doorstep to doorstep, the first and last part of their trip is often perceived as the longest, the most time consuming, the most uncomfortable, and the least reliable. For people to ride transit, their journey does not start when they board transit and does not end where they alight. Their trip begins when they walk to or from the transit stop, or ride a bike, take a taxi, share a car ride or use some other transportation for the connecting parts of their journey.

The connecting journeys before and after the transit ride are influential enough to encourage or discourage a person to ride transit again. A transit traveler evaluates the desirability of a transit trip based on multiple criteria for the entirety of the door-to-door journey. The satisfaction of each part of the journey is not evenly weighted based on actual distance or time, but perceptually weighted based on a person's own needs and comfort levels for each part of the trip. In this way, the 5-minute walk in undesirable conditions can discourage a 15-minute transit journey, even if the person will use more total time and cost to make the journey by a personal automobile. The resulting dilemma is ubiquitous in urban areas: half empty rail transit lines speeding past highways congested with single-occupant vehicles.

Not only are the first and last legs of the trip disproportionate in their effect on transit demand, but their impact on transit providers is also disproportionate. For mass transit providers and especially for major fixed right-of-way investments like rail, productivity and efficiency depend on large numbers of people moving along linear transit sheds of a walkable distance to transit stops. The more complete the network, the higher the utilization that can be expected. To complete the network with conventional transit, services become inefficient and difficult to sustain without higher than average subsidies.

The First Mile - Last Mile, shortened to First/Last Mile (FLM) is a term now applied to transit, but was originally coined for use in logistics businesses (Fed EX, UPS, etc.) and telecommunications industries, for which high utilization and system efficiency for the "trunk" line services depend on establishing many smaller, less-efficient connections over short distances. For this reason, in the logistics and utility fields, it is commonly called the "First/Last Mile Dilemma." For physical infrastructure, it is expensive to match high capacity hubs to individual user locations. In the 1970s and 1980s, cable TV companies had to individually wire each household very high cost; however, a cost that would be amortized over many years.

The FLM Dilemma is also true for transit providers. For this reason, transit agencies and cities across the nation are working to develop and implement strategies to improve FLM connections to their transit services, stops, and stations to facilitate seamless and convenient travel experiences and attract more riders.

Successful fixed-route transit services rely on direct alignments through high-density corridors. Traditionally, it was left to individual riders to get themselves to and from transit stops by walking, bicycling, driving, or getting dropped off or picked up. Starting in the 1970's, public agencies, employers, and Transportation Management Associations (TMAs) have been providing shuttle connections, dial-a-ride and car-pooling services to facilitate FLM mobility, and more recently, private companies have begun to provide FLM services that connect to major transit lines.

Increased route coverage with fixed route deviations or fixed route feeder services is often not cost-effective for increasing ridership. As a result, other FLM strategies must be used.

The need for new FLM strategies to support ever increasing pressure for greater utilization and expansion of urban mass transit has never been greater. Fortunately, information and vehicular technology innovation, as well as disruptive person-to-person (P2P) and public-private-partnership (3P) delivery models are transforming urban FLM mobility. From traditional to the cutting edge, the range of FLM connective modes, technologies and delivery models include many options that can be organized into 4 modal groups:

- **Pedestrian Modal Group:**
    - Walking
    - Special needs for elderly or people using wheelchairs
- **Bicycle, Board & Skate Modal Group:**
    - Personal Bicycles
    - Bike Sharing
        - Dock-based
        - Dockless
    - E-Bikes and E-bike Sharing
    - Skateboards
    - Electric Skateboards
    - Foot Skates
    - Segway and other Personal Mobility
- **Vehicular Modal Group:**
    - Park-and-Ride
    - Kiss-and-Ride
    - Park-and-Ride with Plug-In Electric Vehicles (PEV)
    - Neighborhood Electric Vehicles (NEV)
    - Car Sharing:
        - Pod-based,
        - Free Floating
        - Station Cars
        - Peer-to-Peer Networks
    - Ride Sharing & Traditional Taxi
    - Autonomous Vehicles (AV) Station Cars
- **Transit Modal Group:**
    - Conventional Transit Services – Public Provider
    - Micro Transit – Private Providers and some P3
    - Advanced Group Rapid Transit (GRT)
    - Aerial Cable Transit (ACT)



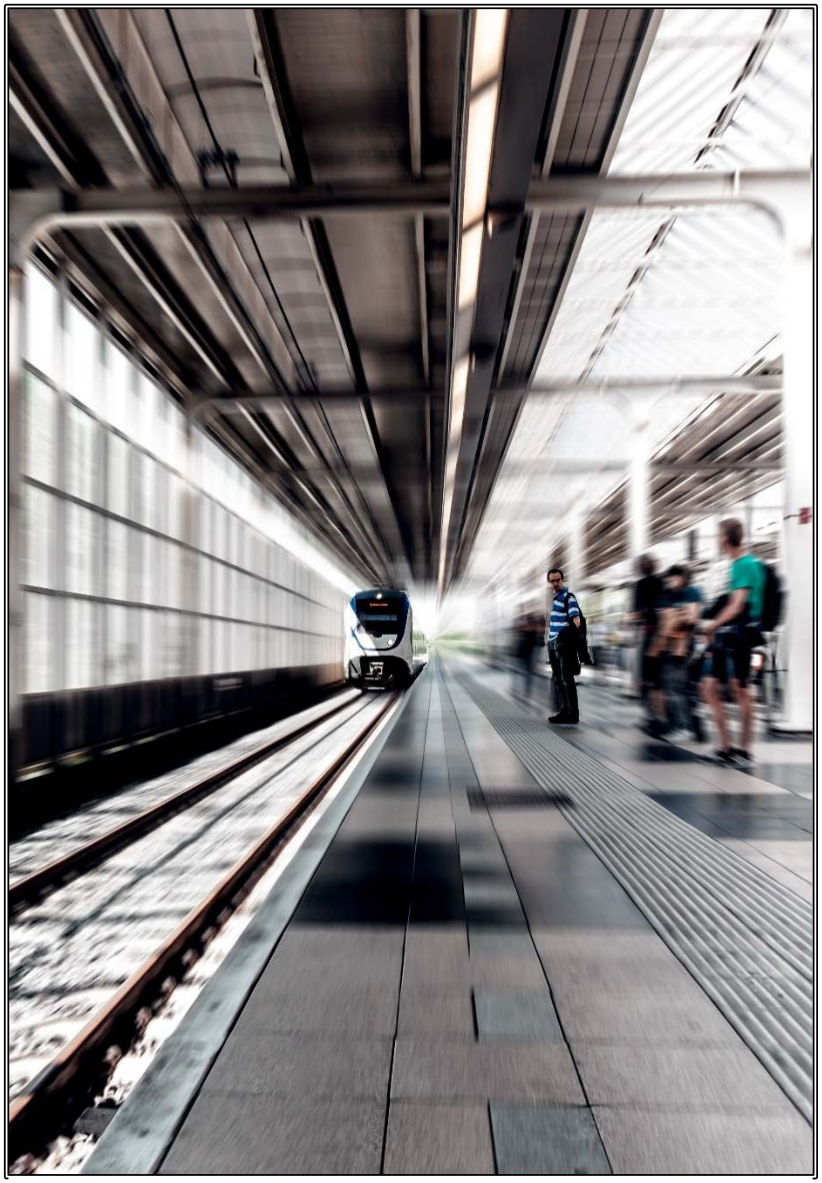



Each mode has its own characteristics of suitability that are context sensitive. Each whether owned or operated by governmental entities or not, has its own specific needs for infrastructure, policy and regulatory support, funding, and integration with primary fixed-route transit systems. As each of the modes are affected by: 1) greater acceptance from end users, 2) more innovation in delivery models, and 3) continued technological advancement, the modal option fuse into a continuum of overlapping FLM strategies.

For both telecommunications and logistics, FLM has large literatures of public and private research to use toward optimizing these complex chains, but packages and digital signals are not people. People make mode choices that are not centrally controlled and are difficult to predict at an individual level. Notwithstanding similarities between telecommunications, goods movement and passenger travel, FLM for transit is behavioral, so recommending FLM strategies starts with starts with understanding travel choices based not only on characteristics of the mode, but also on the built environment in which it operates, the demographics of travelers, and the *comparative* characteristics of the FLM modes.

An individual's preference to use fixed-route transit for a linked journey, is dependent on comparative preferences about real and perceived travel advantages, such as:

- journey time
- time enroute
- wait time
- reliability
- comfort
- security
- convenience
- integrated real-time travel information
- multi-tasking connectivity, and
- out-of-pocket cost



Urban High Capacity Rail Station: Amsterdam Amstel Station
(photo credit, Reginar, Unsplash creative commons license)

Modeling accurate forecasts of adaptation for non-transit users to switch to transit use is complex, and each combination of mode, technology and delivery model varies in its suitability for different environments. The criteria are assumed to be:

- Primary fixed-transit mode that FLM mode connects to;
- Distance between home origins and transit station / stop;
- Distances between commercial destinations and transit stations;
- Multi-modal infrastructure among origins, destinations and transit stations (pedestrian, non-motorized, and vehicular facilities in complete streets)
- Residential densities and commercial intensities for FLM transit shed areas, as a proxy people that create the demand for travel;
- Land use mix as it relates to internal capture relative to the vehicular network and the importance of the pedestrian and bike network;
- Station facilities to accommodate specific modes;
- Street grid connectivity;
- Attractive “friendly” paths for pedestrians and non-motorized modes (trees, building transparency, scale and orientation) that are safe, secure and include placemenking as points of interest to increase walking distance.

From a transit perspective, the goal of FLM strategies is two-fold:

1) increase the size of the transit shed and the total number of people from which transit can draw a percentage of travel;
2) increase the percentage of transit share, further improving the viability of planned transit.

By policy, the transit shed is ¼-mile to ½-mile on each side of a fixed route transit line. It is possible that in many areas, the actual transit shed is smaller because of environmental conditions. FLM strategies expand the transit shed from a ½ mile corridor to 2 miles or more by improving options to meet the demand of new transit travelers in the expanded corridors.

Urban CBD Transit Context with Bus
(Photo credit, Florida TOD Guide)


General Urban Transit Context with Light Rail Transit (LRT)
(Photo credit, Florida TOD Guide)


Suburban Transit Context
(Photo credit, Florida TOD Guide)

A secondary outcome is a symbiotic interaction between transit and FLM, whereby at shorter distances FLM supports a high capacity transit corridor, and at longer distances, FLM becomes a primary mode for other travelers. In both cases, single-occupant vehicle trips are replaced; reducing congestion, improving air quality, reducing energy use improving urban quality of life, and supporting more equity in urban mobility.

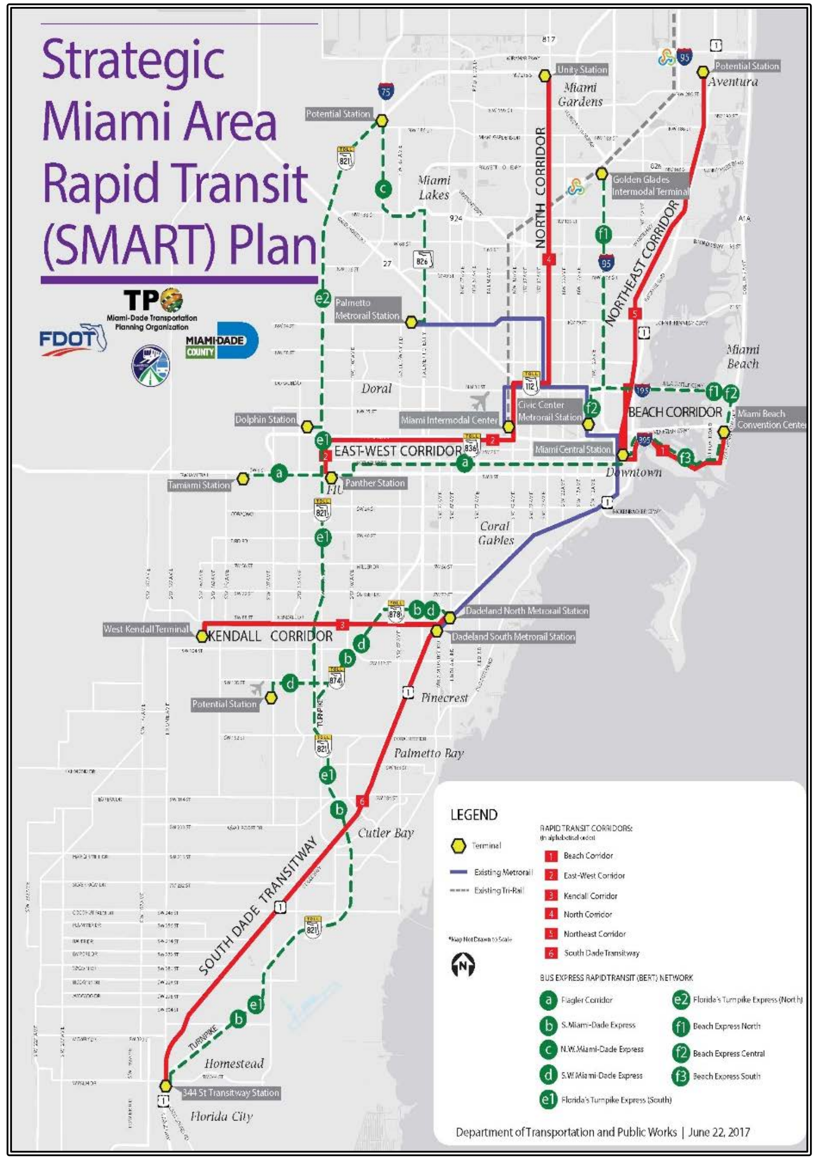
For Miami-Dade County, the goal of the of FLM strategies is focused on supporting the *Strategic Miami Area Rapid Transit* (SMART) Plan: a comprehensive program of projects to significantly improve mobility in Miami-Dade County and the South Florida Region.

The SMART Plan will address the mobility needs in Miami-Dade County through development of fixed-route, high capacity rapid transit in each of six corridors:

- Beach Corridor (MacArthur Causeway)
- East-West Corridor (SR-836)
- Kendall Corridor (SW 88th Street)
- North Corridor (NW 27th Avenue)
- Northeast Corridor (Tri-Rail Coastal Link)
- South Dade Transit Way (South Dixie Highway / US-1)

The SMART Plan will also develop a network of nine Bus Express Rapid Transit (BERT) services, including:

- Flagler Corridor
- South Miami-Dade Express
- Northwest Miami-Dade Express
- Southwest Miami-Dade Express
- Florida's Turnpike Express, South
- Florida's Turnpike Express, North
- Beach Express, South
- Beach Express, Central
- Beach Express, North



Miami-Dade SMART Plan Corridors

While these corridors have been examined in the past, what makes the SMART Plan unique is its approach to develop a comprehensive, county-wide transit system. All six corridors are moving forward in the Preliminary Design & Engineering (PD&E) studies at the same time. After the findings for each corridor are evaluated, a unified plan will be developed to move forward as a Program of Interrelated Projects, which will include: New Starts, Small Starts, and Core Capacity Projects, as defined by the Federal Transit Administration (FTA).

Each corridor and rapid transit project will have unique needs based on the context and primary modes identified. Development and implementation of FLM strategies in the corridors can improve the project justification ratings for FTA funding, by:

- *Mobility*: Increasing the total number of linked trips using each proposed project;
- *Transit Dependent Mobility*: Creating viable link options for transit dependent (low income or no-car households) trips beyond the ½ -mile corridor;
- *Tools to Implement Land Use Policies*: Extending the potential area to implement transit-supportive land use policies and joint developments;
- *Impact on Regional Land Use*: Extending the station area of influence to cause economic development effects by increasing the area of land available for transit supportive development for housing and commercial employment opportunities;
- *Plans and Policies to Maintain or Increase Affordable Housing*: Extending the station influence areas for the transit project with transit-supportive development of affordable housing in the corridors.

Urban High Capacity Transit Corridor: proposal for Hialeah, Florida (exhibit courtesy of Plus Urbia LLC)

Urban Transit Corridor with FLM Strategies: proposal for SW 8th St. Miami, Florida (exhibit courtesy of Plus Urbia LLC*)*

While a major focus of FLM strategies is the support of SMART Plan corridor funding potentials, FLM is uniquely different from major transit capital projects in its diversity of delivery options.

Traditionally, the delivery of mobility improvements has been through mechanisms of local, state and federal funding for planning, environmental analysis, design and construction. The transit infrastructure, equipment and stations are typically constructed, owned and operated by government entities or public authorities.

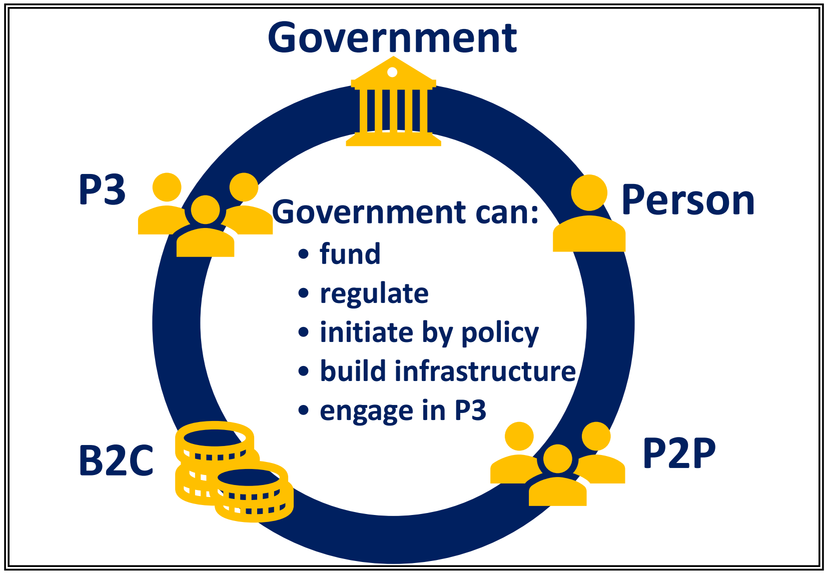
Deployment of FLM strategies includes these mechanisms; however, the most prominent growth of FLM has been through the entry of private companies and non-government organizations into urban mobility markets. In some cases, this has been the participation of private companies owning and operating traditional public transportation services such as vanpools, micro transit, and taxis.

The largest growth of FLM options is through the rapid expansion of networked car sharing (such as Uber, Lyft, Via), pod-based car sharing located at transit stations, and privately-owned and operated bicycle sharing in docked or dockless models with significant bike availability at transit stations. Delivery models that are already involved in providing FLM mobility strategies include:

- Government (traditional public funding, ownership & operation)
- Personal (traditional walking, biking, and park-and-ride)
- Public-Private Partnerships (P3)
- Business to Consumer (B2C)
- Peer-To-Peer (P2P)

For the purposes of governmental actions, the emphasis is on using its resources to fund, regulate, build infrastructure, initiate by policy, and engage in partnerships in ways that support and foster the development of privately-owned and operated mobility options.

Car 2 Go Car Sharing, Coconut Grove, Miami, FL

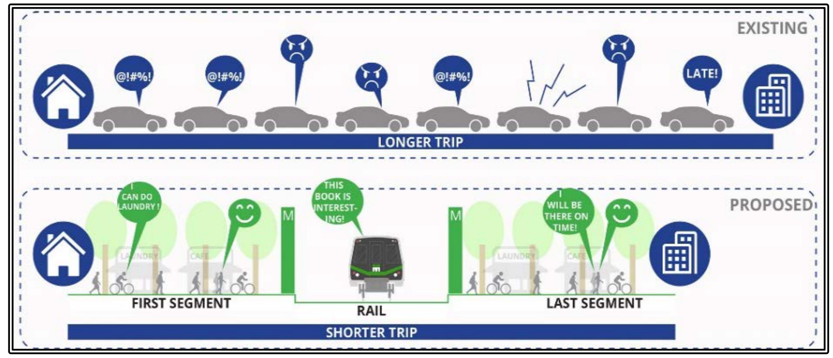


First / Last Mile Delivery Models:
business/ownership/consumer models and role of government

FIRST & LAST MILE MOBILITY GOALS

The purpose of the FLM Mobility is to foster economically, ecologically and socially sustainability urban mobility by integrating traditional transit and transportation infrastructure with mobility innovations as a system to:

- Increase the transit shed, market capture area and potential ridership for the high-capacity transit investments;
- Provide a network of market-responsive, flexible mobility alternatives for unchained trips that decrease SOV mileage;
- Provide a network of mobility alternatives that democratize urban mobility for providers and users, so that there is more equitable access to the area's economic opportunities;
- Increase the proportion of regional travel trip mileage that is made without reliance on petroleum product-fueled vehicles to improve the region's personal and environmental health, reduce greenhouse gases, and provide a positive impact to reduce global warming;
- Support and refocus urban development as functional high-quality communities along broad, highly integrated mixed-use SMART corridors that continue to serve generations to come;
- Improve the quality of life for Miami-Dade County residents by decreasing their 242 hours of average annual time commuting, of which 74 hours are attributable to congestion delay.[1] Using FLM strategies and transit, some of these hours can be more productively or enjoyably spent on the move but not driving.



FLM Graphic - The Consumer Benefits of First/Last Mile Mobility and Transit

[1] Adelia Santos, FHWA NHTS Program Manager N/A, Nancy McGuckin and Hikari Yukiko, Travel Behavior Associates; Danielle Gray and Susan Liss, Cambridge Systematics; *Summary of Travel Trends, National Household Travel Survey*, US Department of Transportation, Washington DC, 2011

FIRST MILE LAST MILE STUDY

PURPOSE & PROCESS

The purpose of the *First Mile–Last Mile: Options with High Trip Generator Employers* Study is to introduce the concepts of First / Last Mile (FLM) mobility and provide practical, implementable strategies for deployment in the developed and planned corridors for the SMART Plan high-capacity transit investments.

To provide opportunities to test the strategies, two case studies will be identified, and the applicable strategies applied. The two case studies will be for high trip generator employers.

Currency

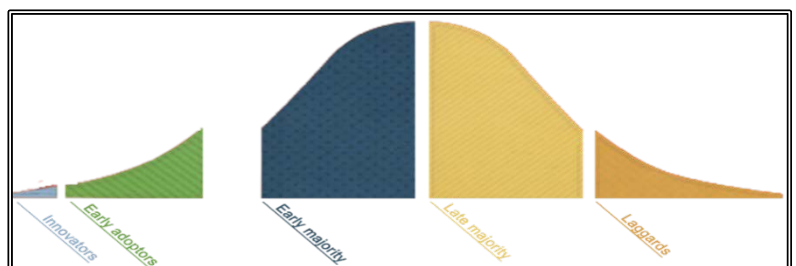
Urban mobility FLM strategies, deployments and implementations have been rapidly advancing in the field as needs, innovation and collaboration continue to align. With rapid advancement, also comes a transient quality to some aspects of FLM study, as many technological innovations that are important to FLM are nascent or on the cusp of wide-spread market acceptance and adoption. Similarly, smart technology enhanced shared mobility business models that accommodate rapid technology advances are also on the cusp from early adopters to majority markets. It is therefore, important to note that the data, information and concepts embodied in this report are current yet developing too. The report was researched and written from July 2017 through November 2017. It is recommended that FLM recommendation be regularly updated, to incorporate new technology advances and new business innovation.

Study Advisory Committee (SAC) (Task 1)

The process of the Study included the formation of a Study Advisory Committee (SAC) to assist with, review and guide the development of the study, recommendations, and selection of the case studies. The Steering Advisory Committee first met on July 24, 2017. The second meeting of the SAC was held on October 12, 2017 to discuss options for the case study locations. The SAC met for the third time on December 5, 2017.

The Study Advisory Committee members are:

David Henderson	Intermodal Manager, Miami-Dade TPO
Eric Tullberg	Chair, Miami-Dade Bicycle & Pedestrian Committee
Sue Kawalerski	President, Everglades Bicycle Club
Elizabeth Stacey	FDOT Dist. 6 Bicycle/Pedestrian & ADA
Victoria Williams	FDOT Turnpike
Vinod Sandanasamy	Supervisor, Transportation Planning RER
Matt Vinke	Miami-Dade Transportation and Public Works
Rolando Jimenez	Miami-Dade Roadway Engineering & ROW Division
Mark Heinicke	Miami-Dade Parks Recreation & Open Space Dept.
Mayra Diaz	Miami-Dade Expressway Authority
Jeannine Gaslonde	Project Manager, Miami-Dade TPO
Mary-Tery Vilches	Transportation & Region Manager, Miami-Dade TPO
Wilson Fernandez	Asst. Director of Mobility Management, Miami-Dade TPO
Mark Alvarez	The Corradino Group, Project Manager



Product Innovation Adoption Cycle, applicable to consumer adaption to new FLM Mobility technologies, modes, and delivery models

ORGANIZATION OF THIS REPORT

First / Last Mile Strategies (Tasks 2, 3, 4, and 7)

This report incorporates the results of a literature research to identify current practices and strategies for each of the FLM connectivity options; review of local plans and documents, the development of "Tool Kit" strategies for improving FLM mobility and access to and from transit hubs. The Tool Kits include applicable strategies for each FLM modal group that are context sensitive for each SMART Corridor station type and each potential SMART Plan primary transit mode.

To address the context sensitivity, before addressing the FLM modes, there is a section describing the characteristics of primary transit modes that are relevant to SMART Plan Corridor possibilities, and a section describing the systematic characterization of Transit Oriented Development (TOD) typologies.

For ease in understanding and applicability, this report will be organized in sections by FLM modal groups. Contained within each modal group section are:

1. A narrative to introduce the mode and its most salient features toward utilization for FLM, and past-experience with its use in other locations based on research in literature, professional and academic journals, and other studies. Tables are provided to summarize the characteristics of the modal group, and illustrations are provided to help visualize concepts, trends and other pertinent relationships.
2. Implementation Tool Kit:

   The Tool Kit recommendations will focus on actionable items that can be implemented by Miami-Dade County and local governments. The range of these include:
   - Build and change infrastructure;
   - Regulate infrastructure and public spaces;
   - Provide other public realm spaces;
   - Initiate action with policy;
   - Land development regulations;
   - Promote private sector investment with incentives;
   - Engage in 3P projects;

Recommendations cover a wide range of applicable possibilities with reference to the context and other setting characteristics. This includes the primary transit modal options and station area development. At this level of study cannot be specific to locations. The recommendations generally consider the following:

Infrastructure:
- Grid pattern;
- Complete Streets;
- Dedicated transit rights-of-way;
- Pedestrian facilities, including adequate sidewalks;
- ADA requirements;
- Bike and other non-motorized facilities;
- ITS infrastructure;
- Autonomous vehicle infrastructure;
- Transit vehicle, ride sharing and car sharing parking and pick-up/drop-off areas.

Traffic Operations:
- Signal preemption for transit;
- Signal transit priority treatments and queue jumps;
- Protected pedestrian phases or scramble zones.

Public realm:
- Placemaking to extend walkable distances, comfort and security.

Policy:
- Amend comprehensive plans and other land use policy;

- Amend capital improvement programs (CIP) to include recommended infrastructure;
- Provide for institutional space at a fine grain for walkable schools within the corridor.

Other Policy and Regulations:

- Amend zoning regulations to implement recommended residential densities, commercial intensities, compact urban form and housing mix, destination & community retail, and flexible work spaces;
- Regulations to permit NEV;
- Regulations and policy to support car sharing and ride sharing;
- Amend parking regulations to support FLM.

Incentives:

- Provide effective development incentives to the private sector to construct recommended compact development;
- Offer incentives and fee reductions to induce car sharing and bike sharing for early adaptor markets.

Public Funding:

- Federal, State and Local.

P3 Projects:

- Station area development;
- Station area community-scale commercial uses;
- Station area shared mobility systems;
- Web-based, integrated dynamic information.

SMART Corridors Data Collection (Task 5)

Data has been collected that are relevant to the case studies are summarized (Task 5). The TPO staff and SAC agreed that one of the case studies would test the currently in-development Accessibility GIS Model proposed for application to the Miami Dade TPO Long Range Transportation Plan (LRTP) to score, map and test accessibility based on existing conditions and proposed modifications. While the Accessibility Model is multimodal, in its current development as applied to Miami Dade GIS, it is best applied to pedestrian analysis; therefore, one of the Case Study locations was selected to focus on Pedestrian FLM. The other case study was evaluated to work through a decision framework to apply the FLM Tool Kit as provided in this study.

First Last Mile High Trip Generator Employers Case Studies (Task 6)

To provide opportunities to conceptually test the FLM strategies, two case studies are identified, and the applicable strategies applied. The two case studies are for high trip generator employers/destinations that are located near existing SMART Corridor) transit hubs.

The two case study locations and FLM strategies were developed in coordination with the Study Advisory Committee (SAC). The analysis needed to perform a preliminary assessment to initiate a transit station FLM plan is tested with regard to recommending Tool Kit strategies. The purpose is to aid future planning efforts with a test of Tool Kit strategies and analysis methods that are appropriate to the context. The recommendations for each case study include the application of the FLM Tool Kit using context sensitive strategies that reduce barriers to ridership.

The final determination for case studies was:

North Corridor:	**North Dade College**	**FLM Tool Kit**
South Corridor:	**South Dade Civic Center**	**Accessibility Model**

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PRIMARY TRANSIT MODE

HIGH CAPACITY TRANSIT MODE CHARACTERISTICS

The applicability of First–Last Mile mobility strategies are dependent on the urban context and the primary transit mode for the corridor. The urban context is covered in the next section. In this section, the primary mode is covered. There are four important effects that the primary transit mode has on FLM strategy applicability.

1. Size of Station Area Transit Market;
2. Trip Length;
3. Station Spacing;
4. Station Size and Amenities.

Following is a short discussion of each, along with transit mode characteristics table on pages 16and 17 summarized from the Transit Capacity and Quality of Service Manual (TCQSM).[2]

Miami Dade MetroRail and MetroMover, Heavy Urban Rail and People Mover

[2] Transit Cooperative Research Program (TCRP), Federal Transit Administration (FTA), Transit Capacity and Quality of Service Manual, Third Edition, National Academies Press, Washington DC, 2013, Chapter 2, Mode and Service Concepts.

Kansas City Street Car, light rail in mixed traffic, shared ROW: Kansas City, MO

Chicago Area Transit System, Elevated Heavy Urban Rail in CBD

Size of Station Area Transit Market

The primary mode has strong implications for the total number of home-origin trips and work or other destination trips. Each primary mode has a different range of capacity and cost which influence the density and intensity of development in the station area. The higher the potential number of riders on the transit system, the higher the base potential market for FLM strategies.

While for pedestrian access, there is little difference among modes since pedestrian infrastructure is necessary for any transit access, for modes that require fixed infrastructure investment by private business participants, such as station cars or bike sharing, the difference in market size matters.

Table 1
Transit Mode Capacity at 10-Minute Headway

Primary Transit Mode	Passenger Capacity @ 10 min. Headway
Rail Rapid Transit	4,300 – 15,000 / hr.
Light Rail Transit	600 – 4,300 / hr.
Bus Rapid Transit	480 – 750 / hr.
Bus	480 – 750 / hr.

[3]

Trip Lengths

The primary mode also strongly implies a range of trip lengths and times. The longer the trip, the more likely a traveler will consider using FLM strategies other than walking to access the primary mode. The primary mode is an indicator of trip length. Based on the TCQSM national data, average trip lengths for primary modes under consideration for SMART corridors are shown along with the proportion of average pedestrian and bicycle trip legs. The shorter the trip on the primary transit mode, the shorter or less likely a traveler is to use a chained mode to the transit station. As the proportion becomes larger, the FLM mode can become the primary mode.

Table 2
Transit Mode and FLM Trip Lengths Comparison

Primary Transit Mode	Primary Mode Trip Length[4]	Walk Trip Length at Origin & Destination*		Average Bike Share Trip Length**	
Rail Rapid Transit	5.3 mi.	½ mi.	9%	2 mi.	43%
Light Rail Transit	3.7 mi.	½ mi.	12%	2 mi.	52%
Bus Rapid Transit	N/A	½ mi.	N/A	2 mi.	N/A
Bus	3.7 mi.	½ mi.	12%	2 mi.	52%

* Walk distance based on ¼ mile walk radius assumption. Research data suggests average distance is higher at 0.47 miles to station, but does not survey destination station. See also CUTR survey data for BRT.

** Bike average distance based on information provided by LimeBike, a free-floating share models that is not biased by bike station locations.

[3] Transportation Research Board (TRB), Transit Capacity and Quality of Service Manual 3rd Ed. (TCQOS M) National Academies Press, Washington DC, 2013.

[4] Transportation Research Board (TRB), Transit Capacity and Quality of Service Manual 3rd Ed. (TCQOS M) National Academies Press, Washington DC, 2013.

Station Spacing

Each primary mode has a characteristic range of station spacings that are typically applied. Each FLM modal strategy applies to different ranges of distance from the station. As the station spacing along a corridor becomes smaller, the station areas begin to overlap; this is particularly true for the larger radius transit supportive area described in next section. As these areas of influence and application of FLM strategies overlap, then the market and interconnectivity for FLM strategies becomes richer, potentially larger, and potentially having greater attraction for private FLM business participation.

Table 3
Transit Mode Typical Station Spacing Range

Primary Transit Mode	Primary Mode Station Spacing Range[5]
Rail Rapid Transit	0.2 mi. to 2.1 mi.
Light Rail Transit	0.1 mi. to 1.0 mi.
Bus Rapid Transit	0.25 mi. to 0.75 mi.
Bus	0.05 mi. to 0.25 mi.

On the low end of the spacing range, station areas overlap for any mode and it is possible to walk between bus or BRT stations. It is possible to bike between stations for bus, bus rapid transit, and light rail transit, so the person using one of these FLM strategies to the primary transit has a choice of stations, and more probability to complete the trip on the FLM mode.

Station Size and Amenities

Each primary mode has a characteristic range of station size and infrastructure, from the large off-street station platforms and sheltered access areas for heavy rail, to simpler on-street bus shelters with comparatively few amenities for bus and bus rapid transit.

Station area infrastructure for FLM modal strategies varies from off-street parking for station cars, pullout and waiting areas for personal transit group transit and some car sharing options, and bike storage for personal and shared bike options. As a general indication of a station capacity to include FLM fixed equipment and infrastructure, station platform length and right-of-way location are summarized in the table below by primary transit mode.

Table 4
Transit Mode Typical Right of Way Location

Primary Transit Mode	Right-of-Way Location	Station Platform Length
Rail Rapid Transit	Exclusive ROW Grade Separated	600 to 800 ft.
Light Rail Transit	Exclusive ROW at Grade	100 to 300 ft.
Bus Rapid Transit	Exclusive or Shared ROW at Grade	60 to 70 ft. without taper
Bus	Shared ROW at Grade	60 to 70 ft. without taper

[5] Transportation Research Board (TRB), Transit Capacity and Quality of Service Manual 3rd Ed. (TCQOS M) National Academies Press, Washington DC, 2013.

Table 5 Primary Transit Mode Characteristics Relevant to FLM Strategies, *(Source: Transit Capacity and Quality of Service Manual, 3rd Ed.)*

North American Transit Systems Characteristics	Bus	Bus Rapid Transit	Aerial Guideway Transit	Trolley	Monorail	Light Rail Transit	Rail Rapid Transit	Commuter Rail
Typical Settings	High - Medium Density Urban Area	High Density Urban Area	Downtowns, Airports, Institutional,	Downtowns, Recreational	Downtowns, Airports, Institutional,	High Density Urban Area	High Density Urban Area	Inter-City
Average Trip Length	3.7 mi.	not available	1.0 mi.	1.6 mi.	1.0 mi.	3.7 mi.	5.3 mi.	23.7 mi.
Right-of-Way Type	Shared	Grade Crossings	Exclusive	Grade Crossings	Exclusive	Grade Crossings	Exclusive	Exclusive
Average Station Spacing	0.10 mi.	0.50 mi.	0.30 mi.	0.50 mi.	0.50 mi.	0.52 mi.	0.88 mi.	3.20 mi.
Station Spacing Range	0.05 mi. to 0.25	0.25 mi. to 0.75 mi.	0.2 mi. to 0.4 mi.	0.25 mi. to 0.75 mi.	0.50 mi. to	0.1 mi. to 1.0 mi.	0.2 mi. to 2.1 mi.	0.8 mi. to 11.7 mi.
Impacts on Land Use in Station Area	Weak	depends on ROW and station design	Strong	Strong	Strong	Strong	Strong	Strong
Typical Headway	short to medium	short to medium	short	short	short	short	short	medium to long
System Capacity @ 10min. headway	480 - 750 / hr.	480 - 750 / hr.	600 / hr.	240 - 600 / hr.	1,800 / hr.	600 - 4,300 / hr.	4,300 - 15,000 / hr.	3,200 - 10,800 / hr.
First Last Mile Modal Option Applicability								
Pedestrian	yes	yes	yes	yes	yes	yes	yes	yes
Low Speed Urban Alternatives (skateboards, electric boards, etc.)	yes	yes	yes	yes	yes	yes	yes	yes
Bicycle, Personal	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	strong (storage space avail.)	strong (storage space avail.)
Bicycle, Shared	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	weak (depends on storage)	strong (storage space avail.)	strong (storage space avail.)
Low Speed Electric Vehicles	no (EV parking space required)	no (EV parking space required)	no (EV parking space required)	no (EV parking space required)	weak (if EV parking space)	weak (if EV parking space)	yes	yes
Car Sharing, other driver (taxi, Uber, Lyft, etc.)	yes	yes	yes	yes	yes	yes	yes	yes
Car Sharing, Station Cars	no (EV / ICE parking required)	no (EV / ICE parking required)	no (EV / ICE parking required)	no (EV / ICE parking required)	weak (if EV parking space)	weak (if EV parking space)	yes	yes
Personal Rapid Transit, Autonomous	weak (depends on drop-off/pick-up)	weak (depends on drop-off/pick-up)	weak (depends on drop-off/pick-up)	weak (depends on drop-off/pick-up)	yes	yes	yes	yes
Group Rapid Transit, Autonomous	no (transfer, not FLM)	no (transfer, not FLM)	weak (transfer, weak due to distance traveled)	weak (transfer, weak due to distance traveled)	weak (transfer, weak due to distance traveled)	weak (transfer, weak due to distance traveled)	yes	yes
Feeder Transit, Driver	no (transfer, not FLM)	no (transfer, not FLM)	weak (transfer, weak due to distance traveled)	weak (transfer, weak due to distance traveled)	weak (transfer, weak due to distance traveled)	weak (transfer, weak due to distance traveled)	yes	yes

Table 6 Primary Transit Mode Characteristics, *(Source: Transit Capacity and Quality of Service Manual, 3rd Ed.)*

North American Transit Systems Characteristics	Bus	Bus Rapid Transit	AGT	Trolley	Monorail	LRT	Rail Rapid Transit	Commuter Rail
Typical Use								
Typical Settings	High - Medium Density Urban Area	High Density Urban Area	Downtowns, Airports, Institutional, Recreational	Downtowns, Recreational	Downtowns, Airports, Institutional, Recreational	High Density Urban Area	High Density Urban Area	Inter-City
Alignment Length		7.4 mi.	3.9 mi.		3.9 mi.	8.6 mi.	15.7 mi.	45.8 mi.
Average Trip Length	3.7 mi.	Not Available	1.0 mi.	1.6 mi.	1.0 mi.	3.7 mi.	5.3 mi.	23.7 mi.
Vehicle Dimensions								
Length	40 ft.,51 ft.articulated	40 ft.,51 ft.articulated	30 ft.	30 ft. to 50 ft.	34 ft.	40 ft.,51 ft.articulated	75 ft.	60 ft. to 72 ft.
Width / Guage	8 ft.	8 ft.	2' - 2.62'	8.5 to 10 ft.	8 ft. 8 in.	W:8.5'- 9.5' G:4'8.5"	W:8.5'- 9.5' G:4'8.5"	4 ft. 8.5 in.
Height	11 ft.	11 ft.		12 to 13 ft.	10 ft. 5 in.	13' w/ pantograph at lowest position	11 ft. 10 in.	13' w/ pantograph at lowest position
Weight	12.5 - 17.5 tons	12.5 - 17.5 tons	9.5 - 13.75 tons	12 - 28 tons		35.5 - 43.5 tons	47 - 87 tons	46 - 75 tons
Energy Source	ICE or Hybrid	ICE or Hybrid	Electric	Electric	Electric	Electric	Electric	Electric / Diesel
Right-of-Way								
Type	Shared	Grade Crossings	Exclusive	Grade Crossings	Exclusive	Grade Crossings	Exclusive	Exclusive
Control	Visual	Visual	Automated	Visual	Automated	Visual / Signals	Signals	Signals
At-Grade or Grade Separated	At-Grade	At-Grade	Grade Separated	At-Grade	Grade Separated	At-Grade	Both	Both
2-Way ROW Width Requirement	uses existing lanes	exclusive lanes: 24' w/o shoulder	negligible - fully grade separated	24' if in exclusive lanes	negligible - fully grade separated	30' w/ catenary support	30' w/ catenary support	30' w/ catenary support
Verticle Clearance	12 ft.	12 ft.	12 ft.	15.5 ft.		15.5 ft.		
Station Platform Length	up to 70' w/o approach/departure taper	60' to 70' w/o departure taper	70 ft.	40 ft. to 60 ft.	250 ft.	100 ft. to 300 ft.	600 ft.to 800 ft.	
Average Station Spacing	0.10 mi.	0.50 mi.	0.30 mi.	0.50 mi.	0.50 mi.	0.52 mi.	0.88 mi.	3.20 mi.
Station Spacing Range	0.05 mi. to 0.25	0.25 mi. to 0.75 mi.	0.2 mi. to 0.4 mi.	0.25 mi. to 0.75 mi.	0.50 mi. to	0.1 mi. to 1.0 mi. 0.4 mi. to 2.2 mi.	0.2 mi. to 2.1 mi.	0.8 mi. to 11.7 mi.
Aesthetics / Community Impact								
Station Area Land Use Impact	Weak	depends on ROW and station design	Strong	Strong	Strong	Strong	Strong	Strong
Infrastructure Impacts	None	None	Negative - Elevated Guideway	Negative - Caternary	Negative - Elevated Guideway	Negative - Caternary	Negative - Elevated Guideway	Negative - Caternary
Vehicle Impacts	Negative - noise, diesel emmissions	Negative - noise, diesel emmissions	Neutral - rubber tiredvehicles are quiet, no point emmissions	Positive - some caternary and rail noise, no point emmissions appealing design of vehicle	Neutral - rubber tiredvehicles are quiet, no point emmissions	Neutral - some caternary and rail noise, no point emmissions	Slightly negative - rail noise, no point emmissions	Neutral - typically more segragated from development and pedestrians rail noise, diesel emmissions
Market Image	Negative	Higher than bus	Positive	Positive	Environmentally friendly, quiet	Positive		
Construction Impacts	none	minimal	construction of elevated guideway	construction of guideway in vehicle lanes	construction of guideway - prefabrication mitigates	construction of guideway - worse if elevated	construction of elevated guideway	generally not along roadways
Passenger Capacity								
Typical Headway	short to medium	short to medium	short	short	short	short	short	medium to long
System @ 10min. headway	480 - 750 / hr.	480 - 750 / hr.	600 / hr.	240 - 600 / hr.	1,800 / hr.	600 - 4,300 / hr.	4,300 - 15,000 / hr.	3,200 - 10,800 / hr.
Train (number of vehicles)	1 straight or articulated	1 straight or articulated	1 to 3 cars	1 streetcar	6 cars	1 to 4 cars	4 to 10 cars	4 to 10 cars
Transit Unit Capacity (seated & sta	80 - 125	80 - 125	100	40 - 100	300	83 - 800	720 - 2,500	540 - 1,800
Performance								
Maximum Operating Speed	70 mph	70 mph	50 mph	30 mph	40 mph	65 mph	80 mph	100 mph
Service Speed	10 - 25 mph	18 - 40 mph	12 mph	12 mph	9 mph	10 - 25 mph	18 - 37 mph	
Capital Costs								
average / mile	0.68-million	$1-m, mixed traffic; $4.7-m, guided bus; $6.6-m, arterial busway; $7.5-m, busway; $272-m, tunnels	$91-million	$34-million	$121-million	$37-million	$63-million - Elevated $164-million - Subgrade	
range / mile		$1 - $272-million	$111 - $131-million	not available	$116 to $125-million	$19.5 to 361-million	$63-million to $174-million	
source: TCQSM 2nd Ed, 2003								
Operating Costs								
average $ / revenue mile	$4	$4	$16	not available	$39	$19	$46	
average $ / person capy. mile	$0.05	$0.05	$0.16		$0.13	$0.07	$0.03	
			1-car train		6-car train	2-car train @ 142 seats	8-car train @ 200 persons	
Safety								
incidents / million route miles			20.38			39.4		
injuries / million route miles			20.38			78.18		

Data Source: TRB Transit Capacity and Quality of Service Manual (cost and accident data require update)

Miami-Dade Transportation Planning Organization

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TRANSIT AREA DEVELOPMENT

DENSITY, INTENSITY, USES, URBAN FORM

FLM modal strategies require discussion of two concepts: mobility and access.

Access is the ability to meet a person's daily needs with a minimum of travel and cost. Access has a stronger relationship to urban design and land use, as the emphasis is satisfying needs with minimization of travel.

Mobilty is the ability to get around by a variety of means. The need to travel is assumed and mobility does not seek to minimize travel, but to lower the time and cost of it, while making the experience convenient, safe, secure and enjoyable.

For each station area, the primary concept is to develop the "pathway" by which existing and future SMART Plan transit users can access corridor transit stations.

The Pathway develops the mobility and access infrastructure network to reduce the distance and time it takes people to travel from their origins and destinations to primary transit stations in the SMART Plan corridors, while simultaneously improving the user experience in more qualitative ways. The core concept of the Pathway is to provide a context-specific set of mobility and access improvements that extend to and from the primary transit stations. Pathways vary by station / stop, primary mode, regional context, and distance from the station / stop.

Ultimately, the goal of the Pathways is to expand the transit user access shed.

Pathway infrastructure is substantially dependent on the development of public realm infrastructure and private-sector developments. Many of the specific mobility improvements to develop FLM modal options are presented in the appropriate mode-specific sections. The focus of "Transit Area Development" is how proposed station area developments improve access by condensing and co-locating higher residential density with non-residential land uses into compact mixed-use districts, responsive to context and form.

There is a wide body of literature and prior planning efforts that cover these strategies that are under the general topic of Transit Oriented Development (TOD).

Several main approaches to station area TOD are reviewed next, including:

1. A brief introduction based on concepts summarized from the literature review to compliment the practical TOD approaches;
2. Florida Department of Transportation's *Florida Transit Oriented Development Guidebook*. Published in 2012, it is based on 10 case studies and focused on Florida development patterns;
3. The New Urbanist (NU) transect approach. Implemented as Miami 21, which is already being tested as implemented for the City of Miami land development regulations;
4. The Transit Oriented Development Institute, based in Washington DC.

An underlying assumption is that in the long term, SMART Corridor station areas will have policies, regulation and incentives applied that will foster TOD development. At the conclusion of this section, three tables, one for each primary mode considered for the SMART Plan, summarize station area development scenarios and implications for FLM mobility

Transit Oriented Development - Introduction

Transit Oriented Development is higher-density development with pedestrian priority, located within easy walking distance of a major public transit station or stop. TODs are viewed as offering the potential to boost transit ridership, increase walking activity, mitigate sprawl, accommodate growth, and create interesting places.

TOD projects involve a wider variety of stakeholders than typical development, reflecting in part the more extensive involvement of transit agencies and government funding sources. TOD stakeholders may have a wide range of complementary or competing objectives.

Travel-related objectives include:

- Increasing opportunities for residents and workers to meet daily needs by taking transit or walking;
- Attracting new riders to public transit, including “choice” riders who could otherwise choose to drive;
- Shifting the transit station mode of access to be less reliant on park-and-ride and more oriented to walking and other FLM strategies;
- Reducing the automobile ownership, vehicular traffic, and associated parking requirements that are otherwise necessary to support a similar level of more traditional development;
- Enhancing the environment, through reduced emissions and energy consumption derived from shifts in commuting, other trip making, and improved station access to environmentally friendly travel modes.

Non-transportation objectives may include:

- Providing desirable and affordable housing choices;
- Enhancing sense of community and quality of life;
- Supporting economic development or revitalization;
- Shifting development from sensitive areas;
- Minimizing infrastructure costs;
- Reducing sprawl;
- Financial return for stakeholders, including transit agencies. Rents can be a significant source of non-farebox revenue accruing from development on system-owned land adjacent to transit stations/stops.

A TOD concentrates trip generation and attraction around transit stations/stops and stations resulting in greater transit ridership per stop, even if it is assumed that TOD transit mode shares are no higher than produced by conventional development in the same locations. Typically, however, the special attributes of well-designed TODs result in transit shares that are higher with automobile mode shares that are lower. This outcome leads to even further elevation of transit ridership levels. With regard to vehicular traffic volumes, the extent to which TOD travel concentrations may result in more local area automobile travel in total depends on the degree of concentration on one hand and the success in achieving lower auto driver mode shares on the other. Quantitative examples of actual transit ridership gains that can be clearly attributed to TOD implementation are few because of the many sources of ridership, multiplicity of inter-related factors, and relatively few before and after studies.

While TODs are categorized according to regional context, land use mix, and primary transit mode, a variety of factors appear to influence the traveler response to TOD, including land use and site design, automobile ownership, relative transit and highway accessibility, parking supply, parking pricing, transit support, and self-selection of residents as well. Various influences on TOD travel behavior choices are decidedly interactive in nature, and these factors are not all transportation-related. This suggests that it takes more than good transportation policy alone to develop high-quality and effective TODs. Density, diversity, and design influence TOD impacts in much the same way that they impact non-TOD land development, and are associated with more transit use and walking and fewer automobile trips per resident and per worker in both situations. TOD also facilitates accomplishment of activities within the development itself, on foot or by FLM strategies, thereby eliminating the need for some automobile trips.

Research indicates that there may be greater differences between the travel choices of “urban-oriented” residents of conventional suburbs and similarly inclined persons residing in TOD-like traditional city neighborhoods than there are between the travel choices of “suburban-oriented” residents located in one or the other of these two disparate environments. The cause appears to be inability of urban-oriented residents to act on private automobile preferences, whereas it remains feasible for suburban-oriented residents to choose to drive even in highly urban environments.

Given this, TOD resident self-selection could be a positive force in reducing regional auto travel and enhancing transit ridership.

Florida Transit Oriented Development (TOD) Guidebook

While there are dozens of texts and guides from other jurisdictions, the most on-point sources relative to transit and land use in Florida’s urban areas is *The Florida TOD Guidebook* (FDOT, December 2012) It provides framework for evaluating station area typologies, surrounding contexts, and strategies to address increasing transit ridership through land use and design. It includes model TOD regulations to help Florida jurisdictions apply a consistent methodology for evaluation of transit-supportive strategies.

The Florida TOD Guidebook is based on a best-practices review in 10 American cities:

i. Boston, Massachusetts
ii. Charlotte, North Carolina
iii. Cleveland, Ohio
iv. Dallas, Texas
v. Denver, Colorado
vi. Los Angeles, California
vii. New Jersey
viii. Portland, Oregon
ix. San Francisco, California
x. Washington, DC

Land development strategies are provided relative to station area place types. They represent different typologies of TOD scale and are mostly dependent on the type of transit system, activity and accessibility, and the community context, including where the transit station is with relationship to the hubs and ends of the entire transit system.

The Florida TOD guidelines work along three dimensions that significantly characterize TODs. The selected dimensions are:

1. Regional context, referred to as the *Station Place Type*
2. Access and distance context, referred to as a *Station Area*
3. *Primary transit* mode at the core of the TOD

Transit Station Place Types

There are three place types:

Regional Center

The Regional Center is the regional nexus of economic and cultural significance. It can be the central business district that serves a regional travel market and can be served by a mix of transit types ranging from high speed, heavy or commuter rail to BRT or local bus service. In a radial regional transit network, it is the hub of connecting alignments. Usually emphasizing employment uses, the Regional Center is increasingly being sought out for residential uses in response to changing demographics and housing preferences. The Regional Center is larger in size than community centers or neighborhood centers and include within it more than one transit station and multiple bus stops. Within the Regional Center these is high integration of intermodal transfers, and many opportunities for modal transfers. Small block sizes, fine street grid, high lot coverage, higher intensities and densities of development, large civic open spaces, and minimal surface parking are typical characteristics that result in the highly urban development pattern of the regional center.

In Miami Dade County, the Miami Central Business District (CBD) and Brickell is the Regional Center.

Quarter-section of the Regional Center TOD Station Area with radii at 1/4-mile and 1/2-mile, showing general concept of street grid, form, and general land use concept showing:

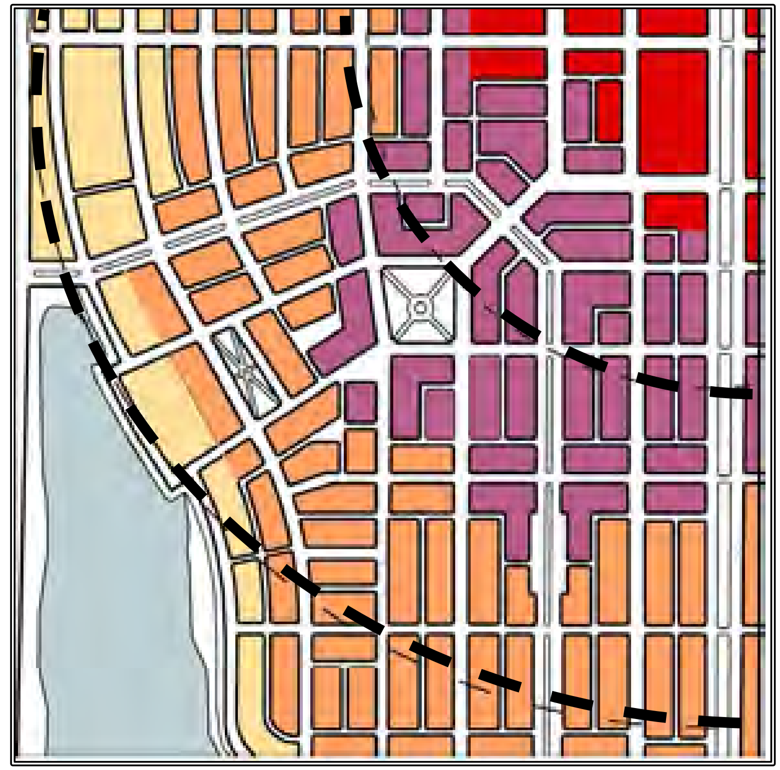
- Primarily commercial mixed use at higher intensity (red)
- Lower intensity mixed use (purple)
- Primarily residential mixed use at lower intensity (orange)

Community Center

Community Centers function as sub-regional or local centers of economic and community activity and include urban and town centers served by one or more transit types. Residential densities and non-residential intensities in Community Centers are typically lower than in the Regional Center, but the mix of uses in them is typically more balanced between residential and employment uses. More intense or dense development in Community Centers is typically concentrated within walking distance of the transit station. The pattern of development in Community Centers can range from urban to suburban. Block sizes, lot coverage, and development intensities and densities all tend to be moderate. Parking is typically structured and located close to the transit station.

In Miami Dade County, the transit-related Community Centers are Dadeland South, the Civic Center, and the Miami Intermodal Center (MIC) as a major regional destination, employment center and intermodal center.

The SMART Plan would potentially add other Community Centers, including but not limited to, Miami Beach, Florida International University (FIU), Aventura and Kendall West. The establishment of new Community Centers depends on transit network development and land development. While the Coral Gables CBD is, from a land use standpoint a Regional Center, its CBD is outside of the SMART corridors, and it is not a Regional Center for transit purposes, since regional transit connectivity currently depends on bus transfer and the Coral Gables Trolley service.



Quarter-section of the Community Center TOD Station Area with radii at 1/4-mile and 1/2-mile, showing general concept of street grid, form, and general land use concept showing:

- Primarily commercial mixed use at higher intensity (red)
- Lower intensity mixed use (purple)
- Primarily residential mixed use at lower intensity (orange)
- Lower density residential (yellow)

Neighborhood Center

Neighborhood Centers are dominated by residential uses and served by some type of premium transit. Non-residential uses in them are limited to local-serving retail and service establishments. Residential densities in Neighborhood Centers tend to be lower than in community centers, and at their highest within walking distance of the transit station. Neighborhood Centers are found in older urban areas and newer suburban developments. Open space is usually abundant in them, and parking is mostly in surface lots.

In Miami Dade County, most of the other stops along the MetroRail lines and Busway are broadly categorized as Neighborhood Centers.

Quarter-section of the Neighborhood Center TOD Station Area with radii at 1/4-mile and 1/2-mile, showing general concept of street grid, form, and general land use concept showing:

- Primarily commercial mixed use at higher intensity (red)
- Lower intensity mixed use (purple)
- Primarily residential mixed use at lower intensity (orange)
- Lower density residential (yellow)

Transit Station Area Definitions

A station area is comprised of approximately 320 to 500 acres within a half-mile walk distance around a transit station. Walk distance is often expressed generally as a circular radius (500 acres), but can be more accurately measured as an orthogonal distance along the street grid (320 acres).

For urban areas with a regular orthogonal street grid, the orthogonal method is more accurate and results in a jagged-edged diamond on north-south, east-west street grids. For areas with radial, hierarchal streets resulting in cul-de-sacs, and other irregular street morphologies, a radial measurement is a good starting point.

Actual walk distances are affected by pedestrian infrastructure, street crossings, signal operations, barriers, the built environment, safety, and perceptions about security.

Pedestrian access to the station is typically the most prevalent FLM modal choice in the Transit Core, with bicycle and urban alternative personal mobility (such as skateboards, electric boards, skates, etc.) also used. The Transit Neighborhood is also in the realm of high pedestrian, bicycle and urban alternative personal mobility; however, vehicular modal strategies become increasingly important because of the lower densities and greater distance to the transit station/stop.

For the purposes of FLM considerations, the Transit Supportive Area is a 2-mile radius. In the Transit Supportive Area, bicycle is also important; however, vehicular FLM modal choice are increasingly utilized.

There are new GIS-based (geographic information systems) tools in development that can accurately define walking distances based on multiple real-world factors, including: street network morphology, crosswalks, signal timings, physical barriers, street amenities, street-level development patterns, and regional behaviors for walking distances.

Transit Core

The ¼-mile, 5-minute walk part of the station area is called the ***Transit Core***. This is the area where the highest proportion of transit access trips to and from the transit station are expected to be pedestrian. It is also the area with the highest number of non-transit-related pedestrian trips among the urbanized uses within. The Transit Core is typically mixed-use development, with the mix primarily vertical. Street-level retail, entertainment, food service, cultural and civic uses establish a streetscape that promotes pedestrian urban lifestyles. Mid-level floors may be non-retail workspaces, with upper building floors occupied by residential uses. The vertical mixed uses along with the higher transit mode split may be used to reduce parking requirements and facilitate effective shared parking facilities. Parking is primarily off-street, and as much as practical located away from streets for high pedestrian activity. Relative to the station place type, the residential density, intensity and building height should be the highest in the transit core.

Table 7
Transit Station Core Area Metrics

	Radial Measure	Orthogonal Measure
Walk Distance	¼ mile	¼ mile
Area (acres)	125	80
Blocks (300'x300')	61	39
Intersections	77	52

Miami-Dade Transportation Planning Organization

Transit Neighborhood

The part of the station area that rings around the Transit Core and is within a walk distance of ¼-mile to ½-mile is called the ***Transit Neighborhood.*** The Transit Neighborhood comprises a ring-like area around the Transit Core. Less transit access trips to and from the transit station are expected to be pedestrian, and there is more reliance on other modes, especially non-motorized. The transit neighborhood is typically mixed-use development; however, the mix is shifted to residential uses. Parking is primarily off-street, and as much as practical located away from streets for high pedestrian activity. Compared to the Transit Core, residential density, intensity and building height are lower and give greater decision weight to compatible transition to existing adjacent neighborhoods.

Table 7
Transit Station Neighborhood Area Metrics

	Radial Measure	Orthogonal Measure
Travel Distance	¼ to ½ mile	¼ to ½ mile
Area (acres)	377	240
Blocks (300’x300’)	182	116
Intersections	198	129

Transit Supportive Area

The part of the station area that rings around the Transit Neighborhood and is within a walk distance of ½-mile to 1-mile is called the ***Transit Supportive Area.*** It comprises a ring-like area around the Transit Neighborhood and station area. Fewer transit access trips to and from the transit station are expected to be pedestrian, and there is more reliance on other modes, including bicycle, car and ride sharing, and transit.

Compared to the Transit Core and Transit Neighborhood, residential density, intensity and building height are lower and give greater decision weight to compatible transition to existing neighborhoods. This area is predominantly residential, with residential densities similar to the surrounding neighborhoods or one transition higher. Depending on densities, parking is on or off-street.

A transit supportive area may be an employment destination, in which an agglomeration of major employment or destination trip attractors are located. Examples include: large university campuses, medical complexes, office parks, industrial districts, and large shopping malls. Parking is primarily off-street in these transit supportive places and street typology is appropriate to the business.

Table 8
Transit Supportive Area Metrics

	Radial Measure	Orthogonal Measure
Travel Distance	½ to 2 miles	½ to 2 miles
Area (acres)	7,540	4,800
Blocks (300’x300’)	3,649	2,323
Intersections	3,743	2,398

Access Shed Distances and FLM Modal Strategies

The range of FLM modal strategies, technologies and delivery models continues to evolve. Each mode has its own characteristics of suitability that are context sensitive. Each mode, whether owned or operated by governmental entities or not, have their own specific needs for infrastructure, policy and regulatory support, funding and integration with primary fixed route transit systems.

In the context of TOD, each mode has a role in increasing the mobility and increasing the effectiveness of TOD accessibility.

Table 9 Access Shed Distances and FLM Modal Strategies

(summary of analysis in following sections of report)

	Transit Core ¼ -mile	Transit Neighborhood ½ mile	Transit Supportive Area (Redevelopment) 1 mile	Transit Supportive Area (Residential / Employment) 2 miles
Walk				
Wheelchair				
Skates, Skateboards, Urban Personal Modes				
Personal Bike				
Shared Bike				
Neighborhood Electric Vehicle				
Advanced Transit (autonomous vehicles in dedicated or shared ROW)				
Conventional Feeder Transit				
Station Cars (transit-based car sharing)				
Park & Ride, Carpool, Demand Responsive Networked Car Share				

Density / Intensity

Residential density and non-residential intensity vary by primary transit mode, station place type, and station area component. Ranges of residential density appropriate to each are summarized in the *Florida TOD Guidebook*, and the overall summary table is provided below. Most important to note is that ultimately, transit and FLM trips are made by people. The importance of station area planning is ultimately to locate a sufficient number of people as residents, workers, or destination visitors in a area that is compact enough so that transit is supported and single-occupant vehicular trips and trip miles are reduced on a regional scale.

While residential density, employment space intensity and infrastructure are the primary tools, the actual driver for TOD success is total residents, total employment, and total visitors to the station area. Based on this, the tables on pages 37 through 42 have been developed as a product of this study to provide metrics for the built environment, driven by population and employment numbers to develop base development scenarios and base numbers for potential transit and FLM trips. They are provided as a starting point for policy development, and are intended to be further refined by station are specifics, and additional mode share data collection.

Table 10 Station Area Calculated Average Residential Density Targets

Source: Florida TOD Guidebook

TOD Place Type	Heavy Rail			Commuter/Light Rail			BRT/Bus		
	Density Target for **Residential Portion Only** of Station Area (Framework)	Percentage of Station Area Residential (Framework)	Average Residential Density Target for **Entire Station Area**	Density Target for **Residential Portion Only** of Station Area (Framework)	Percentage of Station Area Residential (Framework)	Average Residential Density Target for **Entire Station Area**	Density Target for **Residential Portion Only** of Station Area (Framework)	Percentage of Station Area Residential (Framework)	Average Residential Density Target for **Entire Station Area**
Regional Center	*55-75 du/ac*	35%	19-27 du/ac	*35-55 du/ac*	35%	12-19 du/ac	*20-35 du/ac*	35%	7-12 du/ac
Community Center	*35-65 du/ac*	45%	16-29 du/ac	*25-35 du/ac*	45%	11-16 du/ac	*10-20 du/ac*	45%	5-9 du/ac
Neighborhood Center	*12-15 du/ac*	75%	9-11 du/ac	*9-12 du/ac*	75%	7-9 du/ac	*7-9 du/ac*	75%	5-7 du/ac

The Framework specifies a percentage of each Station Area for Residential Uses (Table 3-1) and specifies density ranges for the residential portion in order to achieve the residential unit targets set forth in Table 3-2. The calculated average assumes all parcels in the Station Area have residential uses, specifying a lower minimum density to achieve the total residential unit targets in Table 3-2. The ultimate strategy to achieve the residential unit targets will be calibrated to local conditions and preferences.

Best Practices: New Urbanism Approach

To a large extent, many of the design concepts and organization principals that are part of the discussion about the design of TOD are based on *New Urbanism (NU)*, *Smart Growth* concepts. The main tenets of New Urbanism, Smart Growth address relationships of the urban built environment in a pragmatic, holistic way that promote sustainability, equity and compatibility through forms that stimulate walking and more interaction in the public realm, and reduce the primacy of automotive infrastructure. Many of these principals address mixed use development, pedestrian connectivity, public realm pedestrian access, and re-orientation of building dispositions away from automobile-centric function to an urban streetscape, but they also address the question of scale, height, façade, density and intensity.

NU classifies and arranges urban form and function as urban-rural transects. In defining the urban-rural built environment, the transect is arranged in order from T1 to T6, as illustrated below. Use of the transect in this form is applied almost universally, with special districts for special civic areas, industry, airports and other transportation facilities, etc. The illustration below includes photographs to help clarify transect identities in more recognizably urban forms.

While transects define an ordered development form, they do not necessarily exist in a "wedding cake" geography from the city center to its edge. Instead, they form a geographic patchwork, defined by the built environment and its functional relationships. The defining characteristics for each category are listed on the following pages.

New Urbanism Typical Transect Progression Diagram with photo examples

T6 T6, the ***Core*** is the densest and most urban. Most cities have only one core, the downtown or the central business district (CBD). It is the place with the tallest buildings, busiest streets and greatest variety of uses and attractions. Buildings are often vertically mixed uses (retail on ground floor with residential and/or office above), attached and with aligned fronts. Setbacks are small to none, sidewalks are wide. Floor Area Ratio (FAR) and lot coverage is high with open space more often occurring in public plazas. Structured parking is typical. Net residential densities range from 25 to 100 DU/Ac. ***Transit is typically available.***

The T6 Core Transect is directly comparable to the Regional Center Transit Station Place Type, and applicable to the Transit Core and Transit Neighborhood for the Station Area, but is not comparable to the larger Transit Supportive Area for the Regional Center.

T5 T5, the ***Center*** is similar to the Core in having buildings of vertical as well as horizontal mixed uses, but the geographic character is more of a main street or arterial, rather than a two-dimensional, interconnected downtown. As with the core, building fronts are aligned, setbacks are small and sidewalks are less wide than in the Core. FAR is lower than the CBD, open space more often occurs in building sites, and building heights are in the range of 4 to 5 stories. Density may allow for some surface parking in block centers. Net residential densities range from 15 to 40 DU/Ac. ***Transit is often available.***

The T5 Center Transect is directly comparable to the Community Center Transit Station Place Type, but is not comparable to the larger Transit Supportive Area for the Community Center.

T4 T4, ***General Urban*** is primarily residential with an urban character. In T4, there are identifiable neighborhoods with 5-minute walking distance centers. Streets are mostly residential sections and still have sidewalks of about 5-ft. width on both sides with raised curbs. Setbacks are in the range of 5 to 25 ft. and buildings are less likely to be attached. Parks form the community open spaces. Housing consists of a range from single-family homes through townhomes and duplexes to small apartment buildings (about 8 units or less). There may be some local business and civic uses, but buildings are smaller than in the Center. Net residential densities range from 6 to 20 DU/Ac. ***Transit is generally within walking distance to the Center.***

The T4 General Urban Transect is directly comparable to the Neighborhood Center Transit Station Place Type, and may be comparable to the larger Transit Supportive Area for many of the Transit Station Place Types.

T3 T3, the ***Suburban Zone*** is residential without a distinctly urban character. Lots are larger, streets are residential, and more likely with swale drainage and no sidewalks. Setbacks are large and buildings are not connected. Housing consists of a range from single-family homes, possibly with ancillary units. Net residential densities range from 2 to 8 DU/Ac.

The T3 Suburban Transect is often comparable to the Neighborhood Center Tran**sit Station Place Type.**

T2 The ***Rural Transect*** is not relevant to this review.

T1 The ***Natural Transect*** is not relevant to this review.

Miami 21:

While the tenets of New Urbanism and Smart Growth are well documented in professional literature, it is also enacted as land development code in many US cities. The geographically closest implemented example that relevant to the SMART Plan, is the "Miami 21" zoning code that regulates new development in the City of Miami.

Miami 21 applies the same transect forms with the exception that T6 is additionally sub-classified by height ranges that accommodate its use along sections of some corridors that radiate out from the CBD. (Transitioning from a prior set of land development regulations, this avoided creating many legal non-conformities.) The Miami 21 code includes seven T6 sub-classifications:

- T6-8 maximum building height to 8 stories
- T6-12 maximum building height to 12 stories
- T6-24 maximum building height to 24 stories
- T6-36 maximum building height to 36 stories
- T6-48 maximum building height to 48 stories
- T6-60 maximum building height to 60 stories
- T6-80 maximum building height to 80 stories

The sub-classification of T-6 into these zoning districts assures that higher categories are located in and directly near the Miami CBD, while corridors that radiate beyond the CBD are T6-8, and T6-12.

The highest zoning categories around the City of Miami's 11 Metrorail stations are listed in Table 11, along with their distance from the Miami Downtown CBD. All stations outside of the CBD are T6-8 (8 floors) except for: the CI-HD which is a special regionally significant district; and the Douglas Road Station which is T6-12.

Table 11, Miami 21 Transects in Metrorail Station Areas

Station	Highest Station Area Transect (¼ mile)	Maximum Height (floors)	Distance from Miami CBD (miles)
Earlington Heights *NW 40th St. & NW 22nd Av.*	T-6-8	8	3 ¼
Allapattah *NW 12th Av. & NW 35th St.*	T6-8	8	2 ½
Santa Clara *NW 12th Av. & NW 21st St.*	T6-8, D1, D2	8	2
Civic Center *NW 12th Av. & NW 15th St.*	CI-HD Civic Institution Health District	Permit by warrant or exception to FLR 8.0 w/ step back above 8th floor	1 ½
Culmer Station *NW 11th Tr. & NW 7th Ct.*	T6-8	8	1
Historic Overtown / Lyric Theater *NW 1st Ct. & NW 7th St.*	T6-60	60	CBD
Government Center *NW 1st Av. & NW 1st St.*	T6-80	80	CBD
Brickell *SW 1st Av. & SW 11th St.*	T6-36	36	CBD
Vizcaya *SW 1st Av. & SW 32nd Rd.*	T6-8	8	2
Coconut Grove *South Dixie Hwy & SW27thAv*	T6-8, D1	8	3 ¾
Douglas Road *South Dixie Hwy & SW37thAv*	T6-12, D1	12	4 ¾

The Transit Oriented Development Institute

The *Transit Oriented Development Institute*[6] is the leading national planning organization working to promote the implementation of walkable, mixed-use, sustainable communities around rail stations. The *TOD Institute* brings together business and political leaders with experts and leaders in rail, urban design, sustainability, and real estate development to advance knowledge sharing and TOD best practices. The *Institute* is a project of the US High Speed Rail Association, America's leading advocate for development of national intercity rail. As such, the TOD Institute includes principals and components beyond urban transit, with a focus toward connecting metropolitan areas. FLM is a critically important component of the Institute's concepts for developing TOD.

The Transit Oriented Development Institute recommendations are provided in the its *Station Area Planning, TOD 202* publication. The concepts and guidelines are similar to and consistent with the *Florida TOD Guidebook*, with a few important distinctions:

1. The *TOD Institute* includes Transit Town Center as a station place type relevant to commuter rail stations in ex-urban areas;
2. The *TOD Institute* recognizes special use employment districts as described for special cases of Transit Support Areas;
3. In addition to nodal development patterns, the *TOD Institute* identifies Corridors as a development form where station spacing and development merge into a corridor. The corridor approach also has important relevance to maintaining a narrow band of development around a transit line that provides a benefit to allow for better transition into existing neighborhoods, and less potential for development conflicts about compatibility issues.
4. Beyond development forms, densities, intensities and lifestyles, the *Institutute* lists among the componets of TOD, five FLM general strategies (bolded) in addition to land development strategies.
   - Walkable design with pedestrian as the highest priority
   - Train station as prominent feature of town center
   - Public square fronting train station
   - A regional node containing a mixture of uses in close proximity (office, residential, retail, civic)
   - ***High density, walkable district within 10-minute walk circle surrounding train station***
   - ***Collector support transit systems including streetcar, light rail, and buses, etc.***[7]
   - ***Designed to include the easy use of bicycles and scooters as daily support transport***
   - ***Large ride-in bicycle parking areas within stations***
   - ***Bikeshare rental system and bikeway network integrated into stations***
   - Reduced and managed parking inside 10-minute walk circle around town center / train station
   - Specialized retail at stations serving commuters and locals including cafes, grocery, dry cleaners

[6] Transit Oriented Development Institute, Transit Oriented Development Institute, US High Speed Rail Association, 840 First St. NE, 3rd Floor Washington, DC, 20002

[7] *The TOD Institute* has a focus on intercity rail as the primary transit mode; therefore, these modes are denoted as FLM. For an urban system, they would be part of the primary transit system, and not part of the station area FLM networks.

The tables below summarize the *TOD Institute's* development guidelines.[8]

Development Guidelines For TOD Place Types

	CENTERS			
	Regional Center	Urban Center	Suburban Center	Transit Town Center
Housing Mix (New Development)	High-rise and mid-rise apartments and condos	Mid-rise, low-rise, some high-rise and townhomes	Mid-rise, low-rise, some high-rise and townhomes	Mid-rise, low-rise, townhomes, small-lot single family
Station Area Total Units Target	8,000-30,000	5,000-15,000	2,500-10,000	3,000-7,500
Net Project Density (New Housing)	75-300 du/acre	50-150 du/acre	35-100 du/acre	20-75 du/acre
Station Area Total Jobs Target	40,000-150,000	5,000-30,000	7,500-50,000	2,000-7,500
Minimum FAR (New Employment Development)	5.0 FAR	2.5 FAR	4.0 FAR	2.0 FAR

DISTRICTS			CORRIDOR
Urban Neighborhood	Transit Neighborhood	Special Use/ Employment District	Mixed-Use Corridor
Predominantly residential district with good access to regional and subregional centers	Predominantly residential district organized around transit station	Local focus of economic and community activity without distinct center	Local focus of economic and community activity without distinct center
Heavy rail, LRT/streetcar, BRT, commuter rail, local bus	LRT/streetcar, BRT, commuter rail, local bus	LRT/streetcar, BRT, potentially heavy rail	LRT/streetcar, BRT, local bus
5-15 minutes	15-30 minutes	15-30 minutes	5-15 minutes
Moderate- to high-density residential uses with supporting commercial and employment uses	Low- to moderate-density residential uses with supporting commercial and employment uses	Concentrations of commercial, employment and civic/cultural uses, potentially with some residential	Moderate-density mix of residential, commercial, employment and civic/cultural uses
Primarily local-serving retail opportunity; need for some community-serving retail	Primarily local-serving retail opportunity	Potential for community- and regional-serving retail but need to balance demands for access	Primarily local-serving retail opportunity; need for some community-serving retail
Expanding local-serving retail opportunities and increasing high-density housing	Integrating moderate-density housing and supporting local-serving retail	Creating sustainable off-peak uses and accommodating peak travel demand	Expanding local-serving retail opportunities and high-density housing opportunities
Fruitvale in Oakland, Greenwich Village in New York City, the Pearl District in Portland, University City in Philadelphia	Ohlone-Chynoweth outside San Jose; Plano, Texas; Barrio Logan in San Diego; Capitol Hill in Washington D.C.	South of Market in San Francisco, Camden Station in Baltimore, South Waterfront in Portland	International Boulevard in Oakland, Washington Street in Boston, University Avenue in St. Paul, Minnesota

ONCE THE PLANNING partners have identified an appropriate place type to guide planning in a particular station area, these guidelines can be used to think through the characteristics of the places they want to create. The following criteria should be discussed:

• ***Housing mix:*** *the range of housing types will vary depending on local conditions and the community vision. These types refer to new, not existing, housing.*

• ***Station area*** *total units target: The range will vary according to local conditions.*

STATION AREA PLANNING

[8] TOD 202 Station Area Planning: How To Make Great Transit-Oriented Places; Federal Transit Administration, 2008

Transit Oriented Development:

Unified Information for SMART Plan Scenarios and First Last Mile Mobility Planning

The various sources of TOD guidelines, design concepts and principals agree on the basic functional and design aspects of TOD. To some extent, the degree of recommended development (intensity, density, height) varies, due in large part to variations in contextual factors that are difficult to account for given the small number of samples used as best practices relative to the wide extent of variation.

Overall, the principals include development aspects, geographic compactness, relationships of uses around compact lifestyles, and expanding the spatial influence of transit and compact lifestyle with FLM strategies. The FLM relevant tenets are:

- Centrally located transit within a defined transit supportive area, with the centrality based on walking or other FLM walking paths, lifestyle experiences, and visual sightlines;
- The Transit Core is based on ¼-mile (5 minute) walking paths to and from the station, and is the area where the emphasis of development and design is focused on walking as the primary FLM strategy;
- The Transit Neighborhood is based on ½-mile (10 minute) walking paths to and from the station, and is the area where development is less intense. Walking is still primary, but other modes begin to have greater importance for mobility, access and FLM mobility to the station. FLM strategies do not increase the base transit market area, but instead focus on increasing transit market penetration into the Transit Neighborhood.
- The Transit Supportive Area is the area outside of the Transit Neighborhood. It is often defined as 1 mile, but may practically extend to 2 miles based on a strong presence of FLM options. Development is less intense; redevelopment from existing conditions may not be necessary at all, and may be undesirable within the first generation of development after the construction of the primary transit station. Walking is important for access, but other modes are the primary FLM strategies for mobility to the station. In the Transit Supportive Area, FLM strategies critically increase the base transit market area, and as such can have great influence on effective transit shed size, transit market, and potential transit ridership.
- Excellent walkability with small blocks and pedestrian traffic management priority, especially in the Transit Core and Transit Neighborhood;
- Extended hours of highly-reliable, fast primary transit service at 5 to 15-minute intervals, that provides systemwide mobility to regional destinations and other Transit Station Areas;
- Land use mix in the station area to meet daily needs of the transit supportive area paired with good connectivity to other activities, via a wide range of effective FLM strategies;
- Compact residential density and/or non-residential intensity sufficient to support cost-effective primary transit, and infrastructure, and to complete a symbiotic relationship among residential marketability and retail viability;
- Managed parking with reduced non-residential supply relative to standard or suburban development.

To provide a contextual stage for discussing SMART Plan Corridor FLM, the various approaches have been combined into the Tables 12, 13 and 14 on pages 37 through 42 to create general development scenarios for: each station place type, each station area within the place type, and for each primary transit mode.

Ultimately, development, access, and mobility by any means is about people. The primary driving forces for factor for each scenario is people: minimum number of resident populations and minimum numbers of destination populations (employees and visitors) to support each mode for each type of station place in the transit system. These minimums are based principally on the *Florida TOD Guidelines* which present overlapping ranges. The lower number of each range is used for a baseline.

Some basic assumptions are made for idealized urban grid forms and land use regulations; however, these are intended to be changed to specific station areas. Scenario inputs and assumptions are italicized and printed in blue.

The outcome of the tables is to define development scenarios along with street forms that help to define populations of people as evening residents or daytime destination occupants, by which a base can be established for FLM modal demand. The minimum transit rider potentials are based on assumed percentages that must be refined with more quantitative survey data. As a reference point, the Miami Downtown Development of Regional Impact (DDRI) Increments I, II and III, as part of its transportation methodology, has established mode splits of: Transit: 19% for the A&E District, 22.4% for the CBD District and 14.2% for the Brickell District; Bike and Pedestrians: 10% for the A&E District, 10% for the CBD District, and 15% for the Brickell District.[9]

In the scenarios, the increase in transit mode split is by 70% for the compact transit station area over suburban development. Transit core and neighborhood area mode splits are increased by 8% where the density of residential development is 10 dwelling units per gross acre or higher, and by 13.5% where the density of residential development is greater than 30 dwelling units per gross acre.[10]

To clarify, the increase in development density does not only increase the potential for transit ridership by adding people within the transit shed (base market), but has an additional factoring effect to increase the percent of that greater number of people that are likely to use transit (market penetration).

The tables are grouped first by <u>Primary Transit Mode</u>:

- Urban Heavy Rail
- Light Rail Transit
- Bus or Bus Rapid Transit

Within each table, the next grouping is by <u>Station Place Type</u>:

- Regional Center
- Community Center
- Neighborhood Center

Within each primary transit mode and station place type, the scenarios are grouped by <u>Station Area Types</u>:

- Transit Core (¼-mile)
- Transit Neighborhood (½-mile)
- Transit Supportive Area (2 miles)

[9] Miami Downtown Development of Regional Impact (DDRI), Increment III, City of Miami, Florida, 2016

[10] Cervero, Robert, Ridership impacts of transit-focused development in California. Berkeley, CA: University of California, Institute of Urban and Regional Development, 2003

Table 12: Transit Mode and TOD Scenarios, The Stage for First / Last Mile Planning – Heavy Rail (Part 1)

Primary Transit Mode ->	URBAN HEAVY RAIL page 1											
Transit Station Place Type ->	**REGIONAL CENTER**				**COMMUNITY CENTER**				**NEIGHBORHOOD CENTER**			
Station Area ->	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**
Transect												
Transect Type	T6	T5	T4		T6	T4	T3		T5	T4	T3	
												
Land Area												
Distance from Station (miles)	*0.25*	*0.5*	*2*		*0.25*	*0.5*	*2*		*0.25*	*0.5*	*2*	
Area (gross acres) (orthagonal method)	80	240	4,800	5,120	80	240	4,800	5,120	80	240	4,800	5,120
Interconnectivity Metrics												
Block Face Size (ft.) (development frontages)	*250*	*250*	*300*		*250*	*250*	*300*		*250*	*250*	*300*	
Block Area (net acres)	1.43	1.43	2.07		1.43	1.43	2.07		1.43	1.43	2.07	
Block Perimeter	1,000	1,000	1,200		1,000	1,000	1,200		1,000	1,000	1,200	
Block Area to Perimeter Ratio	63	63	75		63	63	75		63	63	75	
Average Right-of-Way Cross Section	*100*	*80*	*60*		*100*	*80*	*60*		*100*	*80*	*60*	
Number of Blocks	28	96	1613	1,738	28	96	1613	1,738	28	96	1613	1,738
Blocks per Square Mile	228	256	215		228	256	215		228	256	215	
Number of Intersections	40	117	1695	1,851	40	117	1695	1,851	40	117	1695	1,851
Intersections per Square Mile	321	311	226		321	311	226		321	311	226	
Net Developabe Area (acres)	41	138	3,333	3,512	41	138	3,333	3,512	41	138	3,333	3,512
Residential Metrics												
Station Area Residential Density (DU/Ac.)	*45*	*25*	*6*	*7.50*	*25*	*12*	*6*	*6.58*	*20*	*12*	*6*	*6.50*
Number of Residences (targets: 10k,5k in Transit Core & Transit Neighborhood)	3,600	6,000	28,800	9600 in TN 38400 total	2,000	2,880	28,800	4880 in TN 33680 total	1,600	2,880	28,800	4480 in TN 33280 total
Average Residential Unit Area (gross)	*900*	*1200*	*1500*		*900*	*1200*	*1500*		*900*	*1200*	*1500*	
Total Residential Gross Floor Area	3,240,000	7,200,000	43,200,000		1,800,000	3,456,000	43,200,000		1,440,000	3,456,000	43,200,000	
Persons per Household	*2.5*	*2.5*	*2.5*		*2.5*	*2.5*	*2.5*		*2.5*	*2.5*	*2.5*	
Residential Population Density (/acre)	72,000	40,000	9,600	121,600	40,000	19,200	9,600	68,800	32,000	19,200	9,600	60,800
Employment												
jobs/acre	*400*	*100*	*10*		*100*	*40*	*5*		*30*	*15*	*5*	
Number of Jobs (targets: 60k,18k in Transit Core & Transit Neighborhood)	32,000	24,000	48,000	56000 in TN 104000 total	8,000	9,600	24,000	17600 in TN 41600 total	2,400	3,600	24,000	6000 in TN 30000 total
Average Floor Area per Employee	*500*	*500*	*500*		*500*	*500*	*500*		*500*	*500*	*500*	
Total Non-Residential Floor Area	16,000,000	12,000,000	24,000,000		4,000,000	4,800,000	12,000,000		1,200,000	1,800,000	12,000,000	
Mixed Use												
Employment / Housing Ratio	8.9	4.0	1.7	2.7	4.0	3.3	0.8	1.2	1.5	1.3	0.8	0.9
Percent Residential Floor Area	17%	38%	64%	51%	31%	42%	78%	70%	55%	66%	78%	76%
Percent Non-Residential Floor Area	83%	63%	36%	49%	69%	58%	22%	30%	45%	34%	22%	24%

Table 12 Cont: Transit Mode and TOD Scenarios, The Stage for First / Last Mile Planning – Heavy Rail (Part 2)

Primary Transit Mode ->	URBAN HEAVY RAIL page 2											
Transit Station Place Type ->	**REGIONAL CENTER**				**COMMUNITY CENTER**				**NEIGHBORHOOD CENTER**			
Station Area ->	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**
Parking												
Maximum Residential Spaces / DU	*1.5*	*1.5*	*1.5*		*1.5*	*1.5*	*1.5*		*1.5*	*1.5*	*2*	
Maximum Non-Residential Spaces / ksf	*1*	*1*	*1*		*1*	*1*	*1*		*1*	*1*	*1*	
On-Street Parking Spaces	1,293	4,364	88,000		1,293	4,364	88,000		1,293	4,364	88,000	
Structured Parking Spaces	21,400	21,000	67,200		7,000	9,120	55,200		3,600	6,120	69,600	
Structured Parking Area at 330 sf/sp	7,062,000	6,930,000	22,176,000		2,310,000	3,009,600	18,216,000		1,188,000	2,019,600	22,968,000	
Percent Structured Spaces	94%	83%	43%		84%	68%	39%		74%	58%	44%	
Building Design												
Street Facade Setback/Build-To Limits (ft.)	*10*	*10*	*10*		*10*	*10*	*10*		*10*	*10*	*10*	
Maximum Lot Coverage	85%	85%	87%		85%	85%	87%		85%	85%	87%	
Sum of Building Footprints	1,504,865	5,078,400	126,485,333		1,504,865	5,078,400	126,485,333		1,504,865	5,078,400	126,485,333	
First Floor Retail Employment	752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667	
First Floor Residential Auxiliary	752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667	
Upper Employment Floors	10	2	0		2	-1	-1		-1	-1	-1	
Residential Floors	2	1	0		2	1	1		1	1	1	
Parking Floors	5	2	1		2	1	1		1	1	1	
Total Building Floors	**18**	**6**	**2**		**7**	**2**	**2**		**2**	**2**	**2**	
Building to Street Aspect Ratio (w setback)	1.6	0.7	0.4		0.7	0.3	0.4		0.3	0.3	0.4	
Street Cross Section												
Sidewalk Width (curb to setback)	*10*	*10*	*10*		*10*	*10*	*10*		*10*	*10*	*10*	
Number of Travel Lanes (10 ft. wide)	4	2	2		4	2	2		4	2	2	
Turn Lane	1	1	0		1	1	0		1	1	0	
Number of Parking Lanes (8 ft. wide)	2	2	2		2	2	2		2	2	2	
Number of One-Way Bike Lanes (7ft.)	2	2	0		2	2	0		2	2	0	
Remainder	0	0	4		0	0	4		0	0	4	
Transit Users												
Increase in transit mode split from TSA*	*14%*	*8%*	*4%*		*8%*	*8%*	*3%*		*8%*	*8%*	*2%*	
Assumed percentage of transit users	*4%*	*4%*	*3%*		*4%*	*4%*	*3%*		*2%*	*2%*	*2%*	
Number of Residential Transit Users	347	551	2,448		184	264	2,448		86	156	1,440	
Number of Destination Transit Users	1,235	881	1,632		294	353	816		52	78	480	
Total Transit Market Support	1,582	1,432	4,080	7,094	477	617	3,264	4,358	138	233	1,920	2,292
Potential First / Last Mile Demand												
Walk	*90%*	*30%*	*0%*		*90%*	*30%*	*0%*		*90%*	*30%*	*0%*	
	1,424	430	0	1,854	430	185	0	615	124	70	0	194
Bike	*5%*	*30%*	*10%*		*5%*	*30%*	*10%*		*5%*	*30%*	*10%*	
	79	430	408	917	24	185	326	535	7	70	192	269
Vehicular (car, personal/group transit)	*5%*	*40%*	*90%*		*5%*	*40%*	*90%*		*5%*	*40%*	*90%*	
	79	573	3,672	4,324	24	247	2,938	3,208	7	93	1,728	1,828

Table 13: Transit Mode and TOD Scenarios, The Stage for First / Last Mile Planning – Light Rail (Part 1)

Primary Transit Mode ->	URBAN LIGHT RAIL TRANSIT page 1											
Transit Station Place Type ->	**REGIONAL CENTER**				**COMMUNITY CENTER**				**NEIGHBORHOOD CENTER**			
Station Area ->	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**
Transect												
Transect Type	T6	T5	T4		T5	T4	T3		T4	T3	T3	
												
Land Area												
Distance from Station (miles)	*0.25*	*0.5*	*2*		*0.25*	*0.5*	*2*		*0.25*	*0.5*	*2*	
Area (gross acres) (orthagonal method)	80	240	4,800	5,120	80	240	4,800	5,120	80	240	4,800	5,120
Interconnectivity Metrics												
Block Face Size (ft.) (development frontages)	*250*	*250*	*300*		*250*	*250*	*300*		*250*	*250*	*300*	
Block Area (net acres)	1.43	1.43	2.07		1.43	1.43	2.07		1.43	1.43	2.07	
Block Perimeter	1,000	1,000	1,200		1,000	1,000	1,200		1,000	1,000	1,200	
Block Area to Perimeter Ratio	63	63	75		63	63	75		63	63	75	
Average Right-of-Way Cross Section	*100*	*80*	*60*		*100*	*80*	*60*		*100*	*80*	*60*	
Number of Blocks	28	96	1613	1,738	28	96	1613	1,738	28	96	1613	1,738
Blocks per Square Mile	228	256	215		228	256	215		228	256	215	
Number of Intersections	40	117	1695	1,851	40	117	1695	1,851	40	117	1695	1,851
Intersections per Square Mile	321	311	226		321	311	226		321	311	226	
Net Developabe Area (acres)	41	138	3,333	3,512	41	138	3,333	3,512	41	138	3,333	3,512
Residential Metrics												
Station Area Residential Density (DU/Ac.)	*25*	*13*	*6*	*6.63*	*15*	*10*	*6*	*6.33*	*15*	*10*	*6*	*6.33*
Number of Residences (targets: 5k,3k in Transit Core & Transit Neighborhood)	2,000	3,120	28,800	5120 in TN 33920 total	1,200	2,400	28,800	3600 in TN 32400 total	1,200	2,400	28,800	3600 in TN 32400 total
Average Residential Unit Area (gross)	*900*	*1200*	*1500*		*900*	*1200*	*1500*		*900*	*1200*	*1500*	
Total Residential Gross Floor Area	1,800,000	3,744,000	43,200,000		1,080,000	2,880,000	43,200,000		1,080,000	2,880,000	43,200,000	
Persons per Household	*2.5*	*2.5*	*2.5*		*2.5*	*2.5*	*2.5*		*2.5*	*2.5*	*2.5*	
Residential Population Density (/acre)	40,000	20,800	9,600	70,400	24,000	16,000	9,600	49,600	24,000	16,000	9,600	49,600
Employment												
jobs/acre	*300*	*70*	*10*		*70*	*30*	*5*		*30*	*15*	*5*	
Number of Jobs (target = 40k,12k in Transit Core & Transit Neighborhood)	24,000	16,800	48,000	40800 in TN 88800 total	5,600	7,200	24,000	12800 in TN 36800 total	2,400	3,600	24,000	6000 in TN 30000 total
Average Floor Area per Employee	*500*	*500*	*500*		*500*	*500*	*500*		*500*	*500*	*500*	
Total Non-Residential Floor Area	12,000,000	8,400,000	24,000,000		2,800,000	3,600,000	12,000,000		1,200,000	1,800,000	12,000,000	
Mixed Use												
Employment / Housing Ratio	12.0	5.4	1.7	2.6	4.7	3.0	0.8	1.1	2.0	1.5	0.8	0.9
Percent Residential Floor Area	13%	31%	64%	52%	28%	44%	78%	72%	47%	62%	78%	76%
Percent Non-Residential Floor Area	87%	69%	36%	48%	72%	56%	22%	28%	53%	38%	22%	24%

Table 13 Cont: Transit Mode and TOD Scenarios, The Stage for First / Last Mile Planning – Light Rail (Part 2)

Primary Transit Mode ->	URBAN LIGHT RAIL TRANSIT page 2											
Transit Station Place Type ->	**REGIONAL CENTER**				**COMMUNITY CENTER**				**NEIGHBORHOOD CENTER**			
Station Area ->	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**
Parking												
Maximum Residential Spaces / DU	*1.5*	*1.5*	*1.5*		*1.5*	*1.5*	*1.5*		*1.5*	*1.5*	*2*	
Maximum Non-Residential Spaces / ksf	*1*	*1*	*1*		*1*	*1*	*1*		*1*	*1*	*1*	
On-Street Parking Spaces	1,293	4,364	88,000		1,293	4,364	88,000		1,293	4,364	88,000	
Structured Parking Spaces	15,000	13,080	67,200		4,600	7,200	55,200		3,000	5,400	69,600	
Structured Parking Area at 330 sf/sp	4,950,000	4,316,400	22,176,000		1,518,000	2,376,000	18,216,000		990,000	1,782,000	22,968,000	
Percent Structured Spaces	92%	75%	43%		78%	62%	39%		70%	55%	44%	
Building Design												
Street Facade Setback/Build-To Limits (ft.)	*10*	*10*	*10*		*10*	*10*	*10*		*10*	*10*	*10*	
Maximum Lot Coverage	85%	85%	87%		85%	85%	87%		85%	85%	87%	
Sum of Building Footprints	1,504,865	5,078,400	126,485,333		1,504,865	5,078,400	126,485,333		1,504,865	5,078,400	126,485,333	
First Floor Retail Employment	752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667	
First Floor Residential Auxiliary	752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667	
Upper Employment Floors	7	1	-1		1	-1	-1		-1	-1	-1	
Residential Floors	2	1	1		1	1	1		1	1	1	
Parking Floors	4	1	1		2	1	1		1	1	1	
Total Building Height	**14**	**4**	**2**		**5**	**2**	**2**		**2**	**2**	**2**	
Building to Street Aspect Ratio (w setback)	1.3	0.5	0.4		0.5	0.3	0.4		0.3	0.3	0.4	
Street Cross Section												
Sidewalk Width (curb to setback)	*10*	*10*	*10*		*10*	*10*	*10*		*10*	*10*	*10*	
Number of Travel Lanes (10 ft. wide)	4	2	2		4	2	2		4	2	2	
Turn Lane	1	1	0		1	1	0		1	1	0	
Number of Parking Lanes (8 ft. wide)	2	2	2		2	2	2		2	2	2	
Number of One-Way Bike Lanes (7ft.)	2	2	0		2	2	0		2	2	0	
Remainder	0	0	4		0	0	4		0	0	4	
Transit Users												
Increase in transit mode split from TSA*	*8%*	*8%*	*4%*		*8%*	*0%*	*3%*		*8%*	*0%*	*2%*	
Assumed percentage of transit users	*4%*	*4%*	*3%*		*4%*	*3%*	*3%*		*2%*	*2%*	*2%*	
Number of Residential Transit Users	184	286	2,448		110	204	2,448		65	120	1,440	
Number of Destination Transit Users	881	617	1,632		206	245	816		52	72	480	
Total Transit Market Support	1,065	903	4,080	6,048	316	449	3,264	4,029	117	192	1,920	2,229
Potential First / Last Mile Demand												
Walk	*90%*	*30%*	*0%*		*90%*	*30%*	*0%*		*90%*	*30%*	*0%*	
	958	271	0	1,229	284	135	0	419	105	58	0	163
Bike	*5%*	*30%*	*10%*		*5%*	*30%*	*10%*		*5%*	*30%*	*10%*	
	53	271	408	732	16	135	326	477	6	58	192	255
Vehicular (car, personal/group transit)	*5%*	*40%*	*90%*		*5%*	*40%*	*90%*		*5%*	*40%*	*90%*	
	53	361	3,672	4,087	16	180	2,938	3,133	6	77	1,728	1,811

Table 14: Transit Mode and TOD Scenarios, The Stage for First / Last Mile Planning – Bus / BRT (Part 1)

Primary Transit Mode ->	BUS RAPID TRANSIT, BUS page 1											
Transit Station Place Type ->	REGIONAL CENTER				COMMUNITY CENTER				NEIGHBORHOOD CENTER			
Station Area ->	Transit Core	Transit Neighborhood	Transit Support Area	Station Area Total	Transit Core	Transit Neighborhood	Transit Support Area	Station Area Total	Transit Core	Transit Neighborhood	Transit Support Area	Station Area Total
Transect												
Transect Type	T6	T4	T3		T4	T3	T3		T4	T3	T3	
												
Land Area												
Distance from Station (miles)	*0.25*	*0.5*	*2*		*0.25*	*0.5*	*2*		*0.25*	*0.5*	*2*	
Area (gross acres) (orthagonal method)	80	240	4,800	5,120	80	240	4,800	5,120	80	240	4,800	5,120
Interconnectivity Metrics												
Block Face Size (ft.) (development frontages)	*250*	*250*	*300*		*250*	*250*	*300*		*250*	*250*	*300*	
Block Area (net acres)	1.43	1.43	2.07		1.43	1.43	2.07		1.43	1.43	2.07	
Block Perimeter	1,000	1,000	1,200		1,000	1,000	1,200		1,000	1,000	1,200	
Block Area to Perimeter Ratio	63	63	75		63	63	75		63	63	75	
Average Right-of-Way Cross Section	*100*	*80*	*60*		*100*	*80*	*60*		*100*	*80*	*60*	
Number of Blocks	28	96	1613	1,738	28	96	1613	1,738	28	96	1613	1,738
Blocks per Square Mile	228	256	215		228	256	215		228	256	215	
Number of Intersections	40	117	1695	1,851	40	117	1695	1,851	40	117	1695	1,851
Intersections per Square Mile	321	311	226		321	311	226		321	311	226	
Net Developabe Area (acres)	41	138	3,333	3,512	41	138	3,333	3,512	41	138	3,333	3,512
Residential Metrics												
Station Area Residential Density (DU/Ac.)	*13*	*8*	*6*	*6.20*	*13*	*8*	*6*	*6.20*	*13*	*8*	*6*	*6.20*
Number of Residences (targets: 3k,1k in Transit Core & Transit Neighborhood)	1,040	1,920	28,800	2960 in TN 31760 total	1,040	1,920	28,800	2960 in TN 31760 total	1,040	1,920	28,800	2960 in TN 31760 total
Average Residential Unit Area (gross)	*900*	*1200*	*1500*		*900*	*1200*	*1500*		*900*	*1200*	*1500*	
Total Residential Gross Floor Area	936,000	2,304,000	43,200,000		936,000	2,304,000	43,200,000		936,000	2,304,000	43,200,000	
Persons per Household	*2.5*	*2.5*	*2.5*		*2.5*	*2.5*	*2.5*		*2.5*	*2.5*	*2.5*	
Residential Population Density (/acre)	20,800	12,800	9,600	43,200	20,800	12,800	9,600	43,200	20,800	12,800	9,600	43,200
Employment												
jobs/acre	*150*	*30*	*10*		*30*	*15*	*5*		*30*	*15*	*5*	
Number of Jobs (target = 20k,6k in Transit Core & Transit Neighborhood)	12,000	7,200	48,000	19200 in TN 67200 total	2,400	3,600	24,000	6000 in TN 30000 total	2,400	3,600	24,000	6000 in TN 30000 total
Average Floor Area per Employee	*500*	*500*	*500*		*500*	*500*	*500*		*500*	*500*	*500*	
Total Non-Residential Floor Area	6,000,000	3,600,000	24,000,000		1,200,000	1,800,000	12,000,000		1,200,000	1,800,000	12,000,000	
Mixed Use												
Employment / Housing Ratio	11.5	3.8	1.7	2.1	2.3	1.9	0.8	0.9	2.3	1.9	0.8	0.9
Percent Residential Floor Area	13%	39%	64%	58%	44%	56%	78%	76%	44%	56%	78%	76%
Percent Non-Residential Floor Area	87%	61%	36%	42%	56%	44%	22%	24%	56%	44%	22%	24%

Table 14 Cont: Transit Mode and TOD Scenarios, The Stage for First / Last Mile Planning – Bus / BRT (Part 2)

Primary Transit Mode ->	BUS RAPID TRANSIT, BUS page 2											
Transit Station Place Type ->	**REGIONAL CENTER**				**COMMUNITY CENTER**				**NEIGHBORHOOD CENTER**			
Station Area ->	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**	**Transit Core**	**Transit Neighborhood**	**Transit Support Area**	**Station Area Total**
Parking												
Maximum Residential Spaces / DU	*1.5*	*1.5*	*1.5*		*1.5*	*1.5*	*1.5*		*1.5*	*1.5*	*2*	
Maximum Non-Residential Spaces / ksf	*1*	*1*	*1*		*1*	*1*	*1*		*1*	*1*	*1*	
On-Street Parking Spaces	1,293	4,364	88,000		1,293	4,364	88,000		1,293	4,364	88,000	
Structured Parking Spaces	7,560	6,480	67,200		2,760	4,680	55,200		2,760	4,680	69,600	
Structured Parking Area at 330 sf/sp	2,494,800	2,138,400	22,176,000		910,800	1,544,400	18,216,000		910,800	1,544,400	22,968,000	
Percent Structured Spaces	85%	60%	43%		68%	52%	39%		68%	52%	44%	
Building Design												
Street Facade Setback/Build-To Limits (ft.)	*10*	*10*	*10*		*10*	*10*	*10*		*10*	*10*	*10*	
Maximum Lot Coverage	85%	85%	87%		85%	85%	87%		85%	85%	87%	
Sum of Building Footprints	1,504,865	5,078,400	126,485,333		1,504,865	5,078,400	126,485,333		1,504,865	5,078,400	126,485,333	
First Floor Retail Employment	752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667	
First Floor Residential Auxiliary	752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667		752,432	2,539,200	63,242,667	
Upper Employment Floors	3	-1	-1		-1	-1	-1		-1	-1	-1	
Residential Floors	1	1	1		1	1	1		1	1	1	
Parking Floors	2	1	1		1	1	1		1	1	1	
Total Building Height	**7**	**2**	**2**		**2**	**2**	**2**		**2**	**2**	**2**	
Building to Street Aspect Ratio (w setback)	0.7	0.3	0.4		0.3	0.3	0.4		0.3	0.3	0.4	
Street Cross Section												
Sidewalk Width (curb to setback)	*10*	*10*	*10*		*10*	*10*	*10*		*10*	*10*	*10*	
Number of Travel Lanes (10 ft. wide)	4	2	2		4	2	2		4	2	2	
Turn Lane	1	1	0		1	1	0		1	1	0	
Number of Parking Lanes (8 ft. wide)	2	2	2		2	2	2		2	2	2	
Number of One-Way Bike Lanes (7ft.)	2	2	0		2	2	0		2	2	0	
Remainder	0	0	4		0	0	4		0	0	4	
Transit Users												
Increase in transit mode split from TSA*	*8%*	*0%*	*0%*		*8%*	*0%*	*3%*		*8%*	*0%*	*2%*	
Assumed percentage of transit users	*4%*	*3%*	*3%*		*4%*	*3%*	*3%*		*2%*	*2%*	*2%*	
Number of Residential Transit Users	95	163	2,448		95	163	2,448		56	96	1,440	
Number of Destination Transit Users	441	245	1,632		88	122	816		52	72	480	
Total Transit Market Support	536	408	4,080	5,024	184	286	3,264	3,733	108	168	1,920	2,196
Potential First / Last Mile Demand												
Walk	*90%*	*30%*	*0%*		*90%*	*30%*	*0%*		*90%*	*30%*	*0%*	
	483	122	0	605	165	86	0	251	97	50	0	148
Bike	*5%*	*30%*	*10%*		*5%*	*30%*	*10%*		*5%*	*30%*	*10%*	
	27	122	408	557	9	86	326	421	5	50	192	248
Vehicular (car, personal/group transit)	*5%*	*40%*	*90%*		*5%*	*40%*	*90%*		*5%*	*40%*	*90%*	
	27	163	3,672	3,862	9	114	2,938	3,061	5	67	1,728	1,801

TRANSIT ORIENTED DEVELOPMENT FLM TOOL KIT

D1. LAND USE PLANNING

Goals

- Develop compact station area nodes and corridors that aggregate sufficient residential density, jobs, and destinations to support regional transit use and reduce vehicle miles (VMT) travelled for daily needs and work commutes.
- Balance station area (Transit Core, Transit Neighborhood, and Transit Supportive Area) mixed use to create highly pedestrian-oriented development patterns, densities, intensities, and infrastructure.
- Respect the history, life and vision of communities in the SMART Corridors: amend comprehensive plan future land use elements to recognize community vision, appropriately transition to existing residential neighborhoods, and create a rationally phased, comprehensive redevelopment plan.

Actions

- Review schedule of municipal and County Comprehensive Development Master Plan (CDMP) Evaluation and Appraisal Report (EAR) process, and coordinate with EAR-based amendments.
- Review the Land Use Elements of the County and municipal comprehensive plans, and amend consistent with TOD guidelines appropriate to creating transit supportive station areas and corridors using FLM strategies to expand the use of regional transit systems and to reduce VMT within the corridors.
- Coordinate amendments with TOD guidelines, SMART Corridors land use scenario development, and thorough community input.

Criteria:

- Consistency with State Growth Management Laws, Ch 163 F.S.
- Consistency with County and municipality charters
- Consistency with US and State of Florida constitutional rights
- Number of residents in a station area and residential density in a station area that is progressively transitioned and sufficient to support transit development and FLM access to the transit station according to the minimums contained in Tables 12, 13 and 14 of this Section.
- Number of jobs in a station area and employment density in a station area that is progressively transitioned and sufficient to support transit development and FLM access to the transit station according to the minimums contained in Tables 12, 13 and 14.
- Jobs/housing balance and population/retail balance to maximize internal capture of trips within corridors, and reduce VMT through higher transit utilization and FLM strategy utilization.

Improvements

- Comprehensive Plan amendments:
  - Future Land Use Map (FLUM)
  - Goals Objectives and Policies
  - Other adopted components
- Strategic Plan Amendments
- Amendments to pertinent adopted plans

Timeframe

- Short Term: prior to zoning amendments

Funding

- Minimal funding requirement for regulatory amendments

TRANSIT ORIENTED DEVELOPMENT FLM TOOL KIT

D2. LAND DEVELOPMENT REGULATIONS

Goals

- Develop compact station area nodes and corridors that aggregate sufficient residential density, jobs, and destinations to support regional transit use and reduce vehicle miles (VMT) travelled for daily needs and work commutes.
- Transitioned station area mixed-use to create pedestrian-oriented development patterns, densities, intensities, building form, building disposition, and proportionate public realm space.
- Respect the history, life and vision of communities in the SMART Corridors: amend land development regulations to implement community visions and protect existing residential neighborhoods.

Actions

- Review the Land Development Regulations (LDR) of the County and municipalities, and amend text and/or maps to support Comprehensive Plan Amendments that implement TOD guidelines appropriate to creating transit supportive station areas and corridors using FLM strategies to expand the use of regional transit systems and to reduce VMT within the corridors.
- Perform analysis for each municipality, and or community to provide code that logically progresses toward comprehensive plan goals over time, and assures fair distribution of development. Zoning may progress toward build-out, and not over-zone.
  - Before rezoning, use the County Economic Input Output model (REMI) to determine demand for housing and commercial space
  - Determine short term real estate market absorption rates to develop spatially continuous and progressive development patterns around SMART Corridor stations that maximize land use access for FLM mobility.

Criteria:

- Consistency with County and municipality comprehensive plans
- Consistency with County and municipality charters
- Consistent with US and State of Florida constitutional rights
- Number of residents in a station area and residential density in a station area that is progressively transitioned and sufficient to support transit development and FLM access to the transit station according to the minimums contained in Tables 12, 13 and 14.
- Number of jobs in a station area and employment density in a station area that is progressively transitioned and sufficient to support transit development and FLM access to the transit station according to the minimums contained in in Tables 12, 13 and 14.
- Jobs/housing balance and population/retail balance to maximize internal capture of trips within corridors, and reduce VMT through higher transit utilization and FLM strategy utilization.

Improvements

- Zoning District Maps
- Permitted use, building form and disposition regulations
- Parking regulations to support transit (minimum and maximum)
- Bonus programs
- Possible transfer of development rights (TDR)

Timeframe

- Mid-Term: subsequent to comprehensive plans, prior to development

Funding

- Minimal funding requirement for regulatory amendments

TRANSIT ORIENTED DEVELOPMENT FLM TOOL KIT

D3. REPLATTING DECISIONS

Goals

- Develop walkable station area grid forms with short blocks, as practicable.
- Create and aggregate additional pedestrian and public realm space in logical locations that supports pedestrian, bicycle, and other FLM strategies.

Actions

- Create map of desired pass throughs or public realm spaces on long blocks.
- Amend zoning regulation to provide bonuses or other benefits to support the assembly of parcels, if necessary, and the dedication of new rights-of-way or public plazas.

Criteria:

- Creation of additional public realm space in exchange for other development permits to assure that development rights are not reduced.
- Maximum block lengths for pedestrian and FLM pathways consistent with station area location. (about 500 feet)
- Minimum block face lengths to support commercial space market viability, residential space market viability, and internal parking efficiencies. (about 200 feet)
- Create view corridors with terminated vistas at the transit station to improve natural, language-independent way-finding to the transit station.
- Exception to the criteria are for large blocks that contain structured parking within, lined by continuous active building facades on all sides.

Improvements

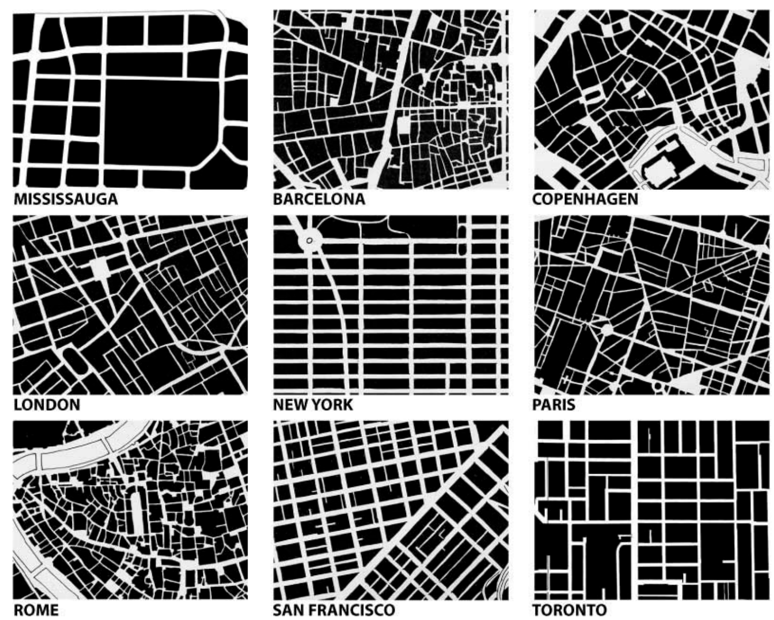
- Reduction of long block lengths with public spaces for walking, biking and other FLM mobility strategies

Timeframe

- Short Term: determine where pedestrian passthroughs and public spaces are needed (see Pedestrian Toolkit P3)

Funding

Minimal funding: administrative or quasi-judicial process.



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PEDESTRIAN FLM STRATEGIES

▪ WALKING – THE PRIMARY MODE

The primary FLM Strategy for existing and future transit hubs is walking. Walking is the beginning and end of every trip by any mode and is the primary mobility mode. Consideration of walking as a FLM modal strategy requires discussion of two concepts: access and mobility.

Access is the ability to meet a person's daily needs with a minimum of travel and cost. Access has a stronger relationship to urban design and land use, as the emphasis is satisfying needs with minimization of travel.

Mobilty is the ability to get around by a variety of means. The need to travel is assumed and mobility does not seek to minimize travel, but to lower the time and cost of it, while making the experience convenient and as safe, secure and enjoyable as possible.

For each station area, the primary concept is to develop the "pathway" by which existing and future SMART Plan transit users can access corridor transit stations/stops.

The Pathway is the mobility and access infrastructure network that helps to reduce the distance and time it takes people to travel from their origins and destinations to primary transit stations /stops, while simultaneously improving the user experience in more qualitative ways. As such, the pathway mostly focuses on mobility, but also considers access. The core concept of the Pathway is to provide a context-specific set of mobility and access improvements that extend to and from the primary transit stations/stops. Pathway vary by station, primary mode, regional context, and distance from the station.

WALKING – PATHWAYS & RESEARCH FINDINGS

If walking is the primary mobility at the beginning and end of every transit trip, with or without FLM, then there are three central questions to consider:

I. How far do pedestrians walk to transit stations/stops?
II. Does walk distance vary by transit mode?
III. What environmental factors influence their route distance and choice?

*Walk Distance: Personal Characteristics*

If environmental considerations are set aside, the answer to the question of how far people walk to transit has great variability by age, gender, ambulatory status, and possibly even cultural biases. Notwithstanding that variance from person to person can be significant, research has a general consensus on a walking distance range of ¼ mile to ½ mile as maximums for the general population. On flat terrain without obstruction, people walk at 3.16 mph (national average, National Personal Transportation Survey (NPTS)).[11] (The MUTCD, for purposes of intersection crossings uses 4.0 ft. /sec. – about 2.7 mph[12]) On average, the consensus range of ¼

[11] Adelia Santos, FHWA NHTS Program Manager N/A, Nancy McGuckin and Hikari Yukiko, Travel Behavior Associates; Danielle Gray and Susan Liss, Cambridge Systematics; *Summary of Travel Trends, National Household Travel Survey*, US Department of Transportation, Washington DC, 2011

[12] Manual of Uniform Traffic Control Devices (MUTCD) US Department of Transportation, Federal Highway Administration, Washington DC, 2012

to ½ mile represents a 5 to 10-minute walk. It turns out that this time frame applies to many FLM modal options as well.

Walk Distance: Wheelchairs and Seniors

Based on guidelines developed for Snohomish County in Washington (Seattle Metropolitan Area), whereas 1,000 ft. walking distance is recommended in general, a 25% shorter distance is recommended for seniors. Average walking speed for seniors ranges widely from a low of 2.5 mph to 3.1 mph. The 25% shorter range used for the Snohomish County guidelines corresponds with the low range of senior walking speeds, again underscoring that the key determinant for walking may be the direct measure of time instead of distance. For people using wheelchairs, research indicates single non-stop trip distances for people in self-propelled wheelchairs at about 600 ft, and about 1,130 ft. for powered wheel chairs.[13] At walking speeds for average self-propelled wheelchairs and 3 to 5 mph for most powered wheelchairs (some travel up to speeds of 10 mph), this corresponds to approximately 3-minute trip times for each.

Walk Distance: By Transit Mode & Regional Location

With regards to whether walk distance varies by mode, there is less data. It appears based on the context of many of the guidelines, that the transit station walk distances are based on transit stations using fixed guideway transit: whether light rail, heavy urban rail, or commuter rail; however, where guidelines and studies have differentiated modes, there is a greater willingness to walk a longer distance to rail stations, whether urban heavy rail or commuter heavy rail, than to bus stations. In studies used for the planning of the Fairfax County Metro Station (Washington DC Area)[14] and the Calgary light rail transit system[15], differential walking distances were identified by primary mode, and confirm that walking time varies by mode, as summarized in Table 15.

Table 15
Walk Distance & Time By Primary Mode & Regional Location

Mode	Urban Bus	Urban Light Rail Transit	Urban Heavy Rail Transit	Suburban Commuter Heavy Rail
Walk Distance @ 3.16 mph	830’ to 1,112’ 1/7 to ¼ mile	1,390’ to 2,780’ ¼ to ½ mile	1,390’ to 2,780’ ¼ to ½ mile	1,950’ to 4,170’ 1/3 to ¾ mile
Walk Time	3 to 4 min.	5 to 10 min.	5 to 10 min.	7 to 15 min.
Primary Mode Avg. Distance	3.7 mi.	3.7 mi.	5.3 mi.	23.7 mi.
Primary Mode Avg. Time	22 min. @10mph	15 min. @15mph	11 min. @30mph	24 min. @60mph
Primary Mode Avg. Station Spacing	0.10 mi.	0.52 mi.	0.88 mi.	3.20 mi.

13 Amol M. Karmarkar, PhD, MS;1 Rory A. Cooper, PhD;2* Hongwu Wang, MS;2 Annmarie Kelleher, MS, OTR/L, ATP;2 Rosemarie Cooper, MPT, ATP2 1Division of Rehabilitation Sciences, University of Texas Medical Branch, Galveston, TX; 2Human Engineering Research Laboratories, Department of Veterans Affairs Pittsburgh Healthcare System, Pittsburgh, PA, and Department of Rehabilitation Science and Technology, University of Pittsburgh, Pittsburgh, PA. Analyzing wheelchair mobility patterns of community-dwelling older adults. JRRD Rehabilitation Research & Development, Volume 48, Number 9, 2011 Pages 1077–1086

14 Pushkarev and Zupan. Public Transportation and Land Use Policy. Indiana University Press from a study by Regional Plan Association of New York (RPA). used in Fairfax County Metro Station Areas Study, 1982

15 O’Sullivan, Sean and John Morrall. Walking Distances to and from Light-Rail Transit Stations. Transportation Research Record 1538.

Walk Distance: Home Origin, Work or Destination

There is also some evidence that walk distance varies by whether the walk is to/from home to the transit station, or to/from the station to work, shopping or other destination. The home side of the trip ("first mile"), appears to allow for longer walking distances than the destination side ("last mile").[16] There are also TOD guidelines[17] that suggest differential walking distances by origin and destination type, summarized in Table 16.

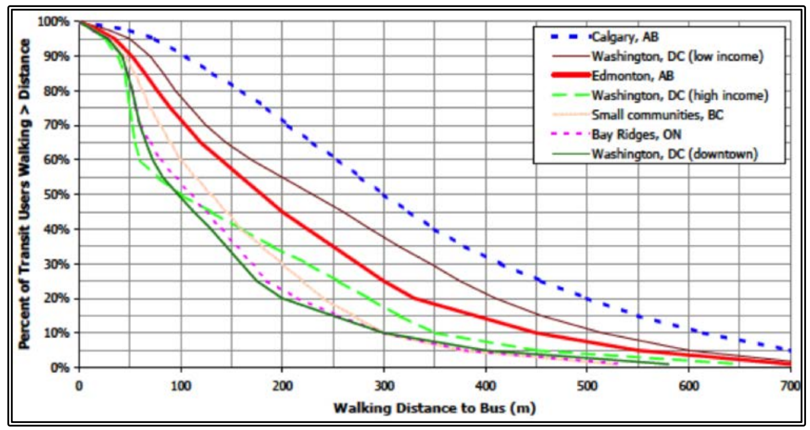
Table 16
Walk Distance & Time By Origin / Destination Type

Mode	Employment	Home
Walk Distance	500 ft. to 1,000 ft.	¼ to ½ mi. 1,320 ft. to 2,640 ft.
Walk Time @ 3.16 mph	2 to 4 min.	5 to 10 min.

Walk Distance: The Effect of Distance Within the Pedestrian Range

Clearly, there is not a sharp cut-off of pedestrian activity at various distances from a transit station. Not unexpectedly, there are always outliers that will walk much greater distances to transit, and people whom will tolerate no more than a transit station below their office or place of employment. Generally, the aim is to provide ranges that represent about 68% (1st standard deviation) to 75% of the population. A survey[18] performed for the BART (heavy rail) system in the Bay Area of California, found that 30% of trips walked to BART station. Of those 30% who walked, 80% walked less than 10 minutes: of those, 35% walked between 6 and 10 minutes, 45% walked under 6 minutes. Overall, the average walking time for transit station access from home origins was 8.8 minutes. The average walking time for transit walkers to their destination at the end of the transit trip was 7.2 minutes.

In a survey performed for the Washington DC Metro[19] (heavy rail), a relationship between distance between home destination and the transit station was developed and found to be a maximum distance of ¾ mile with a decrease of 0.65% in mode share for each 100' of walk distance from the station. The TCQSM also provides relationships of walk distance to transit where the data is available.



Walking Distance Decay for FLM to Bus Transit Stops

[16] Relationship Between Transit and Urban Form Handbook, Transit Cooperative Research Program TCRP H-1, November 1995, page 29. JHK & Associates. Development-Related Ridership Survey, Washington DC Metropolitan Area Transit Authority (1986)

[17] Ditmar, H. and G. Ohlands, The New Transit Town; Best Practices in Transit Oriented Development. (2004) Island Press, Washingotn DC. P. 120

[18] BARTs First 5 Years: Transportation and Travel Impacts (1979) DOT-P-30-79-8

[19] Relationship Between Transit and Urban Form Handbook, Transit Cooperative Research Program TCRP H-1, November 1995, page 29. JHK & Associates. Development-Related Ridership Survey, Washington DC Metropolitan Area Transit Authority (1986)

Table 17 Walking Distance to Transit Summary

WALKING DISTANCE TO TRANSIT						
Distance	**Transit Mode**	**Origin / Destination**	**Location**	**Climate**	**Method**	**Reference**
1,500 ft.	LRT, StreetCar (free), Bus	to transit or shopping	Kansas City Metro	Humid Continental (4 seasons)	guidelines	Mid-America Regional Council, Kansas City , Missouri (2008)Transit Supportive Development Guidebook
500 ft. to 1,000 ft.	Rail	Employment	not specific	-	guidelines	Ditmar, H. and G. Ohlands, The New Transit Town; Best Practices in Transit Oriented Development. (2004) Island Press, Washingotn DC. P. 120
1/4 to 1/2 mile	Rail	Residential	not specific	-	guidelines	Ditmar, H. and G. Ohlands, The New Transit Town; Best Practices in Transit Oriented Development. (2004) Island Press, Washingotn DC. P. 120
up to 1/2 mile	HRT, LRT, Commuter	-	Central California Urban Areas	Mediterranean	guidelines	Minetta, (2002) Envisioning Neighborhoods with Transit Oriented Development Potential
1,500 ft.	MARC Commuter Rail	-	Maryland (Baltimore / Washington DC Metro)	Humid Continental (4 seasons)	guidelines	Mass Transit Administration (1998) Access By Design: Transit's Role in Land Development, Maryland DOT
1/4 mile (5-10 min)	HRT, LRT, Commuter, Bus	to transit or community	New York, New Jersey, Connecticut	Humid Continental (4 seasons)	guidelines	Regional Plan Association (NY, CT, NJ - Tri-Metro Area) (1997) Building Transit-Friendly Communities A Design Development Strategy for the Tri
1/4 mile (5-15 min)	LRT, Commuter, Bus	-	New Jersey	Humid Continental (4 seasons)	guidelines	NJ Transit (1994) Planning for Transit-Friendly Land Use - A Handbook for New Jersey Communities.
2,000 ft.	Rail	-	not specific	-	guidelines	Calthorpe Associates: (1992) TOD Guidelines
1/4 mile	Commuter HRT & Bus	-	Greater Toronto / Hamilton	Humid Continental (4 seasons)	guidelines	Ontario Ministry of Transportation (1992) Transit-Supportive Land Use Planning Guidelines, Ontario Ministry of Municipal Affairs
1,000 ft.	Bus	-	Snohomish, Washington	Pacific Oceanic	guidelines	Snohomish County Transit Authority (!989) A Guide to Land Use and Public Transportation for Snohomish County , Washington
1,000 ft.	Park & Ride	-	Snohomish, Washington	Pacific Oceanic	guidelines	Snohomish County Transit Authority (!989) A Guide to Land Use and Public Transportation for Snohomish County , Washington
750 ft.	Seniors	-	Snohomish, Washington	Pacific Oceanic	guidelines	Snohomish County Transit Authority (!989) A Guide to Land Use and Public Transportation for Snohomish County , Washington
1/4 to 1/3 mile	Rail	-	Snohomish, Washington	Pacific Oceanic	guidelines	Snohomish County Transit Authority (!989) A Guide to Land Use and Public Transportation for Snohomish County , Washington
1,500 ft.*	HRT Subway, Washington Metro	Residential	Washington DC	Humid Continental (4 seasons)	survey	Transportation Research Board, (2004) TCRP Report 102: Transit Oriented Development in the United States : Experiences, Challenges, Prospects p.143
1/4 mile	Transit	-	not specific	-	NPTS survey	EPA Smart Growth Network (1996) Ewing, R. Best Development Practices: A Primer. EPA Smart Growth Network pp. 1-29
mode share decreases 0.65% / 100' to 3/4 mile	HRT Subway, Washington Metro	Residential	Washington DC	Humid Continental (4 seasons)	survey	JHK, Transit Cooperative Research Program (TCRP) (1995)Relationship Between Transit and Urban Form Handbook
92% within 1/4 mi. commuting to SF	HRT, BART	Residential	Bay Area Califronia	Mediterranean	survey	Cervero etal, Transit Cooperative Research Program (TCRP) (1995)Relationship Between Transit and Urban Form Handbook
1/4 to 1/3 mile	HRT Subway, Washington Metro	Residential	Washington DC	Humid Continental (4 seasons)	survey	Paget, Donnelly, Price, Williams and Assoc. Rail Transit Impact Studies: Atlanta, Washington, San Diego. 1982, p.28
30% trips to station walk. 80% of walks under 10 minutes, 45% under 6 min.	HRT, BART	Residential	Bay Area Califronia	Mediterranean	survey	BARTs First 5 Years: Transportation and Travel Impacts (1979) DOT-P-30-79-8
1,000 ft.	HRT Subway, Washington Metro	-	Alexandria, VA	Humid Continental (4 seasons)	survey	Gladstone Associates, Norhtern Virginia Metro Station Impact Study: Development Potentials at Metro Stations (1974) p.23
1,500 ft.	HRT, LRT, Commuter	-	Maryland	Humid Continental (4 seasons)	policy	Maryland Mass Transit Administration (1988)

Although the walking distance and decay findings provide an appealing level of precision, many other factors affect their transferability to other regions and settings. The relationships are provided for general guidance.

Walking Paths

The beginning of this section posed three questions to consider pedestrian access and mobility as a FLM modal strategy.

I. How far do pedestrians walk to transit stations?
II. Does walk distance vary by transit mode?
III. What environmental factors influence their route distance and choice?

This section is about the last question regarding how environmental factors influence pedestrian route distance and patterns, and how the "Tool Kit" recommendations may improve the pathway and inducing greater transit station/stop utilization.

In addition to a review of FLM Plans, research data is summarized here to help identify characteristics and determinants of the paths that people chose when walking to a transit station/stop. A study was performed by the Mineta Transportation Institute in 2007[20], based on stated preference and attitude surveys, with geo-positioning equipment used to determine actual walking paths, and walkability audits used to evaluate the walking environment.

The surveys were performed for 5 rail stations in Portland and the San Francisco Bay Area. Stations were selected that were in neighborhoods laid out on grid pattern so that surveyed pedestrians had multiple routes to the stations available to them. The stations included:

- *Japantown Station* in Santa Clara, California along the Santa Clara Valley Transportation Authority's light rail system. System ridership is relatively small at 21,000 weekday boardings in 2005. The built environment varies substantially from block to block, and there are some recent high and medium density residential projects.
- *El Cerrito Station* is along the Bay Area Rapid Transit (BART) heavy rail transit which serves four counties and has a system ridership of 93-million annual passenger trips. The station area is primarily residential with commercial streets and a shopping center. The catchment area is reportedly large with regard to rail station spacing.
- *Hollywood Station* in Portland, Oregon is a long the TriMet Max Light Rail system. System ridership on the 44-mile system is 100,000 per day. The station are is mostly residential but the station lies along a highway and railroad track that bifurcates the area.
- *Gresham Station* in Portland, Oregon is a transit transfer hub (LRT to bus) in the TriMet system. The area is primarily residential and there are no major arterials except to the edges of the station area where there are large commercial areas and offices.
- *Rockwood Station* in Portland, Oregon is located along a busy commercial corridor with multi-family and single-family residences in all directions spanning out from the corridor.

(Sample size was 338 surveys with a 45% response rate.)

[20] Marc Schlossberg, PhD, Asha Weinstein Agrawal, PhD, Katja Irvin, Vanessa Louise Bekkouche. How Far, By Which Route, and Why? A Spatial Analysis of Pedestrian Preference. Mineta Transportation Institute, San Jose, California. June 2007.

Findings:

Who: Approximately half (53%) were male and 47% were female, and 73% were between the ages of 30 and 59. Self-report median household income was $60,000, and 53% were renters rather than homeowners. Thirty percent rarely or never had access to a car, except the Rockwood station at 67%. For most of the stations, about 2/3 of the sample were choice riders.

Transit Trip Purposes: The majority of trips were home-based work-trips (78%) with home-based personal shopping trips second (8%) and home-based school trips third (5%).

Walk-to-Transit Lengths: While the accepted distance for walking to transit is around ¼ mile, this survey found that the average among these stations was 0.52 miles with a median of 0.47 miles. The minimum walk distance was 0.02 miles and the longest walk to transit was 1.88 miles.

The longer average underscores the need to plan for a ½ mile pedestrian access pathways to transit; however, transferring the finding requires caution: The surveyed station areas are part of very extensive and mature transit systems, and some regional biases should also be considered.

Also notable is that respondents' self-reported walking distances were not very accurate. About 43% estimate their walk distance within 0.1 miles of their actual measured walk. Thirty-one percent were off by up to ¼ mile, and 20% more were off by up to ½ mile, with 6% off by over ½ mile. With an average actual distance at ½ mile, self-report distance percent deviation is high. This underscores the idea that time, rather than distance may be a more important metric for pedestrian trips to transit and possibly other FLM modal options to transit.

Most respondents had agreeable attitudes toward walking, with over ¾ stating that they like walking and about ¾ stating that they find walking relaxing and like the health benefit of walking. Fifty-five percent walk because it is the fastest or most convenient, and 46% because it is the least costly way. While half cite utilitarian reasons, over 70% also consider lifestyle criteria in their choice to walk. Walking propensity has strong attitudinal motivations.

Route Choice Considerations: The transit-destined pedestrians chose the same route consistently 74% of the time. Deviating among 2 routes was done by 19%. People were surveyed to provide their route choice criteria, as open-ended questions (fill in the blank) and as a closed end questions (pick from choice).

Table 18
Open-Ended Choice of Factors Influencing Walk Route

Factor	Anywhere in List	First	Second	Third
Shortest/Fastest	64%	52%	10%	3%
Safety	28%	8%	14%	6%
Convenience	9%	6%	2%	1%
Attractive	8%	2%	3%	2%
Habit	6%	3%	1%	2%
Stopped at Business	3%	2%	2%	0%
Other	27%	13%	9%	5%
Unclear Response	16%	9%	5%	3%
Blank	n/a	3%	50%	77%

Table 19
Closed-End Importance of Factors Influencing Walk Route

Factor	Strongly Agree	Agree	Disagree Strongly Disagree
Shortest Route	82%	17%	1%
Traffic Devices Present	55%	30%	15%
Traffic Drives at Safe Speeds	46%	41%	13%
Sidewalks in Good Condition	43%	44%	13%
Attractive Buildings, Trees, Landscaping	35%	44%	21%
No Traffic Lights where it takes a long time to cross	29%	39%	32%
Other People Walking	23%	37%	40%
Shops & Businesses to Stop In	14%	32%	54%
Shops & Businesses with Windows to Look In	11%	25%	65%
Benches & Places to Sit	11%	15%	75%
Friend or Neighbor Along the Route	7%	18%	75%

To summarize, route choice considerations of pedestrians walking to a rail transit station, include:

1. ***The primary consideration is minimizing time and distance***
2. The secondary factor is safety, which includes traffic safety, the presence of sufficient sidewalks, crosswalks, and the to some extent, the presence of other people walking may impact a sense of security.
3. Convenience, indicating that other factors are present.
4. Attractive streetscapes, including buildings, trees and landscaping are somewhat important, with about 8% citing attractiveness of the route on the open-ended survey, and about 80% noting the importance of this when specifically asked.
5. While the planning profession places great emphasis on mixed-use walking environments with rich amenities, the survey findings do not support this. On the open-ended survey, only 3% of the transit station pedestrians stopped at a business. When specifically asked about the importance of comfort amenities and en-route points of interest, more people disagreed with the importance of these than agreed.

WALKING – DISTANCE AND PATHWAYS SUMMARY

With the availability of faster and more convenient options, pedestrian access to transit stations may be replaced by other FLM strategies, as well as the presence of new FLM modal options inducing new transit demand. The exact relationship or proportion of the effect of non-walk FLM on replacing walking and inducing new transit demand is not known.

1. There is a general agreement in research literature and professional guidelines that the pedestrian access shed for a transit station is mostly within a ¼ mile, but that the ½ mile distance also provides sufficient ridership potential that facilities to accommodate pedestrians should be planned at least to this distance.
2. The number of walkers to transit decays with distance. While it is often assumed that walk distance does not cut-off at the end of the transit shed, the shape of the decay curve is not well established based on prior studies. New GIS-based tools are being used to help determine these relationships, and with the input of new location-specific survey data, these relationships can be better determined to more precisely forecast transit ridership and FLM modal shares.
3. With other factors, it becomes clear that walking time may be the actual determinant for modal share in the pedestrian transit access shed. People estimate time better than distance. More importantly, by shifting the criterion to time, then consideration of delay factors such as traffic signal waits, are more easily integrated into planning for a pathway. The walking time for transit sheds is generally 5 minutes, with the 10-minute shed providing sufficient ridership potential that facilities to accommodate pedestrians should be planned.
4. It takes greater effort and possibly more time for seniors and wheelchair users to accomplish a walking pathway to a transit station, so "universal design" that provides equitable access to persons at all levels of mobility is essential.
5. The transit mode affects the distance or time that people are willing to walk to a transit station, with bus being the shortest and commuter rail being the longest. In addition to the users' perceptions of the quality of transit travel, there is a relationship to station spacing, and there may be correlations between walk time and time/distance on the primary mode.
6. The origin or destination type by which a transit station is accessed has a relationship to walk distance and time. Home-origin walks are generally longer than for walks from transit to employment and destinations, and may have as high as a 1 to 2 relationship (destination having ½ the walk as the home walk). This may also be affected by a typical pattern where home origin walks must be longer, and employment walks shorter due to the higher proportion of people that work in a regional center.
7. The primary consideration in choosing a pedestrian path is minimizing time and distance. This places the greatest emphasis on creating continuous, direct paths. In addition to adequate sidewalks and crossings, emphasis is on orthogonal street grids with short blocks, carefully planned mid-block pass-throughs or paseos where blocks are too long and reducing crossing of barriers, such as highways, railroad tracks, large inaccessible parcels and canals or rivers.
8. The secondary considerations are traffic safety and security. The emphasis is also on sidewalk adequacy, crosswalks, and traffic signal operations that prioritize quick and safe access for pedestrians to cross streets.

9. Amenities and mixed-use points of interest are of tertiary importance to facilitate walk to transit. Recognizing that to fully achieve TOD is a long-term process, this does not imply to de-emphasize the planning for TOD with mixed use and fine accessibility, but that the infrastructure improvements of points 7 and 8 need to be in place first.

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PEDESTRIAN FLM TOOL KIT

P1. TRANSIT ACCESS PEDESTRIAN SURVEY

Goals

- Supplement generalized American Community Survey, Journey to Work and pedestrian survey data from other transit systems with observed and stated preference survey data specific to the needs of the existing and future Miami-Dade SMART Plan.
- Supplement the existing program of Miami-Dade TPO pedestrian and bicycle count program with base data relevant to transit FLM.

Actions

- Identify existing transit station areas to survey that provide adequate diversity and statistical validity that survey outcomes may be directly used for Miami Dade SMART Plan FLM efforts.
- Spatially target selected transit station areas in which to collect walkability and audit data and to conduct observed and stated preference survey. Prefer stations with multiple paths, and evenly distributed pedestrian sheds, and include stations with barriers.
- Perform a GIS-based, spatially encoded tool for a walkability audit (see Pedestrian Tool 2) and determine criteria for walk paths.
- Develop, pretest, and implement a statistically valid survey instrument and methodology to capture relevant attitudinal and observed data regarding the length of transit-related pedestrian trips, route selection, and sensitivity to the built-environment.

Timeframe

- Short term: before planning and programming improvements

Funding

- Unified Planning Work Program (UPWP)
- Transit Development Program (TDP)

Factors Influencing Walk Route to Survey and Audit

Characteristic	Observed (audit)	Stated (survey)
Mode to Transit Station Split	√	
Final Origin and Final Destination Type		√
Origin / Destination Location		√
Distance Traveled	√	√
Time Traveled	√	√
Existing Shorter Path	√	
Grid Morphology and Block Length	√	
Traffic Crossing Delay Time	√	√
Barrier Delay Time & Distance	√	√
Streetscape Amenities (quantitative)	√	√
Other People on Path	√	√
Friend or Neighbor Along the Route		√
Mixed Use – Points of Interest	√	√
Accessibility (entry points)	√	√
Lighting	√	√
Dead Spots	√	√
Visual Security Symbols	√	√

PEDESTRIAN FLM TOOL KIT

P2. TRANSIT ACCESS PEDESTRIAN AUDIT

Goals

- Supplement land use planning for SMART Corridors and station areas, with information to program pedestrian FLM improvements.
- Provide baseline data to plan and program universal design pedestrian improvements.

Actions

- Identify SMART Corridor station locations and primary transit modes. Identify forecast ridership levels by station/mode, and mode split to and from the station. Identify station location as on-street at grade, elevated, or off-street.
- GIS geolocating pad-based methodology to inventory existing amenities and infrastructure pertinent to pedestrian mobility and access within the station area.
- Integrate pedestrian audit with other necessary station area FLM infrastructure audits.
- Develop comprehensive Pedestrian Level-of-Service benchmarking method and criteria based on station area characteristics.
- Develop prioritization program to coordinate improvements with land use and transit development of the station areas.

Timeframe

- Short term – before planning and programming improvements

Funding

- Unified Planning Work Program (UPWP)
- Transit Development Program (TDP)

Station Area Pedestrian Audit

Characteristic	Existing	Future
Pedestrian Grid Limits by Grid Paths	√	√
Pedestrian Grid Hierarchy	√	√
Identify Barriers	√	√
Pedestrian Path Travel Times With and Without Crossing Delay	√	√
Pedestrian Volumes	√	√
Sidewalk / Pedestrian Path Adequacy (UD, ADA)	√	√
Crossing Queue Area Adequacy (UD, ADA)	√	√
Crossing Ramp Adequacy (UD, ADA)	√	√
Crossing Distances with and without Medial Refuge	√	√
Sidewalk Lighting for pedestrian safety and security effectiveness	√	√
Landscaping – aesthetic and shade	√	√
Pedestrian Amenities - distances	√	√
Accessibility Score	√	√
Pathway Points of Interest	√	√
Signage and Sidewalk Wayfinding	√	√
Vista Terminations to Station	√	√

PEDESTRIAN FLM TOOL KIT

P3. ADEQUATE SIDEWALKS

Goals

- Provide complete network of pedestrian pathways throughout station area core (¼-mile) and neighborhood (½-mile) that have sufficient capacity relative to station area proximity, development density and intensity, and other uses.
- Enhance the built environment toward inducing a higher pedestrian FLM mode split, and higher transit station utilization.
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.

Actions

- Identify sidewalk deficiencies based on the Transit Access Pedestrian Survey (P1) and Transit Access Pedestrian Audit (P2).
- Identify necessary sidewalk improvements and cost by location.
- Identify growth trends and planned changes in land development regulations that impact future pedestrian volumes for determining the width of the clear pedestrian path.
- Identify zoning code amendments to change setbacks, build-to lines or mid-block pass-throughs that facilitate pedestrian path adequacy by providing buffer zones and areas for kiosks, outdoor cafes and gathering spots.
- Identify where street travel lane widths are 12 ft. and may be narrowed to 11 or 10 ft.[21]
- Identify programmed infrastructure improvements that sidewalk or curb reconstruction/enhancements can be coordinated with.
- Develop a station area prioritized strategic plan to implement complete walking paths.
- Develop and adopt policy and land development regulations that specify minimum sidewalk widths based on the walking paths plan for the station area.

Criteria:

- Continuous pedestrian paths along street network.
- Use Highway Capacity Manual (HCM) Pedestrian Level of Service methodology to determine effective walkway width based on horizon year pedestrian volume forecasts.
- Roadway travel lanes may be narrowed to provide additional width for sidewalks. When identifying where roadway travel lane widths may be restricted to 10 feet, consider the following criteria:
  - Where applied to downtown and commercial streets, 12-foot lane widths are counterproductive to safety and accessibility and lead to faster traffic.
  - Truck volumes, bicycle volumes and the presence of bicycle lanes must be factored into the decision.
  - As a general rule, where vehicle speeds are at or near bicycle speed (15 to 20 mph), then bike lanes may not be necessary.
- ADA requirements at minimum (36" wide with passing spaces of 60" width spaced within 200 feet, maximum slope of 1:20, no discontinuity greater than ½-inch), but **use 60" minimum unless compelling physical or operational limitation**.
- Determine Effective Walkway Width required
- Determine Total Walkway Width by adding:
  - width of landscape and amenities based on P11

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[21] AASHTO, A Policy on Geometric Design of Highways and Street (The "Green Book"),

- width of bus stations and FLM pick-up/drop-off areas and driveway ramps
- width of sidewalk bicycle storage areas

- Total sidewalk width must be within Public Realm: the area from property line to existing or planned curb line.
- Setback areas may be used for amenities, kiosks, gathering spaces, outdoor café areas, or landscape buffers to building lines.

Improvements

- New sidewalks
- Widen, extend, level, resurface or reconstruct existing sidewalks. (minimum 60" if buffered from curb, 72" at curb, wider in mixed-use districts)
- Additional surfaced or planted space reserved for amenities

Timeframe

- Short term. Creating the shortest path for pedestrian priority is highest priority to transit station pedestrian trip making. Land development and amenity space are to be considered, but based on survey data, their implementation can be secondary priorities.

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)
  - Bus and Bus Facility Formula Grants (5339)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

PEDESTRIAN FLM TOOL KIT

P4. ENHANCED CROSSWALKS

Goals

- Enhance the network of pedestrian pathways throughout station area core (¼-mile) and neighborhood (½-mile) to reduce delay time to pedestrians.
- Enhance the safety of pedestrian travel
- Enhance the perception of safety for pedestrians
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.
- Induce additional pedestrian travel to transit stations by demonstrably reducing pedestrian time along pathways to the transit station.
- Enhance crosswalks to reduce the need for bulb-outs that inhibit the reallocation of roadway surfaces for other FLM modes.

Actions

- Identify crosswalk deficiencies based on needs identified in the Transit Access Pedestrian Survey (P2) and Transit Access Pedestrian Audit (P3).
- Identify necessary crosswalk improvements and cost by location.
- Develop a station area prioritized strategic plan to implement continuous, shortest and fastest walking paths

Criteria:

- Continuous pedestrian paths along street network
- Roadway jurisdiction, functional classification and number of lanes
- Roadway design speed
- Curb radii
- Roadway existing and horizon year traffic volumes
- Presence of permissive right turns
- Traffic Control (stop sign or signal)
- Planned signal phasing and timing (protected pedestrian phase?)

Improvements

- New crosswalks or Enhanced Crosswalks
  - Textured or Raised crosswalks immediately surrounding Transit Station with in-road warning lights or rapid flash beacons.
  - Type B Crosswalks (ladder markings) at all Transit Core crossings, and Station Neighborhood Crossings of more than 2 travel lanes or 40-foot pavement width (> 9 sec.). Where possible, include in-road warning lights or rapid flash beacons.
  - Type A Crosswalks (transverse markings) only at crossings of 2 or fewer travel lanes or 40-foot pavement width or less (9 sec.)
- Change curb radii where practicable to correctly locate adequate width crosswalks with access ramps perpendicular to the street centerline and curb. Curb radii should be 10 to 15 feet. With a parking lane, this corresponds to a 26 to 31-foot effective radius, which allows turn speeds of 11 to 13 mph (friction factor of 0.35)

Timeframe

- Short term. Creating the shortest path with least delay and greatest safety is the highest priority to station area pedestrian trip making.

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

PEDESTRIAN FLM TOOL KIT

P5. DIAGONAL CROSSINGS

This is a type of traffic signal movement that temporarily stops all vehicular traffic, and allows pedestrians to cross an intersection in every direction, including diagonally, at the same time. It includes specific pavement markings in the intersection. It is sometimes called a “pedestrian scramble”, “x-crossing” or “Barnes Dance.”

Goals

- Enhance the network of pedestrian pathways in the station area core (¼-mile) at intersections nearest the transit station, where the probability of pedestrians needing to cross both directions of an intersection is highest.
- Enhance the safety of pedestrian travel by providing a protected pedestrian phase
- Reduce pedestrian walk times by reducing signal wait time and reducing distance traveled
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.
- Induce additional pedestrian travel to transit stations by demonstrably reducing pedestrian time along pathways to the transit station.
- Improve pedestrian wayfinding by using a visually distinct intersection crossing only on path to and near the transit station

Actions

- Identify intersections nearest station and with the highest probability of diagonal crossing need
- Perform traffic operations study to assess impacts of lowered vehicular green time and prohibited right turns
- Prioritize and program diagonal crossings.

Criteria:

- Continuous pedestrian paths along street network
- Roadway jurisdiction, functional classification and number of lanes
- High pedestrian crossing volumes observed or forecast
- Manual of Uniform Traffic Control Devices (MUTCD) design criteria

Improvements

- New crosswalks
  - Textured or Raised crosswalks immediately surrounding Transit Station with in-road warning lights or rapid-flash beacons.
  - Type B crosswalk markings (ladder markings) in perpendicular directions, include in-road warning lights or rapid-flash beacons.
  - Signage and pedestrian signals in all directions per MUTCD
- As with enhanced crosswalks, change curb radii where practicable to correctly locate adequate width crosswalks with access ramps perpendicular to the street centerline and curb.
- Include diagonal curb cuts in compliance with ADA requirements

Timeframe

- Short term. Creating the shortest path with least delay and greatest safety is the highest priority to station area pedestrian trip making.

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

PEDESTRIAN FLM TOOL KIT

P6. MIDBLOCK CROSSWALKS

Goals

- Enhance the pedestrian pathways network throughout station area core (¼-mile) and neighborhood (½-mile) to reduce pedestrian barriers and delay
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.
- Induce additional pedestrian travel to transit stations by demonstrably reducing pedestrian time along pathways to the transit station.

Actions

- Identify long blocks where mid-block crosswalks are needed
- Identify necessary crosswalk improvements and cost by location.
- Develop a station area prioritized strategic plan to implement midblock crossings where needed

Criteria:

- Block face lengths of more than 300 feet
- Land use and occupancies on block faces (fine grained retail and lifestyle retail that attracts higher pedestrian traffic)
- Roadway jurisdiction, functional classification and number of lanes
- Roadway design speed
- Roadway existing and horizon year traffic volumes
- Presence of roadway medial barriers or turn lanes and approach tapers

Improvements

- New midblock crosswalks or Enhanced Crosswalks
  - Textured or Raised crosswalks immediately surrounding Transit Station with in-road warning lights or rapid-flash beacons.
  - Type B Crosswalks (ladder markings) at all midblock crosswalks. Where possible, include in-road warning lights or rapid-flash beacons.
  - Pedestrian-actuated flashing warning beacons to motorists
  - ADA compliant curb cuts with sufficient room on sidewalk for turning safely (48")

Timeframe

- Short to Medium term. Creating the shortest path with least delay and greatest safety is the highest priority to station area pedestrian trip making; however, some locations depend on development criteria.

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

PEDESTRIAN FLM TOOL KIT

P7. SIGNAL OPERATIONS

Goals

- Enhance the pedestrian pathway network throughout station area core (¼-mile) and neighborhood (½-mile) to reduce pedestrian delay time.
- Enhance the safety of pedestrian travel
- Enhance the perception of safety for pedestrians
- Induce additional pedestrian travel to transit stations by demonstrably reducing pedestrian time along pathways to the transit station.

Actions

- Identify intersection crossing critical path delay improvement areas based on the Transit Access Pedestrian Survey (P1) and Transit Access Pedestrian Audit (P2).
- Perform traffic operations analysis to determine impacts of a protected pedestrian phase in all directions that allows a minimum of 1 second crossing time for each 3 feet of unprotected cross distance on the widest approach, plus 3 seconds delay at the beginning of the phase for reaction time. (This allows for a slower walk speed of 2 ½ mph) (approximately 25 seconds for a 4-lane road with parking on both sides)
- Develop a station area prioritized strategic plan to progressively implement pedestrian-protected phases.

Criteria:

- Roadway jurisdiction, functional classification and number of lanes
- Roadway design speed
- Roadway existing and horizon year traffic volumes
- Presence of permissive right turns
- Needed, planned or programmed signal replacement
- Existing and forecast pedestrian volumes
- Presence of pedestrian-protected crossings within 500 feet of elementary, middle or high schools, or large populations of seniors (residential or destinations).

Improvements

- Changes to signal timing
- Signage to prohibit right-turns-on-red, where appropriate
- Possible red turn arrows (depending on traffic study)

Timeframe

- Short term and on-going. Creating the shortest path with least delay and greatest safety is the highest priority for station area pedestrian-transit trip making.
- Timing changes may also be programmed along with signal replacement programs, or with development traffic mitigation plan implementations associated with new development.

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)
- On-going signal replacements
- Development mitigation

PEDESTRIAN FLM TOOL KIT

P8. PEDESTRIAN LIGHTING

Goals

- Enhance the safety of pedestrian travel
- Enhance the perception of safety for pedestrians
- Induce additional pedestrian travel to transit stations by improving pedestrian sense of security at night.

Actions

- Through land use planning process, identify areas of high pedestrian, night-time activity within the station area. Through community input, identify pedestrian lighting design theme that is consistent with roadway lighting (not two systems)
- Consider using special lighting along primary pedestrian paths leading to/from the station as a night-time wayfinding system, in addition to enhancing safety and security.
- Work with roadway jurisdictions, local governments and Florida Power & Light (FPL) to develop plans, and estimate capital and operating costs.
- Develop a station area progressive prioritized strategic plan to implement planned pedestrian lighting improvements.

Criteria:

- Existing and planned land use
- Identification of primary paths to station
- Existing and forecast pedestrian volumes
- Traffic / pedestrian night-time incident history

Improvements

- New or additional pedestrian lighting as planned

Timeframe

- Midterm and on-going
- Pedestrian lighting improvements may also be programmed as part of:
  - Community Redevelopment Area (CRA) programs,
  - Corridor Improvements
  - New development or redevelopment

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
- CRA programs
- Corridor Enhancements
- New development (not in CRA)

PEDESTRIAN FLM TOOL KIT

P9. PEDESTRIAN PATH NETWORK

Goals

- Enhance the network of pedestrian pathways throughout station area core (¼-mile) and neighborhood (½-mile) to reduce travel time to pedestrians.
- Create a pedestrian network in addition to the roadway network, using pass-throughs and obsolete alleys
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.
- Induce additional pedestrian travel to transit by demonstrably reducing pedestrian time along pathways to the transit station.

Actions

- Identify long blocks where mid-block pass throughs are needed.
- Identify locations where mid-block crosswalks have been planned on two sides of a block and evaluate benefits of continuing path through the block.
- Examine station area platting to determine if obsolete alleys are present that may be used as pedestrian paths.
- Develop station area prioritized strategic plans to implement midblock passthroughs based on station area street grid.

Criteria:

- Block face lengths of more than 300 feet where the alignment of the length is a barrier to efficient pedestrian travel to the station location.
- Redevelopment potential for block (pass-throughs and alleys)
    - Age of structure
    - Market obsolescence
    - Vacancy
- Existing land use controls and incentives
- Planned land use controls and incentives
- Homogeneous or complementary characteristic of land use on both sides of pass-throughs
- Ability to reorient uses to relocate alley service functions
- Presence of utilities and easements (alleys)

Improvements

- Land development regulations and incentives to implement high-quality mid-block pedestrian pass throughs, along with specific criteria for ADA-compliant paths that are open, secure and safe 24 hours per day. Pass throughs must be lighted and active.
- Land development regulations, necessary policy and easement agreement amendments to support repurposing existing service or utility alleyways for pedestrians and non-motorized travel.
- Active, well-lighted pedestrian pass-throughs at critical mid-block locations.
- Separate pedestrian network from motorized vehicular traffic, where possible.

Timeframe

- Short term: amendments to land use controls
- Midterm and on-going to implement along with redevelopment

Funding

- Private development or P3 (pass-throughs)

PEDESTRIAN FLM TOOL KIT

P10. BARRIER BRIDGES

Goals

- Induce additional pedestrian travel to transit stations by demonstrably reducing pedestrian time along pathways to the transit station.
- Enhance the network of pedestrian pathways throughout station area core (¼-mile) and neighborhood (½-mile) to reduce travel time to pedestrians.
- Enhance the safety of pedestrian travel
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.

Actions

- Identify barriers based on based on the Transit Access Pedestrian Survey (P1) and Transit Access Pedestrian Audit (P2).
- Identify potential benefit to bridging barriers based on existing development and planned development
- Identify locations to bridge barriers based on
  - Distance to bifurcate
  - Proximity to a primary pedestrian path
  - Co-location with development – active bridges that function as part of a development public realm are more effective than simple bridges.
- Identify preliminary design options, feasibility and cost for bridging barriers at preferred locations

Criteria:

- Identified barriers
- Benefit (number of people, time saved, safety, reduced incidents)
- Distance to primary pedestrian pathways to transit station

Improvements

- ***Where primary transit stations are along major corridors, pedestrian access at both ends of the platform should extend to both sides of the corridor main street, without exception, as a basic criteria of station design.***
- Foot and bike bridges over canals
- Elevated pedestrian / bicycle bridges over highways or high-volume, high-speed arterials
- Elevated pedestrian plazas or paths as part of adjacent development
- Elevated paths developed as part of transit station (if transit is elevated)

Timeframe

- Short term to midterm: Creating the shortest path with least delay and greatest safety is the highest priority to inducing station area pedestrian transit trip making; however, cost/benefit on bridges versus other improvements may move their priority in a progressive program.
- Ongoing for bridges collocated and built with of land development

Funding

- Eligible FTA Programs for sidewalks as part of FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)
  - Private development or P3

PEDESTRIAN FLM TOOL KIT

P11. PEDESTRIAN AMENITIES

Goals

- Enhance the network of pedestrian pathways throughout station area core (¼-mile) and neighborhood (½-mile) to induce greater pedestrianism and transit use through convenient, enjoyable, active pedestrian network paths.
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.
- Using Crime Prevention Through Environmental Design (CEPTD) principles, assure that streetscape amenities increase or at minimum do not diminish safety and security
- Use xeriscapic landscape, without regular irrigation requirement
- Use hurricane resilient planting that withstands wind loads within the buffered urban setting, and/or is quickly restorable
- Coordinate buffer spaces on sidewalk to serve the needs of pedestrians and the infrastructure needs of other FLM modal strategies.

Actions

- Through the land use planning process, results of the Transit Access Pedestrian Survey (P1) and the Transit Access Pedestrian Audit (P2), identify areas of high pedestrian activity within the station area. Through community input, identify amenity design themes for benches, activity kiosks, information kiosks, shade landscaping, ground landscaping and other amenities
- Coordinate with other FLM infrastructure needs to assure that sidewalk buffer areas provide infrastructure and space for all FLM modal strategies.
- Develop a station area progressive, prioritized streetscape program to implement planned amenities that induce higher transit station utilization vis-a'-vis increased pedestrianism.

Criteria:

- Sidewalk buffer areas available
- Adjacent land use
- Community input

Improvements

- Benches
- Activity kiosks
- Information kiosks
- Shade landscaping
- Ground landscaping
- Hardscape open space
- Plazas, mini-parks, outdoor café areas

Timeframe

- Short Term: reserve buffer space as an interim hard surface or ground cover
- Midterm and on-going: implement along with redevelopment and implementation of other FLM modal strategies

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)
  - Bus and Bus Facility Formula Grants (5339)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

PEDESTRIAN FLM TOOL KIT

P12. WAY FINDING

Goals

- Enhance the network of pedestrian pathways throughout station area core (¼-mile) and neighborhood (½-mile) to induce greater pedestrianism and transit use by decreasing pedestrian travel time.
- Using universal design concepts, produce environments that are inherently accessible to older people, people without disabilities, and people with disabilities.
- Use low-maintenance materials and strategies
- Coordinate with lighting (P8) and amenities (P9) to develop differential themes that provide indications of being on a primary path to a transit station.
- Utilize the basic street grid structure to the extent possible, by terminating street vistas with transit station architecture

Actions

- Through the land use planning process, results of the Transit Access Pedestrian Survey (P1) and the Transit Access Pedestrian Audit (P2), identify primary pedestrian paths that lead from the edge of the station area to the transit station, and place the pedestrian within view of the station as quickly as practical.
- Develop a station area wayfinding plan to implement in coordination with other improvements

Criteria:

- Pedestrian path hierarchy
- Shortest paths
- Station visibility
- Land use
- Pedestrian Audit pedestrian path preferences

Improvements

- Signage
- Sidewalk medallions
- Differential lighting
- Differential amenity themes

Timeframe

- Short Term and on-going: to implement along with redevelopment and implementation of other FLM modal strategies.

Funding

- Eligible FTA Programs for sidewalks as part of transit station area FLM strategies:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

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PERSONAL URBAN MOBILITY FLM

BICYCLE & PERSONAL URBAN MOBILITY OPTIONS

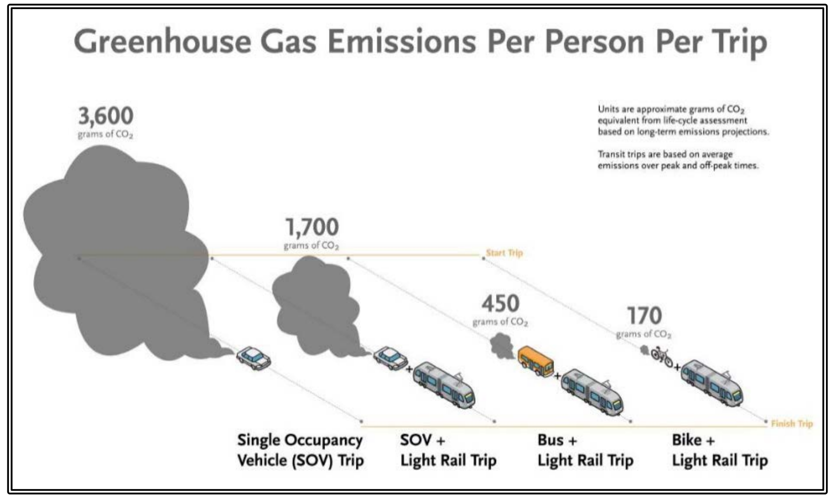
While walking is the primary FLM Strategy for existing and future transit stations, bicycles are the most efficient from energy input perspective.[22] Measured as kilocalories per mile traveled, at 12-14 mph a bicycle is about 30% more efficient than walking, about four to five times as efficient as electric rail, and about 25 to 30 times as efficient as single-occupant-vehicles.[23] It is also the most sustainable mode in terms of greenhouse gas emissions. In highly-developed transit systems, it is also the second or third FLM modal option, after walking, and possibly drop-off or park-and-ride.

This FLM modal strategy groups together several "vehicles" and delivery models, since they all have similar FLM planning needs.

They include:

- Personal Bicycle
- Electric Bike (E-Bike)
- Shared Bicycle
- Roller Blade
- Skate Board (long board, carver, etc.)
- Electric Skate Board

What distinguishes the group is that all are low-speed (approximately 20 mph top speed), high energy efficiency, and personal mobility for one person. They all offer more convenient and time-efficient travel than walking. These alternatives overlap with recreational mobility modes; however, each is evolving as a serious FLM mode, with significant benefits in terms of fuel efficiency, congestion reduction, community health, reduced greenhouse gas emissions, and supporting cohesive transit oriented communities. Their needs must be planned for to support the SMART Plan corridors development.



[24] Source: footnote 24

Most of these options are active mobility modes (human-powered); however, efficient battery-electric hybrids are currently on the market for most of the "vehicles." The electric hybrids do not increase maximum speeds, but do increase the convenience of travel, increase average travel speed for less athletic commuters, and reduce the barriers of special clothing or the need for washing up at destinations.

Bicycling has over several decades become a mode of travel for journeys to work. Average home-based work trips are in the range

[22] David Gordon Wilson; Bicycling Science, Third Edition; MIT Press, 2004.

[23] I Love Bicycling Cycling Club, 2014; Livestong.com 2015

[24] Mikhail Chester et al, Infrastructure and Automobile Shifts: Positioning Transit to Reduce Life Cycle Environmental Impacts for Urban Sustainability Goals , Environmental Research Letters 8, no. 1, 2013

of 10 to 20 miles each way for these trips; however, this analysis is concerned with the use of bicycles and personal urban mobility options as FLM strategies. As an FLM mode, bicycling to work shifts its market from active cyclists whose number one facilities concern (after traffic safety) is showers and a place to clean up and change;[25] to a mainstream market of casual, lower-speed cyclists, travelling shorter distances to and from transit stations in work clothing and possibly with small baggage and backpacks.

Use of skateboards (includes long boards, short boards, cruisers, old school and carvers) and electric boards may have less of a mainstream potential; however, for the millennial generation these modes are evolving from recreational activity to real modes of urban travel. They offer the distinct advantages of low cost, ability to wear shoes, and most importantly the ability to be easily carried on person (or in backpacks) at the destination adding important convenience and security benefits.

To understand the modes for the purposes of FLM, Table 20 summarizes the salient characteristics for each mobility device from a consumer perspective, and in term of travel speeds that influence their FLM Mobility effect to greatly increase the transit shed beyond what is possible with pedestrian travel.

Table 20 FLM-Relevant Characteristics of Personal Low Speed Mobility Devices Modal Group (Human-powered and Electric)

Mobility Device	Capacity (persons)	Owner	Max Range	Max Speed	Avg Speed	10-Minute Range	Quarter Mile Time	Half Mile Time	1-Mile Time	2-Mile Time	Equipment Cost to Consumer (two half-hours)		Rental Cost to Consumer (two half hours)		Energy Cost per Day *	Cost per Weekday (3-years**, 260 weekdays/year)			Avg. Cost per Daily FLM Mile
	(persons)		(miles)	(mph)	(mph)	(miles)	(minutes)	(minutes)	(minutes)	(minutes)	Minimum	Maximum	(two half-hours)			Minimum	Average	Maximum	(two 10-min trips/day)
Personal Bicycle (commuter rider/bike)	1	Rider	not limited by equipment	20	15	**2.5**	1	2	4	8	$100	$3,500	$0.00	$0.00	$0.00	$0.13	$2.31	$4.49	**$0.46**
Shared Bicycle	1	Business	not limited by equipment	20	15	**2.5**	1	2	4	8	$0	$0	$1.00	$4.00	$0.00	$2.00	$2.00	$8.00	**$0.40**
Personal E-Bike	1	Rider	30 miles	20	20	**3.3**	1	2	3	6	$1,000	$4,000	$0.00	$0.00	$0.10	$1.38	$3.30	$5.22	**$0.50**
Shared E-Bike	1	Business	30 miles	20	20	**3.3**	1	2	3	6	$0	$0	$2.00	$2.00	$0.00	$4.00	$4.00	$4.00	**$0.60**
Skate Board	1	Rider	not limited by equipment	15	10	**1.7**	2	3	6	12	$50	$300	$0	$0	$0.00	$0.06	$0.22	$0.38	**$0.07**
Electric Board	1	Rider	12 miles	22	22	**3.7**	1	1	3	5	$1,200	$1,500	$0	$0	$0.05	$1.59	$1.78	$1.97	**$0.24**
Roller Blade	1	Rider	not limited by equipment	15	10	**1.7**	2	3	6	12	$200	$400	$0	$0	$0.00	$0.26	$0.38	$0.51	**$0.12**
Sedgway i2 Or other Electric Personal Mobility	1	Rider	24 miles	12	12	**2.0**	1	3	5	10	$6,000	$6,000	$0	$0	$0.10	$7.79	$7.79	$7.79	**$1.95**
Rental Segway	1	Rider	24 miles	12	12	**2.0**	1	3	5	10	$0	$0	$25	$40	$0.00	$50.00	$65.00	$80.00	**$16.25**
Pedestrian (reference)	1	Walker	not limited by equipment	10 - 15 (run)	3	**0.5**	5	10	20	40	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	**$0.00**

[25] Carl Guarino, CEO Silicon Valley Leadership Group, Using Bicycles for the First and Last Mile of a Commute. Mineta Transportation Institute, San Jose, California, 2009

Any of these devices extends the comfortable range of FLM to a 2-mile-or-more range from the primary transit station, and represent significant triple bottom line benefits over automobiles or circulator transit, including:

- Greenhouse gas reduction
- Lower consumer transportation cost
- Lower public transportation cost
- Increased personal and community health

Rider Types

Recommendations for FLM pathways facilities depend on the intended target user groups. Unlike vehicular travel, where behavior, vehicles and facilities a relatively uniform despite many individual types of drivers and trips, cyclists and other personal low-speed riders vary greatly in ability, attitudes, behavior and equipment. This differentiation among cyclists, skateboarders and foot skaters is critical to understand in providing facilities and services. Recognizing this, the City of Portland, Oregon identified four types of cyclists as part of the basis for planning infrastructure and services.[26]

The “*Strong and Fearless*” comprise fewer than 0.5% of the population. These are the people who will ride regardless of roadway conditions. They are ‘bicyclists;’ riding is a strong part of their identity and they are generally undeterred by roadway conditions.

The “*Enthused and Confident*” are those who are attracted to cycling after significant advances are made in developing the bikeway network and supporting infrastructure. They are comfortable sharing the roadway with automotive traffic, but they prefer bike lanes and paths. This enthused and confident demographic of cyclists are the primary reason why bicycle commuting doubled in Portland between 1990 and 2000. These are the citizens who are and could be attracted to regular riding by continuing to address the barriers of shorter trip distances and better bicycle facilities. This demographic comprises 7% of the population.

A much larger demographic, the “*Interested But Concerned*.” These residents are curious about bicycling. They respond to messages from a wide variety of sources about when the about bicycle culture and a and becoming a bicycle-friendly city. They like riding a bicycle, remembering their youth; they would like to ride more, but, they are afraid to ride. They don’t like the cars speeding down their streets. They get nervous thinking about what would happen to them on a bicycle when a driver runs a red light, or guns their cars around them, or passes too closely and too fast. Very few of these people regularly ride bicycles. Some will ride through their neighborhoods, but will not venture out onto the arterials to the major commercial and employment destinations. They represent about 60% of the City’s (Portland) population. They would ride if they felt safer on the roadways.

About one-third of the population is in the “*No Way, No How*” group that is currently not interested in bicycling at all.

There is some overlap between groups, but this has proven to be a reasonable way to understand existing and potential cyclists for the City of Portland, Oregon to plan its network and facilities. For the purposes of FLM travel to the transit stations in the SMART Corridors, it is useful to understand this, and recognize that the *Strong And Fearless* are already biking and vocal. Planning for this group is to make their travel safer and more enjoyable. The first group

[26] Roger Geller, Bicycle Coordinator, Four Types of Cyclists; Portland Office of Transportation, 2011.

representing a latent demand to attract for FLM, are the Enthused-and-Confident. This is the group of early adaptors that creates the "buzz" and culture that attracts the mainstream group of *Interested-But-Concerned*.

The main focus for FLM bicycle mode is the Enthused and Confident. For Skateboard and Foot Skates, the focus is on Strong and Fearless.

Pathways

In a similar method to Pedestrian FLM analysis, the concepts of access, mobility, and the pathway apply for these modes.

Access is the ability to meet a person's daily needs with a minimum of travel and cost. Access has a stronger relationship to urban design and land use than mobility networks. For these strategies, access is concerned with storage of these devices when a person reached the station and/or other destination. Some can be easily carried at the destination. Others cannot. For those that require storage, personal bikes create needs for both storage and the station and on the transit vehicles. For the purposes of storage, both on-vehicle and at-station, the primary transit mode has a significant impact on capacity and the willingness of the rider. Bike sharing alleviates the need for on-vehicle storage, but requires even greater at-station storage.

Mobilty is the ability to get around. The need to travel is assumed and mobility does not seek to minimize travel, but to lower the time and cost of it while making the experience convenient and as safe, secure and enjoyable as possible. For each station area, the primary concept is to develop the "pathway" by which existing and future SMART Plan transit users can go to stations using personal low speed mobility options. It is assumed that FLM travelers using these modes, are similar to pedestrians in that the primary value is time and second is safety. For mobility then the main emphasis is on the pathway to provide for safety and minimized delay over the shortest paths.

The Pathway is the development of a network that facilitates and induces reliance of these modes to reach origins and destinations to primary transit stations in the SMART Plan corridors, while simultaneously improving the user experience in more qualitative ways.

For these FLM options, the core concept of Pathway mobility is to provide a network, slower than vehicles and faster than pedestrians, that extend to and from the primary transit stations into the ¼-mile Transit Core, ½-mile Transit Neighborhood, and the 2-mile Transit Supportive Area. While the objective of pathway mobility for these modes is still the reduction of travel time through shortest paths and reduced delay, equally important is creating a safe network for these modes through the implementations of dedicated lanes and paths, and shared lanes and paths as appropriate to the context. Access requires providing storage facilities and options.

Historic cycle track depicted in a vintage postcard from Copenhagen. 1938

BIKING & RIDING – PATHWAYS & RESEARCH FINDINGS

As with pedestrian travel to transit stations, there are three central questions to consider for personal-low speed mobility options:

I. How far will transit users travel to transit stations?
II. Do the use of these mobility modes vary by transit mode?
III. What environmental factors influence their choice of mode, distance and route?

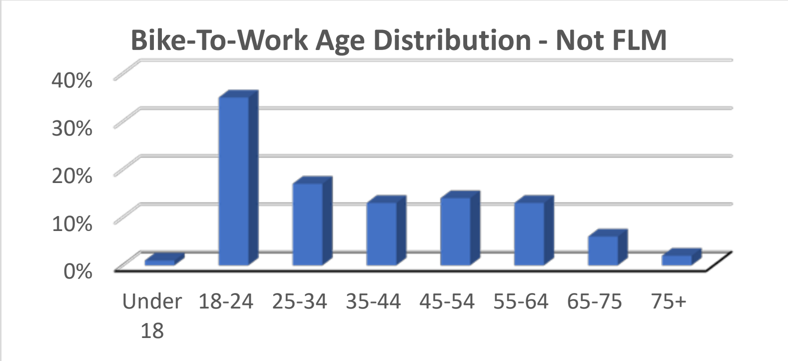
Ride Distance: Modal Characteristics

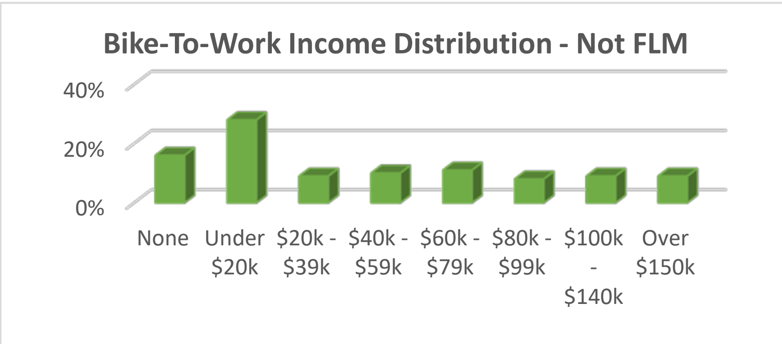
Available research in this area is predominantly for using a bicycle to work as the primary mode. For FLM strategies, transit is the primary mode and the use of bicycles and other personal low speed mobility options are to get to and from the station. With regard to FLM station area distance, if bicycle home-based work trips are in the range of 10 to 20 miles each way, then with increasing the FLM distance, the motivation of the transit rider becomes lower as the sum of transit travel time, wait time, and FLM time (possibly on both trips ends) becomes too long, and the transit rider abandons the transit with FLM concept and either finishes the trip by FLM mode, or reverts back to automobile travel.

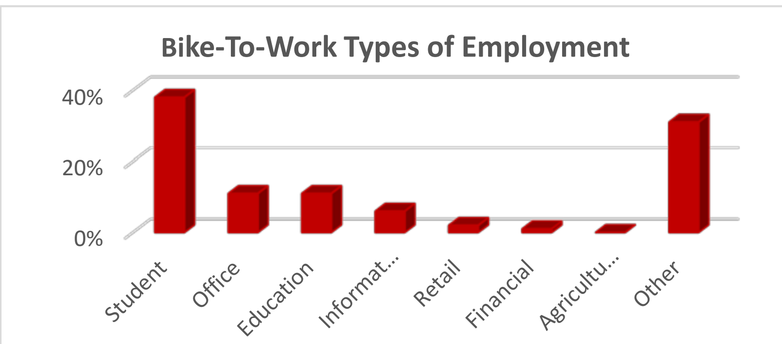
Environmental considerations notwithstanding, how far people will ride a bike or other personal low-speed mobility options to transit has less variability by demographic characteristics. Whether they bike to a transit station does vary with age, gender, income, automobile availability, and type of work. Surveys of bicycle-to-work were performed in Davis, California; Palo Alto, California; and San Luis Obispo, California[27]. They are all very bicycle-friendly in terms of infrastructure and culture. The demographic data is used to form a prescriptive target for attracting these groups.

Bike rider on a dedicated buffered bike lane

[27] Cornelius Nuworsoo, PhD; Erin Cooper; Katherine Cushing, PhD; Eugene Jud, PE. Integration of Bicycling and Walking Facilities into the Infrastructure of Urban Communities, Mineta Transportation Institute, San Jose, California, 2012.







The following observations are made by interpreting the data.

- Age group and income distribution inferred that the bike to work market is predominantly just entering the workforce. Potentially up to ½ of those who enter may remaining loyal to the modal choice is the demographic trend line extrapolates with the current generation. Notably, residents of transit oriented compact development are also younger, more price sensitive workers; however, loyalty to the compact development is less clear as many will move to suburbs, particularly as these urban residents form families with children.[28] ***The take-away is to develop safe, continuous networks of bicycle pathway infrastructure into suburban areas to retain the loyalty of bike to transit riders as they age.***
- The largest proportion of the bike-to-work commuters are students and educational workers. This suggests that university campuses and high schools should have high priority for establishing safe, secure and comfortable bicycle pathways and infrastructure to connect to transit stations.
- After educational uses, office uses (general office and the information business sector) can be expected to generate the next highest levels of bicycle use to transit stations. Within Station Transit Supportive Areas (2-miles), bicycle pathway networks and facilities should prioritize office work spaces.
- Retail employment has the lowest participation in bike-to-work travel even in cities with well-developed bicycle infrastructure. As a FLM strategy, developing bicycle pathway networks and facilities to major retail centers can be a lower priority.

[28] Karla H. Karash, Matthew A. Cooga, Thomas Adler, Chris Cluett, Susan A. Shaheen, Icek Aizen, Monica Simon, Elkridge, MD; Understanding How Individuals Make Travel and Location Decisions: Implications for Public Transportation; Transportation Research board, Washington DC, 2008.

Considering non-work-based trips, there is additional data regarding non-transit linked bicycle trips by destination type, and by attitude to riding a bicycle (to reduce self-selection effects).

Table 21
Average Time Willing to Ride a Bicycle by Trip Purpose for Non-Transit Linked Trips (minutes)

	Shopping	Recreation	Work	Business	Other
All Respondents	15	26	19	15	21
Prefer Bicycling	15	27	20	16	22
Do Not Prefer Bicycling	14	24	15	8	17

The most notable pattern is that for trips that are not recreational, tolerance for time is about 60% of recreational rides, and for business trips, the tolerance for time is about half of the commuting trips. Although these times should not be used for FLM trips, the pattern by trip purpose can provide useful information for planning paths according to development patterns.


On-board bike carriage on heavy rail (left) and light rail (right)

__Bike & Personal Low Speed Options: By Transit Mode__

There is little survey-based research regarding the use of bikes or personal low speed mobility options to transit as to the effect of different primary modes: bus, light rail, or heavy rail. Differences in utilization of these FLM modes to access the transit station are anticipated due to the differences in transit mode vehicle and station characteristics. Larger stations that are typical of heavy rail and located off roadway rights-of-way have more potential for higher capacities for bicycle storage in the station and with larger transit vehicles, more capacity for on-board storage than buses. Table 22 on the next page summarizes the impacts of the primary transit mode on the storage and carriage potential for this FLM modal group.

Bike Carrier on Bus, Miami Dade Transit

Table 22
Summary of Impacts of the Primary Transit Mode on the Storage and Carriage Potential for Bike, Board and Skate Modal Group

	FLM Equipment Storage Needs			Heavy Rail Urban Transit		Light Rail Transit		Bus / BRT Primary Transit Mode	
Station Location				**Off-Street**		**On-Street or Off-Street**		**On-Street**	
Platform Length				**600 ft. to 800 ft.**		**100 ft. to 300 ft.**		**60 ft. to 70 ft.**	
Mobility Device	**On-Board Transit Vehicle**	**At Station**	**Impact of Primary Transit Mode**	**Secure, Illuminated Station Storage**	**Secure On-Board Storage**	**Secure, Illuminated Station Storage**	**Secure On-Board Storage**	**Secure, Illuminated Station Storage**	**Secure On-Board Storage**
Personal Bicycle (commuter rider/bike)	yes	yes	rail is better	100+	up to 128 up to 16 per car	20 - 30	4 to 8 vertical	low capacity	2 outside bus
Shared Bicycle	no	no	unaffected	high capacity	none needed	high capacity	none needed	low capacity	none needed
Personal E-Bike	yes	yes	rail is better	100+	up to 128 up to 16 per car	20 - 30	4 to 8 vertical	low capacity	2 outside bus
Shared E-Bike	no	no	unaffected	none needed	none needed	none needed	none needed	none needed	none needed
Skate Board	carried by passenger	no	unaffected	none needed	none needed	none needed	none needed	none needed	none needed
Electric Board	carried by passenger	no	unaffected	none needed	none needed	none needed	none needed	none needed	none needed
Roller Blade	carried by passenger	no	unaffected	none needed	none needed	none needed	none needed	none needed	none needed
Sedgway i2 or other Electric Personal	yes	yes	rail is better	yes	possible	yes	possible	unlikely	lift required
Rental Segway	no	no	unaffected	yes	none needed	none needed	none needed	none needed	none needed
Pedestrian (reference)	no	no	no	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable

Bike & Personal Low Speed Mobility Options:
By Home Origin, Work or Destination

There is evidence that walking distances to stations vary by whether it is to/from home, or to/from destinations. The home side of the trip ("first mile"), appears to allow for longer walking distances than the destination side ("last mile"). The relationship between these differences is about 2.5 to 1, or that the willingness to walk to the destination is about 40% of the home origin side. The cause of the distinction is not reported in the research literature, so extending the finding to a different mode with different speed and comfort characteristics is avoided.

Distance: The Effect of Distance Within the Station Area

The effect of distance with the personal low speed mobility options is different for human-powered active modes, and limited by time and battery range on the electric options. Within the Station Core Area (¼-mile) and Station Transit Neighborhood Area (½-mile), it is likely that there is little effect of distance on willingness to use the FLM mode. Within the Station's Transit Supportive Area (2 miles), there may be travel time decay on the human powered modes, as a persons' energy used, heat, and time will likely have some effect. Battery-electric powered modes do not cause any additional discomfort with extra distance.

Table 23
Speeds, Mechanical Ranges, and Human Energy Consumption of Modes as Indicators of Distance Tolerance

Mobility Device	Max Range (miles)	Max Speed (MPH)	Avg Speed (MPH)	10 Minute Range (miles)	Calories Burned / Hour (avg. person)	Calories Burned / Mile (avg. person)
Personal Bicycle (commuter rider/bike)	not limited by equipment	20	15	2.5	704	47
Shared Bicycle	not limited by equipment	20	12	2.0	609	51
Personal E-Bike	30 miles	20	20	3.3	50	3
Shared E-Bike	30 miles	20	20	3.3	50	3
Skate Board	not limited by equipment	15	10	1.7	324	32
Electric Board	12 miles	22	22	3.7	215	10
Roller Blade	not limited by equipment	15	10	1.7	381	38
Sedgway i2 Or other Electric Personal Mobility	24 miles	12	12	2.0	215	18
Rental Segway	24 miles	12	12	2.0	215	18
Pedestrian (reference)	not limited by equipment	10 - 15 (run)	3	0.5	160	53

Biking, Boarding, Skating Paths

The beginning of this section posed three questions to consider pedestrian access and mobility as a FLM modal strategy.

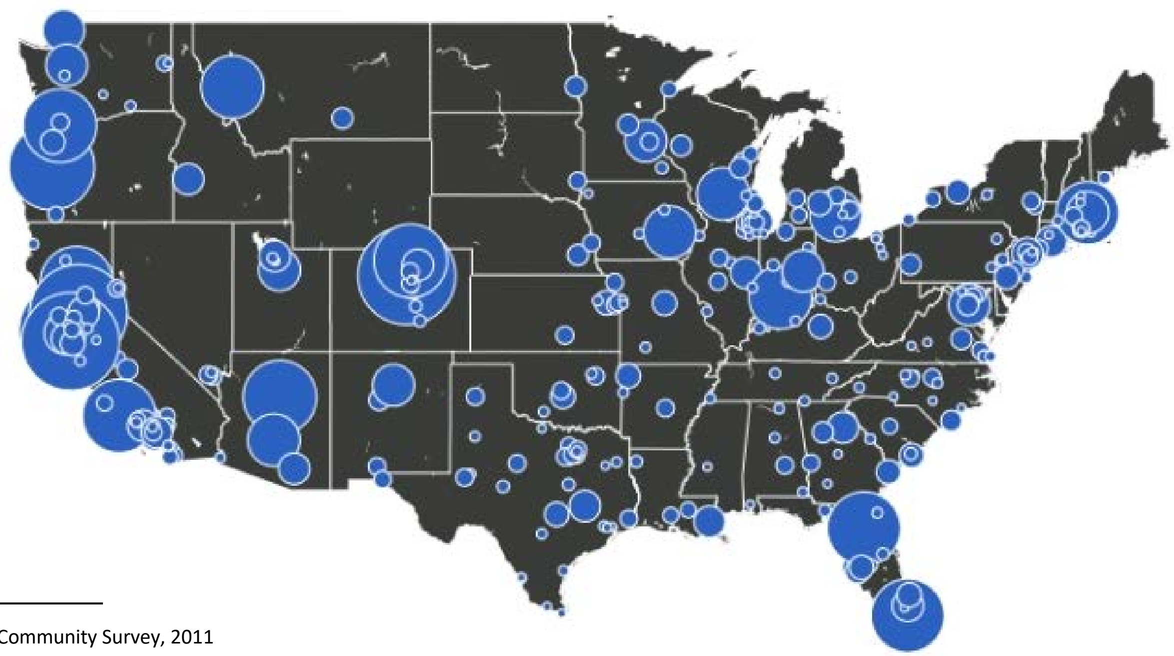
I. How far will transit users ride to transit stations?
II. Does the use of these mobility modes vary by transit mode?
III. What environmental factors influence their choice of mode, distance and route?

The first two questions have been answered. It is environmental factors that are most within the realm of planning actions. Bicycle mobility has grown fastest in cities that provide high levels of pathway development to induce casual riders to commute and meet daily needs by bike as direct unlinked trips or as transit-linked trips.

Nationwide, approximately 778,000 people rode bicycles as their primary means of traveling to work in 2011.[29] In most areas, cyclists account for only a small share of all commuters, about 0.55% to 0.60%, although in some urban areas, much greater percentages of cyclists commute. In 16 of the highest bicycling cities with populations over 50,000, more than 5% of working adults reported biking to work. In Davis, California, where bicycle culture and infrastructure are very supportive, an estimated 16.6% of workers bike to their jobs, more than any other city in the country.

The map below shows the prevalence of biking to work for more than 400 cities and other Census-designated places surveyed. Larger icons represent cities where those who primarily bike to work accounted for higher shares of total commuters in 2011.

Prevalence of Biking to Work in US Cities



[29] US Census Bureau, American Community Survey, 2011

If urban environmental considerations are considered, whether people will ride a bike or other personal low speed mobility options to transit has significant variability according to facilities provided and the attitude of the person towards biking. Observed and stated preference surveys of bicycle-to-work path choice were performed in Davis, California; Palo Alto, California; and San Luis Obispo, California[30]. They are all very bicycle-friendly cities in terms of infrastructure and culture. The information from these surveys helps to prioritize improvements that are needed for attracting higher FLM use of bicycles, boards and skates for increasing primary transit system ridership.

With the understanding that bike-to-work commuters are still a largely self-selecting group, the survey includes attitude toward bicycling to distinguish the preferences of an existing bike or FLM-bike commuter (prefer bicycling), and a latent market (do not prefer bicycling). Both groups are very important: the first to maintain bicycle activity levels and enhance their safety and quality of experience; the second to attract more mainstream travelers away from personal vehicles to transit-linked FLM strategies. The data is summarized in Tables 24, 25, 26, and 27.

Table 24 summarizes the ranking of factors leading to the choice to use a bicycle as a mode of travel. Each of the factors has been shaded green if it is a factor that can be affected by planning efforts to change the urban environment. If it is a factor that cannot be changed, then it is shaded in red.

Distance can be affected in a limited way by focusing on reducing delay at traffic lights, and barriers such as canals or highways.

Table 24
Factors Leading to the Choice of Bicycle as a Mode of Transportation in Highly Developed Urban Bicycle Networks

Factors for Choice of Bicycle as a Mode of Travel	All Respondents	Prefer Bicycling	Do Not Prefer Bicycling
Distance	4.4%	4.3%	4.5%
Other	4.2%	4.1%	4.2%
Locked Parking at Destination	4.0%	4.1%	3.9%
Rain	3.9%	3.8%	4.1%
Terrain	3.8%	3.6%	4.1%
Facilities Connect to Destination	3.7%	3.7%	3.7%
Bicycle Facilities (Lanes and Paths)	3.5%	3.6%	3.5%
Comfort	3.5%	3.5%	3.7%
Ability	3.4%	3.3%	3.7%
Temperature	3.4%	3.1%	3.8%
Bicycle Maintenance	3.2%	3.1%	3.4%
Covered Parking at Destination	2.4%	2.4%	2.3%
Showers at Destination	4.0%	2.3%	2.5%
Personal Lockers at Destination	2.3%	2.2%	2.3%

[30] Cornelius Nuworsoo, PhD; Erin Cooper; Katherine Cushing, PhD; Eugene Jud, PE. Integration of Bicycling and Walking Facilities into the Infrastructure of Urban Communities, Mineta Transportation Institute, San Jose, California, 2012.

Other factors that can be directly influenced by planning actions, include in order of importance:

1. Locked Parking at the Station
2. Bicycle Facilities that provide a continuous path to the station
3. Covered Parking at the Station
4. Personal Lockers at the Station

Showers has been removed from the list because the survey was conducted for un-linked trips that are longer by bicycle, and create more necessity to wash. Trips to the transit station are generally to be under 10 minutes. Speeds and energy effort of the linked trips are less. There are also security issues involved with providing showers at transit stations (instead of a work place). For these reasons, showers are not considered for transit stations.

With regard to more specific feedback about the types of bicycle network facilities preferred for these non-recreational bicycle trips, the following two tables address preferences (stated and revealed) for use of pathways based on traffic and bicycle facilities. Reflecting the bicycle friendliness of the cities where the surveys were conducted, 73% of the bicyclists do not use sidewalks. Nearly all of the 25% who cycle on the sidewalk, do so because of heavy automobile traffic and/or lack of bicycle facilities on the streets.

Table 25
Observed Bicycle Facility Choice
in Highly Developed Urban Bicycle Networks

Frequency of Facility Choice	Major Streets with Bike Lane	Minor Streets with Bike Lane	Major Streets NO Bike Lane	Minor Streets NO Bike Lane	Bicycle Boule-vards	Separated Bicycle Paths
All Respondents	59%	54%	44%	59%	43%	46%
Prefer Bicycling	85%	80%	66%	86%	66%	65%
Do Not Prefer Bicycling	32%	24%	18%	28%	16%	25%

Table 26
Stated Preference of Bicycle Facility Choice
in Highly Developed Urban Bicycle Networks

Stated Preference of Facility Choice	Major Streets with Bike Lane	Minor Streets with Bike Lane	Major Streets NO Bike Lane	Minor Streets NO Bike Lane	Bicycle Boule-vards	Separated Bicycle Paths
All Respondents	4%	4%	3%	4%	4%	4%
Prefer Bicycling	4%	4%	3%	4%	4%	4%
Do Not Prefer Bicycling	5%	4%	3%	4%	4%	4%

There is an equal preference for minor streets in mixed low-speed, low-volume traffic, and bike lanes for major streets with higher vehicular speeds and traffic volumes.

In these cities, bike lanes are even preferred to separated bike paths When surveyed about sharing paths with pedestrians, 60% of the respondents indicated that they were somewhat or very comfortable with sharing pathways or sidewalks with pedestrians.

When asked about their behavior at intersections (riding on-street or in bike lanes), 79% answered that they ride through "like a car" and obey the traffic signals. The next highest response regarding intersections (30%) is that they "take the route with the fewest intersections."

To complete the information about priorities for the Pathway, the table below summarizes the ranking of pathway factors for choice of route for bicycling. Each of the factors has been shaded green if it is a factor that can be affected by planning efforts to change the environment. If it is a factor that cannot be changed, then it is shaded in red.

The factors that can be directly influenced by planning actions, include in order of importance:

1. Separation from high-speed vehicular traffic
2. Good condition of pavement
3. Shortest (quickest) path
4. Parked Cars (safety: maneuvers and doors opening)
5. Crime
6. Adequate quantity and quality of storage at destination

It is useful to note that the general pattern of importance of Pathway factors for bicycle riders is similar to the pedestrian factors. The most important factors are short paths, safety and security, and these aspects need to be the first priorities for the FLM Pathways. While beauty, landscaping, street amenities, and appealing architecture are still of great importance, their priority is secondary to the basics.

Table 27
Factors Leading to the Choice of Bicycle as a Mode of Transportation in Highly Developed Urban Bicycle Networks

Factors for Choice of Bicycle Route	All Respondents	Prefer Bicycling	Do Not Prefer Bicycling
Speed of Autos	4.4%	4.3%	4.5%
Condition of Pavement	4.2%	4.1%	4.2%
Directness	4.0%	4.1%	3.9%
Length	3.9%	3.8%	4.1%
Terrain	3.8%	3.6%	4.1%
Density of Parked Cars	3.7%	3.7%	3.7%
Crime	3.5%	3.6%	3.5%
Beauty	3.5%	3.5%	3.7%

Convenient, secure, weather-protected bike parking at LRT Station, Portland, OR.

Biking, Boarding, Skating, Personal Low-Speed Modes – Distance and Pathways Summary

Planning for FLM Pathways to the primary transit stations should consider the following:

- The use of bicycles, skateboards, foot skates and other low-speed mobility options, whether human powered or battery-electric should be given the highest planning priority after pedestrian needs because they represent the most efficient, affordable, sustainable and resilient FLM modal group. As a group they: extend the range of viable FLM mobility to the entire transit supportive area (2 miles); possibly have the lowest carbon footprint with respect to greenhouse gas emissions per mile; lower consumer transportation cost; lower public transportation operational costs; and increase personal and community health.
- The speed of these modes allows the Transit Core (¼-mile) station area distance to be covered in 1 to 2 minutes not including signal delay. The Transit Neighborhood (½-mile) station area distance is covered in 2 to 3 minutes. For most of these modes, the 2-mile Transit Supportive Area distance can be covered in 10 minutes or less.
- Accepting 10 minutes as an upper FLM limit to access a station from the home origin side of the linked transit trip, this modal group is applicable to the entire station area.
- Accepting 5 minutes as an FLM limit to access a station from the work destination side of the linked transit trip, this modal group is applicable to the entire Transit Core (¼-mile) and Transit Neighborhood (½-mile).
- The primary transit mode indirectly affects whether people will be willing to use some of these modes because of storage and carry-on capacities and convenience. For bicycles, rail is generally better because of greater on-board space for carriage and greater station space for storage.
- The primary consideration in choosing a bicycle or personal low-speed mode path is minimizing distance. From a standpoint of developing Tool Kit strategies, this places the greatest emphasis on creating continuous, direct paths. Barriers such as highways, railroad tracks, large inaccessible parcels and canals or rivers, should be considered for bridging.
- The secondary considerations are traffic safety and security. For developing the FLM Tool Kit, the emphasis is on planning and implementation of continuous, direct bicycle facilities as appropriate to traffic conditions, vehicle mix, vehicle speeds and pedestrian volumes. Riders (both experienced and latent) prefer minor streets and prefer bike lanes – underscoring the need to be protected from higher speed traffic.
- Riders also need protection from parked cars' maneuvers and opening doors. Bike lanes should be buffered from traffic, but are preferably located away from parking lanes, or to the right of the parking lane with the buffer alongside the parking lane.
- Storage for bicycles, Sedgeways, and other larger equipment needs to be provided at the station and on the transit vehicle.
- Storage for personal bicycles should be secure from theft and vandalism, and well protected from weather.
- Shared bike programs eliminate the need for bicycle storage on-board transit vehicles. Since on-board storage space is limited and causes delay, these programs are programs are very

beneficial and need greater support and integration with transit facilities.

- Shared bicycle programs can introduce bicycle-linked transit to non-bicycle riders/owners. Transit-linked programs can be priced well for this modal group.
- Skateboards, both active and battery electric, although typically associated with recreation are being designed and used for commuting and other destination trip purposes. At similar speeds to bicycles, they provide the same level of mobility; however, they provide improved access because they can be carried with ease on transit or into any destination. Their better access is both a private benefit to the traveler, but also a public benefit as the need for storage expenses for bikes t stations or on-board cars is eliminated.
- Foot skates as an FLM mode has the same advantages of skateboards; however, a bench to sit and remove or lace on skates must be provided before reaching the station platform. Foot skates are not permitted on transit platforms or vehicles.
- Skateboards and skaters can mix with both bicycles and pedestrians, but where the volumes of either are high, there should be additional pathway capacity (width) or a separately marked lane.
- For less experienced skateboarders and foot skaters to access a sidewalk to the transit station, a separate marked curb ramp should be provided. The dome-type detectable warning surfaces are incompatible with the smaller wheel diameters of skateboards and skates.

Docked Bike Sharing

Skateboard

Blank page

BIKE, BOARD & SKATE FLM TOOL KIT

B1. TRANSIT ACCESS BIKE & SKATE SURVEY

Goals

- Provide Miami-Dade-specific bike and skate preference and travel data for making FLM connections to SMART Plan corridor stations, and develop quantitative factors for improving the corridor transit capture areas and ridership forecasts.
- Supplement the existing program of Miami-Dade TPO pedestrian and bicycle count program with base data relevant to transit FLM.

Actions

- Identify existing transit station areas to survey that provide adequate diversity and statistical validity that survey outcomes may be directly used for Miami Dade SMART Plan FLM efforts.
- Spatially target selected transit station areas in which to conduct skate and bike observed and stated preference surveys. Select stations with multiple potential paths, and include station areas that have barriers, to evaluate route choice and FLM time.
- Perform a GIS-based, skate and bike-ability audit (see Bike Tool 2) and determine street types, streets and other points for data collection.
- Perform survey to capture relevant attitudinal and observed data regarding the length of transit-linked bike and skate trips, route selection, and sensitivity to the built-environment.

Timeframe

- Short term – before planning and programming improvements

Funding

- Unified Planning Work Program (UPWP)
- Transit Development Program (TDP)

Factors Influencing Bike and Skate Pathway to Survey and Audit

Characteristic	Observed (audit)	Stated (survey)
Mode to Transit Station Split	√	
Final Origin and Final Destination Type		√
Origin / Destination Location		√
Distance Traveled	√	√
Time Traveled	√	√
Existing Shorter Path	√	
Grid Morphology and Block Length	√	
Bicycle Lane, Path or Shared ROW Use	√	√
Roadway Functional Classification	√	
Parked Car Lanes	√	√
Traffic Signal Delay Time	√	√
Barrier Delay Time & Distance	√	√
Bike Racks on Street at Destination	√	√
Indoor Storage at Destination	√	√
Use of Other Street Bike Locking	√	√
Bike On-Board Transit or At Station	√	√
Bicycle Theft Rates On Route	√	√

BIKE, BOARD & SKATE FLM TOOL KIT

B2. BIKE AND SKATE TRANSIT ACCESS AUDIT

Goals

- Supplement land use planning for SMART Corridors and station areas, with planning level information to program bike and skate FLM improvements that support higher primary transit ridership.
- Provide baseline data to plan and program bicycle and skate improvements along SMART Corridors.

Actions

- Identify SMART Corridor station locations and primary transit modes. Identify forecast ridership levels by station/mode, and mode split to and from the station. Identify station location as on-street at grade, elevated, or off-street.
- Using GIS geolocating pad-based methodology, inventory all existing infrastructure and storage pertinent to bicycle mobility and storage within the station area.
- Integrate bike and skate facilities audit with other station area FLM infrastructure audits.
- Develop Bicycle and Skate Mobility Level-of-Service benchmarking method and criteria based on station area characteristics.
- Develop prioritization program for transitioned improvements that enhance transit utilization in the transit supportive areas of each Corridor.

Timeframe

- Short term – before planning and programming improvements

Funding

- Unified Planning Work Program (UPWP)
- Transit Development Program (TDP)

TPO
Miami-Dade Transportation Planning Organization

Station Area Bike and Skate Audit

Characteristic	Existing	Future
Bike & Skate Transit Supportive Area	√	√
Roadway Functional Classifications	√	√
Roadway Cross Section Characteristics: number of lanes, lane widths,	√	√
Roadway LOS and % Heavy Vehicles	√	√
Vehicular Travel Speed	√	√
Vehicle / Bike Travel Speed Ratio	√	√
Sidewalk Adequacy and Zones (effective walkway, buffers, amenities)	√	√
Bicycle Pathway Facilities Adequacy: (separated, buffers, mixed)	√	√
Identify Barriers	√	√
Bike Path Travel Times w Signal Delay	√	√
Bike-To-Transit, Skate-To-Transit Volumes By Mode Share and Station Ridership Scenarios	√	√
Bicycle Pathway Facilities Adequacy	√	√
Bike Path Travel Times w Signal Delay	√	√
Signage and Wayfinding	√	√
Storage at Station		√
Storage at Station Area Destinations, Workplaces and Residential Buildings	√	√

BIKE, BOARD & SKATE FLM TOOL KIT

B3. CONTINUOUS PATH

Goals

- Provide a connected network of pathways for bicycle, skate and other personal low speed FLM modes throughout the transit station area that are responsive to the physical context and the safety, security, comfort and enjoyment of existing riders.
- Induce latent ridership to use these modes for transit-linked FLM to the primary transit station. Latent users are those that state a preference to the mode, but are otherwise inhibited due to inadequacy of facilities.
- Leverage the entry of latent riders, to grow the use of these modes for complete trips in the mixed-use environments, and the use of these modes for FLM trips with further enhancements.
- Leverage development of FLM networks to increase future ridership of the SMART system.

Actions

- Identify bike, board and skate deficiencies based on the Transit Access Bike and Skate Survey (B1) and Transit Access Bike and Skate Audit (B2).
- Identify bike, board and skate pathways consistent with existing development based on outcomes of the Transit Access Bike and Skate Survey (B1) and Transit Access Bike and Skate Audit (B2).
- Identify growth trends, demographic changes, planned changes in land development regulations, planned changes in roadway and pedestrian infrastructure that impact future volumes on pathways of the bike, board and skate station area networks.
- Identify zoning code deficiencies that countervail establishing the bike, board and skate station area networks, and submit amendments for adoption to remove code deficiencies and add amendments to require or promote needed facilities.
- Identify where street travel lane widths are 12 ft. or more and may be narrowed to 11 or 10 ft.[31] See Tool Kit B4, Vehicular Travel Lane Width.
- Identify where parking lanes may be removed or moved to provide additional safe pathways. (coordinate with zoning code review above and area-wide parking plan)
- Identify existing plans and programs where sidewalk bulbouts are to be constructed, and place on hold until coordinated with the bicycle network. Consider alternative pedestrian crossing enhancements as provided in the Pedestrian FLM Section: P4, Enhanced Crosswalks; P5, Diagonal Crosswalks; P6, Midblock Crosswalks; and P7, Signal Operations.
- Identify programmed infrastructure improvements that curb reconstruction/enhancements can be coordinated with.
- Develop a station area prioritized strategic plan to implement complete bike board and skate pathways.

Criteria:

- Continuous, safe and secure bike, board and skate pathways along the street network
- Follow and use FDOT Design Manual guidelines, and MUTCD recommendations to maximize the safety and security for bike, board and skate riders.
- Use Highway Capacity Manual (HCM) Bicycle Level of Service methodologies to determine bicycle facility adequacy for exclusive off-street paths, shared off-street paths, on-street bicycle lanes,

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31 AASHTO, A Policy on Geometric Design of Highways and Street (The "Green Book"),

and interrupted flow bicycle lanes. Use horizon year pedestrian volume forecasts.

- Emphasize use of the HCS shared path LOS methodology to account for skateboarders and foot skaters.
- In the context of roadway jurisdictional requirements, use best practices for designing bike, board and skate pathways.
- Provide separate lanes for each direction of travel on all bi-directional streets

Improvements

- Network of interconnected, safe, secure bicycle, board and skate pathways throughout the station area, connecting on shortest paths to the primary transit station location: Tool Kit B5, Bicycle & Rolling Lanes
- Marked bicycle facilities on the transportation network
- Exclusive and shared paths off the vehicular transportation network. Tool Kit B6, Shared Row & Bicycle Boulevards

Timeframe

- Short term. The network must first be identified to allow time for coordination and prioritization of improvements

Funding

- Eligible FTA Programs for bicycle and personal low-speed FLM strategies as part of transit station areas:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

BIKE, BOARD & SKATE FLM TOOL KIT

B4. VEHICULAR TRAVEL LANE WIDTH

Goals

- Provide sufficient cross-sectional width for safe, buffered bicycle, board and skate facilities.
- Increase frictional effect from narrowing lane width to reduce vehicular travel speed, thereby increasing pedestrian, bike, skateboard and foot skate safety.
- Reduce the need for roadway reconstruction, and especially for curb, gutter and drainage location.

Actions

- Identify ROW cross-section characteristics along station area roadway bicycle network based on network and hierarchies established in Continuous Path, Tool Kit B3.
- Identify need for separated bike lanes based on network and hierarchies established in Continuous Path, Tool Kit B3.
- Identify where travel and turn lanes are 11-ft., 12-ft., or wider.
- Work with roadway jurisdictional entity to re-mark roadway for narrower travel lanes and turn lanes to gain cross-sectional space for buffered bike lanes in both directions.
- Implement new pavement marking as part of unified plan to develop continuous paths.
- Reduce speed limits.

Criteria:

- Continuous bicycle paths along street network
- Roadway jurisdiction, functional classification and number of lanes
- Roadway design speed and observed average speeds
- Roadway existing and horizon year traffic volumes
- Truck volumes and heavy vehicle volumes
- Forecast bicycle volumes
- Roadway design speed, posted speed limit and observed peak segment speeds. As a general rule, where vehicle speeds are at or near bicycle speed (15 to 20 mph), then bike lanes may not be necessary.
- Abutting land uses
- Sidewalk adequacy

Improvements

- Roadway travel lanes may be narrowed to 10’ by re-striping
- Lower posted speed limits
- Marking of new exclusive roadway bicycle facilities or facilities shared with skateboards and foot skates. Coordinate with :Tool Kits B5, Bicycle and Rolling Lanes; B6, Shared ROW and Bicycle Boulevards; and B7, Signal Operations.

Timeframe

- Short term and on-going. Based on the Network Program (B3), begin implementation based on priorities, opportunities to coordinate with other work, and redevelopment.

Funding

- Eligible FTA Programs for bicycle and personal low-speed FLM strategies as part of transit station areas:
  - Urbanized Area Formula Grants (5307)

BIKE, BOARD & SKATE FLM TOOL KIT

B5. BICYCLE & ROLLING LANES

Goals

- Provide vehicle-exclusive facilities for bicycle, skate and other personal FLM modes in the transit station area that respond to the physical context, safety, security and comfort and of existing riders.
- Induce latent ridership to use these modes for complete trips and FLM trips to the primary transit station.
- Leverage the entry of latent riders, to grow the use of these modes for unlinked destination trips in the mixed-use environments.
- Leverage development of FLM networks to increase future ridership of the SMART system.

Actions

- Identify roadway pathways established in Continuous Path (Tool Kit B3) that require buffered bike lanes.
- Identify if there is sufficient road pavement cross-sectional width to accommodate bike lanes (Tool Kit B4)
- Work with roadway jurisdictional entity on narrowing of travel lanes (Tool Kit B4)to gain space for buffered bike lanes in both directions.
- Implement new pavement marking as part of unified plan to develop continuous paths.

Criteria:

- Continuous bicycle paths along street network
- Roadway jurisdiction, functional classification and number of lanes
- Roadway design speed and observed average speeds
- Roadway existing and horizon year traffic volumes
- Truck volumes and heavy vehicle volumes
- Forecast bicycle volumes
- Roadway design speed, speed limit and observed peak speeds.
- Presence of on-street parking
- Abutting land uses
- Sidewalk adequacy

Improvements

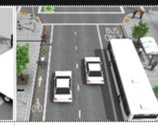
- Bike lanes for shared use of bicycles, skateboards, and foot skaters. Configurations summarized on the table on the following page.
- Bicyclists tend to ride a distance of 2.5 to 3.5 feet from the curb face. If the bicycle lane uses this part of the street, the pavement surface must be smooth and free of structures. Where drain inlets and manholes exist, bike lane width should be adjusted.
- Regular maintenance is critical for bike lanes to keep them smooth, unobstructed, and free of roadway debris.
- Bike lanes should be constructed to normal full-depth pavement standards because motor vehicles will occasionally cross them.

Timeframe

- Short term and on-going. Based on the Network program (Tool Kit B3), begin implementation based on priorities, opportunities to coordinate with other work, and redevelopment.

Funding

- Eligible FTA Programs for rolling facilities for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)
  - Development conditions

Bicycle & Rolling Facility Type	Bicycle Lane at Curb (no parking lane)	Bicycle Lane Outside Parking Lane	Buffered Bicycle Lane Outside Parking Lane	Buffered Bicycle Lane Inside Parking Lane	Contra-Flow Bike Lane (no parking lane)	Left Side Bike Lane	Rolling Lane	2- Way Cycle Track
Illustration								
Rolling Directions	1-way	1-way	1-way	1-way	1-way	1-way	1-way	2-way
Passing Lane	no	no	no	no	no	no	yes	in other direction
Sides of Street	both	both	both	both	one	both	one	one
Total Width	6	5	7	9	7	9	11	13
Effective 1-way Width (ft.)	4	5	4	4	4	4	8	10
Outer Buffer (width, ft.)	0	0	3	0	3	3	3	3
Door Zone Buffer (width, ft.)	0	0	0	3	0	0	0	0
Curb Drainage Buffer (width, ft.)	2	0	0	2	0	2	0	0
Pavement Markings	6" white stripe Bike Symbol and Arrow green inner area	6" outside white stripe 6" parking lane stripe Bike Symbol and Arrow green or blue lane	6" outside white stripe 6" parking lane stripe Bike Symbol and Arrow diagonal hatched buffer green or blue lane	6" outside white stripe Bike Symbol and Arrow diagonal hatched buffer green or blue lane	6" double yellow stripes Bike Symbol and Arrow yellow hatched buffer green or blue lane	6" yellow stripe green inner area	6" outside white stripe Bike Symbol and Arrow diagonal hatched buffer green or blue lane	6" outside white stripes Bike Symbol and Arrow 6" center yellow dashed stripe
Physical Separation from Vehicles	no	no	no	no	no	no	yes flexible delineators or grade separation	yes planted area and parked cars
Street Characteristics								
Street Direction	Bi-Directional	Bi-Directional	Bi-Directional	Bi-Directional	One-Way	One-Way	Bi-Directional	One-Way
Street Travel Lanes	2 or more	2 or more	2 or more	2 or more	1 or more	1 or more	2 or more	1 or more
Vehicle Speeds	25 - 35 mph	25 - 35 mph	25 - 35 mph	25 - 35 mph	25 - 35 mph	25 - 35 mph	25 - 35 mph	25 - 35 mph
Intersections	6" dashed stripes + skip dash color	6" dashed stripes + skip dash color	6" dashed stripes + skip dash color Best practice for hatched area at last parking space behind signalized intersection stop bar, adjacent to bike lane for bike wait and queue area	6" dashed stripes + skip dash color	6" dashed stripes + skip dash color	6" dashed stripes + skip dash color	crossing markings, signage, signal Protected Intersection option	crossing markings, signage, signal Protected Intersection option
Right Turn Lanes	bike lane transition to outside turn lane w skip dash markings	bike lane transition to outside turn lane w skip dash markings	bike lane transition to outside turn lane w skip dash markings	not recommended	not required	not required	not recommended	not recommended
Access Characteristics								
Access to Land Uses	throughout block	intersection	intersection	intersection	intersection	throughout block	throughout block	intersection
Access to On-Street Bike Storage	throughout block	walk from intersection	walk from intersection	walk from intersection	walk from intersection	throughout block	throughout block	walk from intersection
Users								
Bicycles (human-powered)	yes	yes	yes	yes	yes	yes	yes	yes
Tricycles (human powered)	no	no	no	no	yes	no	yes	yes
Bicycles (battery-electric)	yes	yes	yes	yes	yes	yes	yes	yes
Skateboards (human powered)	no	no	no	yes	yes	no	yes	yes
Skateboards (battery electric)	no	no	no	yes	yes	no	yes	yes
Foot Skaters	no	no	no	yes	yes	no	yes	yes
Sedgeways	no	no	no	yes	no	no	yes	yes
Pedestrians	no	no	no	no	no	no	no	no

BIKE, BOARD & SKATE FLM TOOL KIT

B6. SHARED ROW & BICYCLE BOULEVARDS

Goals

- Provide vehicle-shared lanes, "sharrow" and "Bicycle Boulevards" (shared lanes with bicycle priority treatments) to complete the bicycle and rolling network into parts of the roadway network where they are appropriate.
- Provide the greatest extent of a station area bicycle network of low traffic volume and low-speed roads.
- Maximize the FLM area of influence.
- Leverage development of FLM networks to increase future ridership of the SMART system.

Actions

- Identify roadway pathways established in Continuous Path (Toolkit B3) that are appropriate for sharrows or bicycle boulevards.
- Identify existing and future land use based on station area plans.
- Verify that existing and future traffic volumes and heavy vehicle mix are appropriate for shared use.
- Verify that number of lanes, and marked speed limits are appropriate for shared use: 20 mph or less.
- If posted speed limit is at 30 mph or higher, work with the roadway jurisdiction to lower speed limits, especially on local residential streets where shared-use facilities are expected.
- Implement new pavement markings as part of unified plan to develop continuous paths.

Criteria:

- Continuous bicycle pathways along the street network
- Roadway jurisdiction, functional classification and number of lanes
- Roadway existing and horizon year traffic volumes
- Truck volumes and heavy vehicle volumes
- Forecast bicycle volumes
- Roadway design speed, speed limit and observed peak segment speeds.
- Abutting land uses

Improvements

- Shared-use pavement markings
- Shared-use signage.
- Lowered Posted speed limits.
- Where drain inlets exist, they should be made smooth and if slot designs, the slots should be perpendicular to travel. This is not best for skateboards and skates; however, on shared lanes, skaters may be expected on sidewalks depending on rider skill and preference.
- Where manholes exist, they should be made smooth.

Timeframe

- Short term and on-going: Based on the Network program (B3), begin implementation based on priorities, opportunities to coordinate with other work, and redevelopment.

Funding

- Eligible FTA Programs for rolling facilities for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)
  - Bus and Bus Facility Formula Grants (5339)

BIKE, BOARD & SKATE FLM TOOL KIT

B7. SIGNAL OPERATIONS

Goals

- Enhance the safety of the bicycle and personal low-speed mobility network in the station area core (¼-mile) and neighborhood (½-mile).
- Induce additional bike and personal low-speed mobility travel to transit stations by demonstrably improving safety along pathways to the transit station.

Actions

- Identify intersections where signal timing changes may be required to improve bicycle safety.
  - Especially for right-turn lane transitions
  - Contra-flow bike lanes
  - Two-way Cycle Tracks
  - Rolling lanes
- Collect accident data at specific locations and at locations with similar characteristics.
- Perform traffic operations analysis to determine impacts of protected phases and/or prohibitive phases for bicycles.
- Develop a station area prioritized strategic plan to progressively implement signal modifications.

Criteria:

- Roadway number of lanes
- Presence of left-turn lanes and phases
- Presence of right-turn lanes with permissive turns
- Roadway design speed
- Roadway existing and horizon year traffic volumes
- Existing and forecast bicycle volumes
- Needed, planned or programmed signal replacement

Improvements

- Changes to signal timing
- Addition of bicycle signals
- Possible vehicular red turn arrows

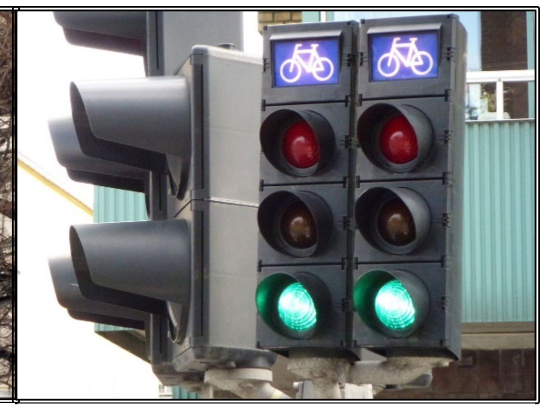
Timeframe

- Short term and on-going. Creating the shortest path with greatest safety is the highest priority to station area bicycle trip making.
- Signal timing changes can be programmed with signal replacements, or development traffic mitigation plan implementations.

Funding

- Eligible FTA Programs for rolling facilities for transit development:
  - Urbanized Area Formula Grants (5307)
- On-going signal replacements
- Development mitigation and/or conditions

Bicycle Signal, Denver, Co.



Bicycle Signals, Portland, Oregon

BIKE, BOARD & SKATE FLM TOOL KIT

B8. BARRIER OVERPASSES & UNDERPASSES

Goals

- Enhance the network of bicycle pathways throughout the station area core (¼-mile) and neighborhood (½-mile) to reduce travel time and increase convenience.
- Enhance safety of bicycle and personal low-speed mobility travel.
- Induce additional bicycle and personal low-speed mobility travel to transit stations by reducing pathway distance to the transit station.

Actions

- Identify barriers based on based on the Transit Access Bike and Skate Survey (Tool Kit B1) and Transit Access Bike and Skate Audit (Tool Kit B2).
- Identify potential benefit to bridging barriers based on existing and planned developments.
- Identify locations to bridge barriers based on
  - Distance to bifurcate
  - Proximity to rolling pathways
- Identify preliminary design options, feasibility and cost for bridging barriers at specific locations

Criteria:

- Identified barriers
- Benefit (time saved, safety, reduced incidents)
- Distance to primary pedestrian pathways to transit station

Improvements

- Rolling / Pedestrian shared path bridges over canals
- Elevated shared pedestrian and rolling path bridges over highways or high-volume, high-speed arterials

Timeframe

- Short term to midterm: Creating the shortest path with least delay and greatest safety is the highest priority to station area bicycle and personal low-speed mobility trip making.
- Ongoing for bridges collocated and built as a part of land development

Funding

- Eligible FTA Programs for rolling facilities for transit development:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)
  - Private development

BIKE, BOARD & SKATE FLM TOOL KIT

B9. CARRIAGE ON TRANSIT VEHICLES - BIKES

Goals

- Enhance the intermodalism for bicycles (including E-Bikes) as FLM to SMART Corridor transit stations.
- Skateboards and foot skates are carry-on, and do not need accommodation for storage on transit vehicles.

Actions

- Forecast bicycle FLM mode for each transit station.
- Forecast origin/destination for bicycle FLM mobilty based on station characteristics and primary transit mode and determine peak demands/ loads for bicycle storage and space for it.

Criteria:

- Primary transit mode and its bike storage capacity
- Ridership forecasts and bicycle FLM share
- Station Area development and demographic characteristics that influence transit ridership forecasts and bicycle FLM share

Improvements

- Bike racks on buses
- Bike carriage on rail cars (HRT and LRT)
- Dedicated bike carriage rail cars (HRT)
- Improve bike carriage on existing MetroRail to meet demand

Timeframe

- Short Term: continue bike rack programs for buses
- Short Term: continue to improve bike carriage on MetroRail
- Long Term: with purchase of primary transit mode vehicles or livery, include sufficient, safe, secure bicycle carriage equipment that is convenient and minimizes stop dwell times.

Funding

- Eligible FTA Programs for bicycle FLM facilities:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)
  - Bus and Bus Facility Formula Grants (5339)

Heavy Rail On-board Bike Carriage

BIKE, BOARD & SKATE FLM TOOL KIT

B10. TRANSIT STATION BICYCLE STORAGE

Goals

- Enhance the intermodalism for bicycles (including E-Bikes) as FLM to SMART Corridor transit stations.
- Skateboards and foot skates are carry-on, and do not need accommodation for storage on transit vehicles.
- Enhance the intermodalism for foot skaters as FLM to SMART Corridor transit stations.
- Foot skaters need convenient seating before vertical lifts or stairs and before entering transit platforms to change into shoes.

Actions

- Forecast or target personal bicycle FLM mode for each transit station.
- Forecast parking accumulation for bicycle FLM based on station characteristics and primary transit mode.
- Forecast potential share of E-bikes, and work with manufacturers to develop charging stations as part of the storage capacity.
- Determine E-bike charging policy (payment or free incentive) based on triple bottom line benefits criteria as well as cost considerations.
- Design secure bicycle storage for human powered bicycles at the station. Security requires:
  - Weather protection
  - Visibility to highly trafficked areas
  - Visibility to station security personnel
  - Effective locking racks that are suitable for all bikes and minimize vulnerability to bike and wheel damage
  - Coordinate with bicycle riders and bicycle industry representatives to determine preferred designs
- Implement transit station bicycle storage systems and E-bike charging locations with station design and construction.
- Include fixed, free air pumps at bike racks.

Criteria:

- Primary transit mode station size and bicycle storage capacity
- Ridership forecasts and bicycle FLM share
- E-bike share and charging policy
- Station area development and demographic characteristics that influence transit ridership forecasts and bicycle FLM share

Improvements

- Bicycle storage at stations: Capacity based on primary transit mode, station design and demand forecasts
- E-bike charging stations
- Improve bike storage at existing MetroRail stations
- Benches for changing foot skates to shoes at ground level locations.

Timeframe

- Short Term: continue and improve MetroRail bike storage
- Long Term: with SMART Corridor stations, include sufficient, safe, secure bicycle storage systems and E-bike charging stations.

Funding

- Eligible FTA Programs for bicycle FLM facilities:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)

BIKE, BOARD & SKATE FLM TOOL KIT

B11. TRANSIT STATION BICYCLE SHARING

Goals

- Enhance the intermodalism for bicycles (including E-Bikes) as FLM to SMART Plan transit stations.
- Increase the potential for non-bicycle riders to use shared bicycles to transit as a path to new bicycle FLM transit riders.

Actions

- Forecast latent bicycle FLM mode for each transit station.
- Coordinate with multiple bike sharing vendors to determine space, visibility, communications and promotion needs at each station.
- Reserve space for bike sharing equipment for initial forecasts.
- Reserve additional space for increased bike sharing demand as the market cycle develops past early adopters to early and late majorities and laggards

Criteria:

- Primary transit mode station size and bicycle storage capacity
- Ridership forecasts, bicycle FLM share and bike share forecasts
- Station area development and demographic characteristics that influence transit ridership forecasts and bicycle FLM share

Improvements

- Adequate space for bike sharing stations at transit stations.

Timeframe

- Short Term: continue to develop for existing MetroRail and Busway stations
- Long Term: with development of stations for each SMART Corridor, include sufficient space for bike sharing facilities and equipment.

Funding

- Public-Private-Partnerships

Light Rail Transit Station Short-Term Bicycle Storage

Bus Rapid Transit Station Short-Term Bicycle Storage

BIKE, BOARD & SKATE FLM TOOL KIT

B12. TRANSIT STATION BICYCLE STATION

Goals

- Enhance the intermodalism for bicycles (including E-Bikes) as FLM to SMART Corridor transit stations.
- Increase the potential for non-bicycle riders to try use of shared bicycles to transit as a path to new bicycle FLM transit riders
- Increase the visibility and information potential for bike, board and skate FLM to transit stations.

Actions

- Forecast or target latent bicycle FLM mode for each transit station, and track bicycle FLM use at each station.
- Select stations with highest ridership and highest bike FLM usage or demand.
- Coordinate with multiple bike sharing vendors to determine space, visibility, electric, communications promotion needs at each station.
- Provide space a Bike Station as part of the transit station kiosks or joint development vendors.
- A "Bike Station" is a vendor space at the transit station that provides services with service personnel:
  - A service counter for services and information
  - Bike racks for short term storage
  - Bike rental or shared-bicycle services
  - Minor repair services or maintenance
  - Refreshments / snack bar / café
  - Washrooms
  - May be combined with serviced shower and changing rooms

Criteria:

- Primary transit mode station size and inclusion of vendor space.
- Transit FLM bicycle usage

Improvements

- Adequate space for bike sharing stations and bikes at transit stations.

Funding

- Public-private partnerships
- Private sector renting station kiosk of station store space.

Bike Station Conceptual Sketch

BIKE, BOARD & SKATE FLM TOOL KIT

B13. STATION AREA SHORT-TERM BICYCLE STORAGE

Goals

- Enhance the intermodalism for bicycles (including E-Bikes) as FLM to SMART Plan transit stations.
- Enhance the use of bicycles (including E-Bikes) for station area mobility on unlinked trips among the mixed use and residential area near stations.
- Enhance the economic of mixed use station areas by increasing access by bicycle.
- Reduce non-residential vehicular parking in station areas, especially on-street, while providing enhanced access by bicycles and E-bikes.

Actions

- Design, regulate or incentivize space for short-term parking of personal bicycles and commercial bike-sharing equipment along mixed-use blocks throughout the station area.
- Regulate requirements for adequate, secure, safe and sheltered bicycle parking for mixed-use blocks in the station area.
- Regulate requirements for adequate, secure, and safe bicycle storage for multifamily residential development in the station area.
- Coordinate with bicycle riders and bicycle industry representatives to determine preferred designs for bicycle racks.
- Coordinate with sidewalk design (Tool Kit P3) and pedestrian amenity programs (tool Kit P11).
- Implement transit station area bicycle storage systems and E-bike charging storage with stations.

Criteria:

- Sidewalk amenity space
- Land development regulations, and future land use plans of mixed uses and intensities
- Station area development and demographic characteristics that influence transit ridership forecasts and bicycle FLM share.
- Use target ratios for residential bicycle parking as bike spaces per dwelling unit

Improvements

- Space for bicycle parking along mixed-use blocks throughout the station area.
  - Space should be sufficient for public access for uses on each side along a block.
  - Space should be sufficient for commercial bike sharing facilities in addition to personal bicycles.
  - Space should be located to provide direct access to bike network facilities and to the pedestrian path.
  - Locate midblock to reduce crowding and conflicts with pedestrians waiting to cross streets.
- Secure bicycle parking for human powered and battery-electric bicycles in the mixed-use station areas.

  Public charging is not required for short-term parking
- Minimum standards for on-street bike parking include:
  - Weather protection – shelters
  - For security reasons, public bike lockers are discouraged
  - Using Crime Prevention Through Environmental Design (CEPTD) principles to that street security is not diminished.
  - Night-time illumination

- Visibility to highly-trafficked areas
- Effective locking racks that are suitable for all bikes and minimize vulnerability to bike and wheel damage

- Minimum standards for off-street residential bike parking include:
  - Weather protection – inside building
  - Dedicated space in common areas of building
  - Effective locking racks that are suitable for all bikes and minimize vulnerability to bike and wheel damage
  - Preferably not in auto parking area for safety reasons
  - Preferred direct access to bicycle facilities on street, without sharing automotive driveways or pedestrian entrances.

Timeframe

- Mid Term and on-going: with redevelopment of station areas for each SMART Corridor

Funding

- Eligible FTA Programs for bicycle FLM facilities:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)
  - Bus and Bus Facility Formula Grants (5339)
- Public private partnerships
  - Working with commercial bike sharing operations
  - Use of business improvement districts to potentially adopt and maintain bike racks
  - For weather protection shelters above bike racks, possible participation with regulated advertising
  - Art in Public Places
- Development
  - Using land development regulatory requirements where essential, or bonus programs where optional, require bicycle racks that meet the design and performance criteria listed above.

Bike Arc racks in Palo Alto, California
providing security, weather protection, visibility, and compact design

BIKE, BOARD & SKATE FLM TOOL KIT

B14. BOARD & SKATE ACCESS

Goal

- Enhance skateboard and foot skate access throughout station areas.

Actions

- Review land development codes and other County and municipal regulations that prohibit the use of responsible skateboarders and foot skaters in public spaces.
- Regulate only against destructive use of skateboards and foot skates (grinding) or uses that may endanger pedestrians, including a variety of tricks including flips, rotations, and ollies.
- Where necessary, install decorative skateboard deterrent structures on walls, rails, benches, planters, and fountains to prevent grinding.
- Coordinate with communities and County or municipal parks departments to plan and program skate parks in the compact urban communities of the SMART Corridors to alleviate use of public pedestrian pathways for skateboard and foot skate tricks, and BMX-type bicycle stunt riding.

Criteria:

- Access to all public realm spaces and all public establishments by skateboards and foot skaters.

Improvements

- Land development code amendments
- Other regulatory amendments
- Benches for changing from foot skates to shoes

Timeframe

- Short Term: code amendments
- Midterm and on-going to implement along with redevelopment and implementation of other FLM modal strategies

Funding

- Minimum funding requirement for regulatory amendments
- Benches coordinated with other streetscape improvements
- Skateboard deterrent structures included with design of new facilities and can be part of O&M for existing facilities
- Skate parks are should be programmed in parks components of CIPs where needed

Commuting by Skateboard

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VEHICULAR FLM STRATEGIES

VEHICULAR FLM OPTIONS

Walking is the primary FLM, bicycles are the most efficient from an energy perspective. The vehicular options are the most common and readily implementable. Many of the vehicular strategies occur with little government participation because the existing roadway infrastructure is already in place.

The Vehicular FLM Strategies comprise an expanding modal group that is greatly influenced by technological advances and business model innovation. The technologies that are important to the vehicular modal group as an FLM strategy are particularly in the areas of battery electric propulsion and autonomous guidance. The business models that are important to the vehicular modal group as an FLM strategy, are commercial carsharing in its various forms.

This FLM modal strategy groups these vehicle types, propulsion types, guidance and business models.

- Park-and-Ride, & Kiss-and-Ride
- Park-and-Ride, Plug-In Electric (PEV)
- Neighborhood Electric Vehicles (NEV), Urban Electric Cars
- Car Sharing: Commercial Pod-based, Free Floating, Station Cars, and Peer-to-Peer Networks
- Ride Sharing & Traditional Taxi
- Autonomous Vehicles (AV) Station Cars

Although widely variant in technologies and business models, the critical similarities that distinguish this FLM group are:

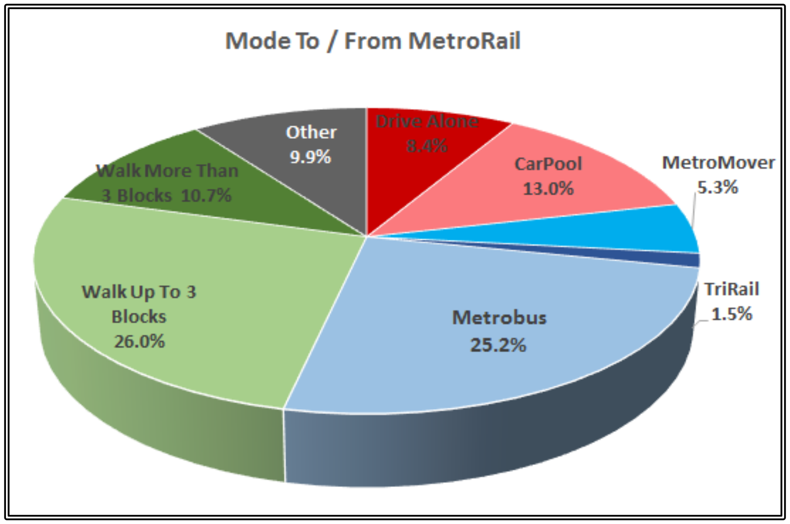
- use of small, multi passenger vehicles;
- route flexibility;
- complete user control of time on FLM mode;
- direct travel for the home-to-transit-station or transit-station-to-destination linked trips; and
- use of the existing roadway network.

Point-to-point travel is a key characteristic in FLM modal choices. With Vehicular FLM options, the transit traveler may or may not be the driver and does not need to have ownership of the vehicle, yet still retains control of time on the mode, direct travel or trip-chaining, other riders, and to some extent, the route to/from the transit station.

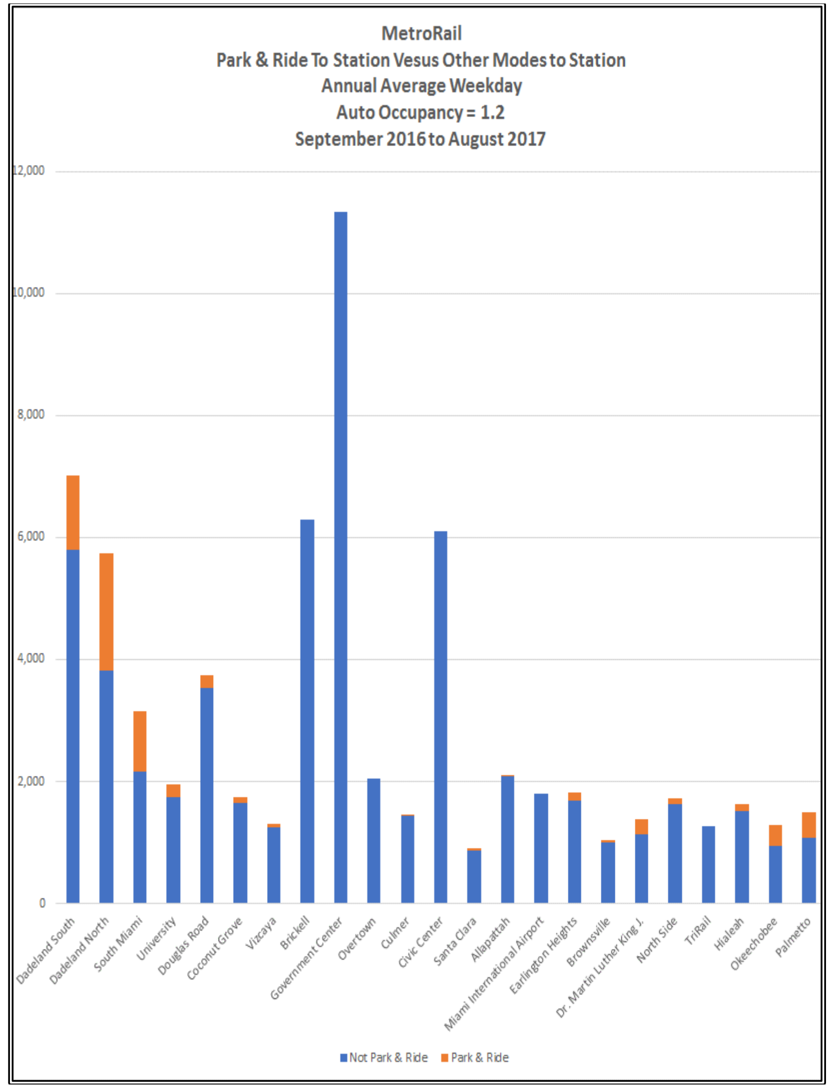
Autonomous vehicle as a station car at employment center conceptual sketch

PARK-and-RIDE, & KISS-and-RIDE

Park-and-ride is one of the most common vehicular modes for transit-linked FLM trips. Based on passenger surveys performed for Miami Dade MetroRail,[32] over 21-percent of system-wide riders arrive and leave MetroRail as part of a chained trip by private automobile. Eight-percent drive alone and park-and-ride, and 13% carpool and are either dropped-off ("Kiss-and-Ride") or park and all vehicle occupants enter the station.



The majority of the activity occurs at a few stations as shown by the station ridership and parking utilization chart.[33] While many of the MetroRail station park-and-rides are underutilized, some of the key park-and-ride locations operate near and sometimes overcapacity.



[32] Center for Urban Transportation Research (CUTR), MetroRail Comprehensive Transit Operational Analysis for Miami-Dade Transit, 2004. Miami Dade Transit, MetroRail Survey, 2009.

[33] Miami Dade County, Ridership Technical Reports; September 2016 through August 2017

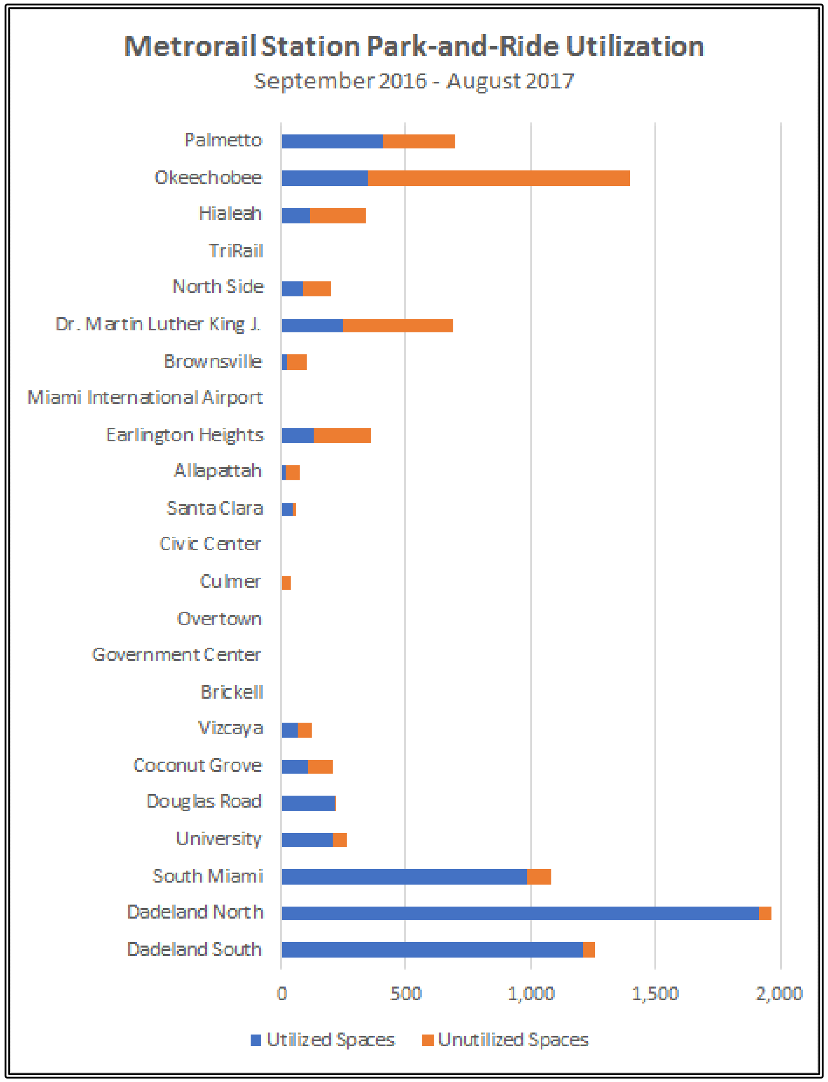
Forecasting the demand for parking at SMART Corridor primary transit stations is a part of a network modeling process, and would be part of the ridership demand estimates for each SMART Plan station. Factors include the primary transit mode, roadway network utilization and home, work and destination activity trip generation throughout the region.

The figure at right shows parking utilization for the existing MetroRail facilities. Utilization is not unilaterally dependent on level of development at the station area, parking capacity, or access to highways. For example, there are four stations in the system with direct highway access, yet each has varying utilization rates.

Park-and-Rides with Direct Highway Access

Palmetto	58% utilization,	1,048 parked	29min to CBD
Okeechobee	25% utilization,	293 parked	26min to CBD
Earlington Heights	36% utilization,	231 parked	11min to CBD
Dadeland North	97% utilization,	1,963 parked	17min to CBD

Understanding the patterns of park-and-ride utilization is complex, and related to regional congestion and development patterns. For example, the GIS graphic on the next page shows the patterns of park-and-ride draw for the Dadeland South MetroRail Station, the largest and most highly utilized park-and-ride in the system. Utilization is high, the parking is combined with retail development with some TOD residential, and there is direct access from the highway network. The distribution of home origins for these park and riders[34] shows a pattern associated with the highway network (Shula Expressway); however, there is also a strong pattern that is apparently associated with latent transit demand along the Kendall Corridor and US-1.

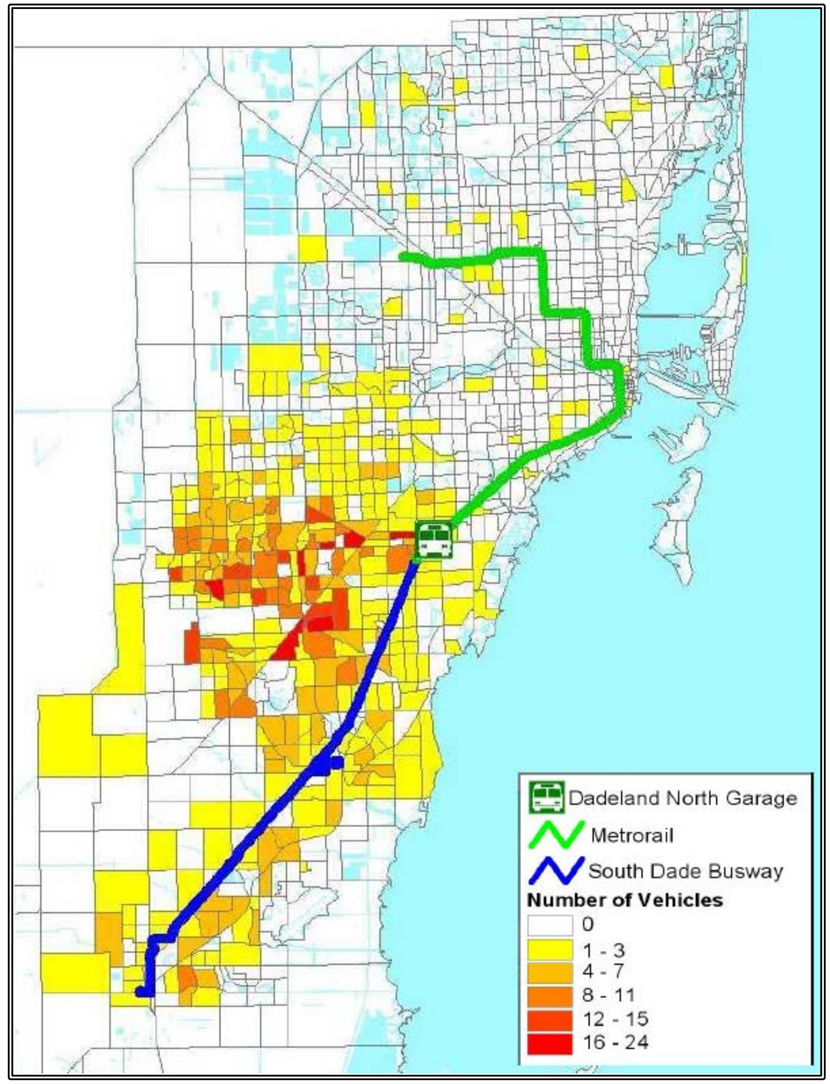


[34] South Dade Busway Feeder Study, Miami Dade Transit, Lehman Center for Urban Transportation Research, 2008.

When locating and designing park and ride facilities for a station, the typical approach is to construct a simple parking field or multi-level parking ramp; however, in the context of TOD development where parking fields conflict with pedestrian access, and multi-level ramps replace transit-oriented development, a more considered and holistic approach is needed. It is preferable to outline a framework for addressing the issues based on local ridership rate expectations, highest-and-best TOD uses, and construction costs. Some of the issues include:

- What is the anticipated transit shed for park-and-ride or kiss-and-ride transit riders? (requires regional transportation modeling)
- How is primary transit ridership affected by alternatives for the station site developable area: parking, residential, office or retail?
- How intense would TOD development need to be to provide the equivalent rail ridership of surface parking?
- What is the full cost of providing surface and structured parking?
- At what land value does structured parking become economical?

While the distribution of home origins exhibits a pattern along the highway network and latent transit demand corridors, the distribution of home origins for Kiss-and-Ride to Metrorail (next page) shows weaker patterning. In both cases the distances for driving alone or in a carpool range from within 2 miles of the station to more than 20 miles. The average is in the range of 5 to 10 miles for this urban area.



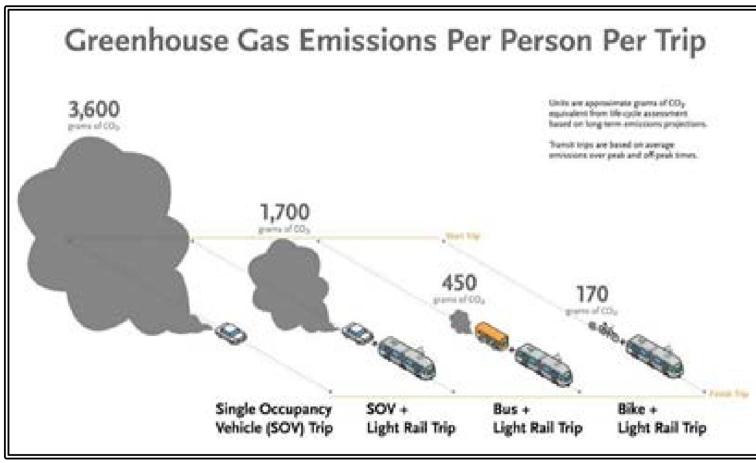
Dadeland North Park-and-Ride Home Origins
Example of highly utilized park-and-ride home origin pattern
Source: South Dade Busway Feeder Study, Miami Dade Transit, Lehman Center for Transportation Research, FIU, 2007

What is important about both Park-and-Ride and Kiss-and-Ride as transit-linked trips, is that the average distances are greater than the 2-mile focus which is typically of concern for urban FLM.

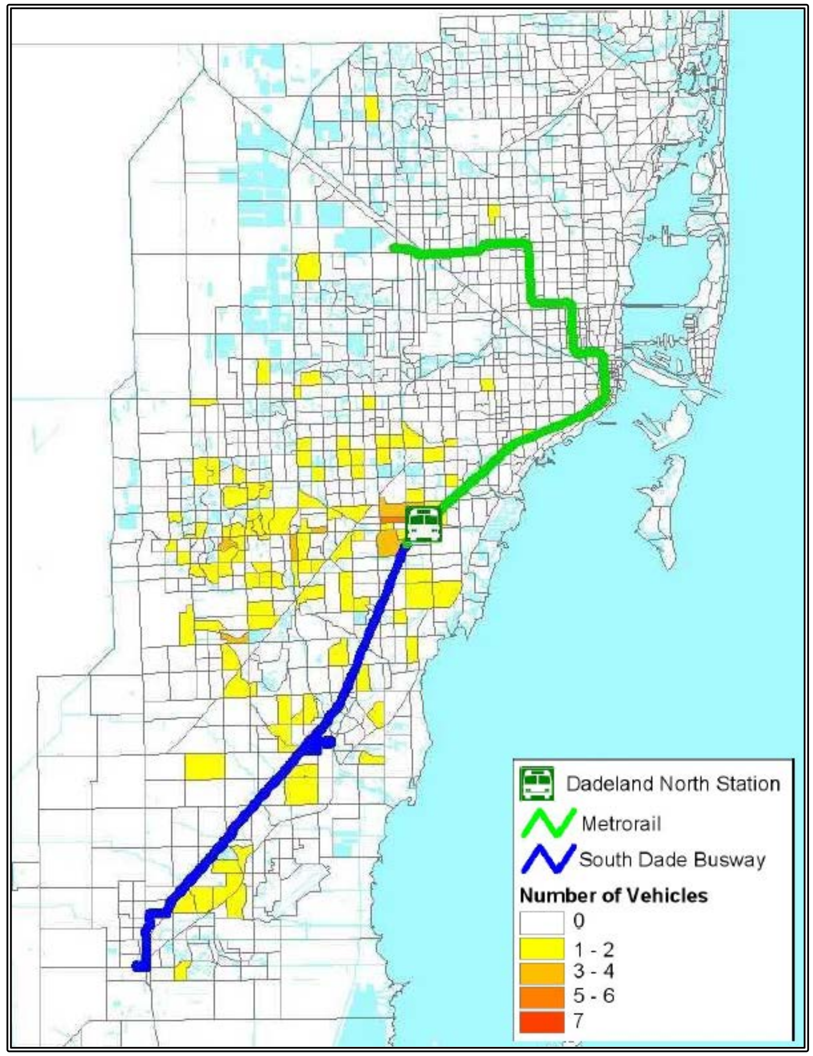
For the purposes of FLM, it is most important that planning for station parking is holistically considered as an alternative to station area TOD, and that where a demand for parking is justifiable, design of the parking is integrated into the TOD and does not impede pedestrian, bicycle, board or skate modes.

Drop-off and pick-up areas should be planned for shared use with other vehicular strategies, but must also be carefully designed not impede pedestrian, bicycle, board or skate modes.

While Park-and-Ride does increase transit utilization compared with other FLM strategies, it still should be prioritized lower than other FLM modes since it represents the least benefit in terms of TOD viability, sustainability, VMT, and GHG emissions.



[35]



Dadeland North Kiss-and-Ride Home Origins
Example of highly utilized kiss-and-ride home origin pattern
Source: South Dade Busway Feeder Study, Miami Dade Transit, Lehman Center for Transportation Research, FIU, 2007

[35] Mikhail Chester et al, Infrastructure and Automobile Shifts: Positioning Transit to Reduce Life Cycle Environmental Impacts for Urban Sustainability Goals , Environmental Research Letters 8, no. 1, 2013

PARK-and-RIDE for PLUG-IN ELECTRIC VEHICLES

The use of personal vehicles for transit-linked trips by using park and ride creates less benefit than other FLM strategies in terms of TOD viability, sustainability, VMT, and GHG emissions among the transit-linked FLM strategies; however, non-point-source GHG emissions may be reduced, depending on GHG impacts of the region's electric power generation. (For Dade, Broward and Palm Beach counties, approximately 60% of electric energy is generated by natural gas and petroleum; 39% is nuclear, and 1% is by renewables.)[36]

The objective to enhance the use of EV for transit-linked park-and-ride are to reduce some of the barriers to consumers purchasing or leasing electric vehicles. Barriers for earlier adopters include: purchase cost; depreciation and maintenance costs; obsolescence; fuel cost; range anxiety; recharging convenience; and product experience. Park-and-ride recharging stations address two of these barriers:

1) Range Anxiety: This is a major barrier to EV adoption for plug-in electric vehicles (PEV) (not hybrids). While manufacturers have designed range performance to match or exceed the daily requirements for most urban daily commuters, there is still consumer anxiety toward not having sufficient energy for necessary daily trips, or prematurely running out of energy due to weather or traffic conditions.
2) Recharging Convenience: The primary point of recharging for EV and is intended to be at home, at night when most EV users are not traveling, electric rates are lower, and more unused grid capacity is available. Additionally, the location of highly-visible public PEV recharging stations is practical at destinations where the vehicle will be parked for long durations. Transit station parking duration for a commuter is typically more than sufficient for recharging if this reduces range anxiety.

Criteria used to locate EV charging spaces were identified for South Corridor Metrorail stations, and include:[37]

- Parking should be as close as possible to an existing electrical panel with sufficient power capacity.
- Minimize disturbance to existing facilities and infrastructure as the amount and complexity of the installation affects cost, including: cutting, trenching, and drilling to add new conduit.
- Lighting is an important consideration in siting EV charging in public areas. Adequate lighting is needed for security, convenience, and safety to read associated signs, instructions or controls.

Rail Station Park-and-Ride Electric Vehicle Charging Space

[36] US Energy Information Administration, State Profiles and Energy Estimates, 2017

[37] Drive Electric Florida, Southeast Florida Electric Vehicle and Infrastructure Alliance, 2013

NEIGHBORHOOD ELECTRIC VEHICLES, NON-AUTONOMOUS

Building on the case for electric vehicles for FLM park-and-ride and kiss-and-ride strategies, the use of Neighborhood Electric Vehicles (NEV) can provide great benefit among transit-linked FLM strategies in terms of TOD viability, sustainability, reduction of regional VMT and GHG emissions. The concept of micro cars for low-speed, urban trips is an important mobility strategy in older European centers where street space and parking are constrained.

1958 BMW Isetta Micro Cars

In addition to the traditional benefits of micro cars being small, with the sustainability advantages of battery-electric power, NEVs are also the focus of ground-up development as autonomous vehicles that will serve FLM and local mobility needs for different delivery models: personal ownership, shared, for hire with or without driver.

A Neighborhood Electric Vehicle is powered vehicle built to have a top speed of 25 miles per hour and a maximum loaded weight of 3,000 pounds. They are legally limited to roads with posted speed limits of 45 miles per hour or less. NEVs fall under the United States Department of Transportation (USDOT) classification for low-speed vehicles. To satisfy federal safety requirements, NEVs must be equipped with three-point seat belts or a lap belt, running lights, headlights, brake lights, reflectors, rear view mirrors, and turn signals.[38] Windshield wipers are not required. Doors are optional. NEVs in current use span a variety of mobility business models from local taxi services, through sharing models, and most commonly for personal use. Often owned by multi-car households, they are typically used for local mobility, being considered to provide enhanced parking convenience and access.

For FLM purposes, their range between recharges (generally about 30 miles, and higher for some models with optional battery capacity) is more than sufficient to serve the transit supportive area; however, station parking recharge points can be beneficial. As for other vehicular FLM strategies, their primary benefit is beyond the ¼-mile Transit Core.

GEM NEV (left), and Renault Twizy (right)

[38] US Department of Transportation, National Highway Traffic Safety Administration 49 CFR Part 571, Federal Motor Vehicle Safety Standards, 1998

NEVs are most common in communities that provide separate routes for them or generally accommodate slow speed traffic on their roadway networks. Some communities design specifically to accommodate NEVs

Typical design changes to accommodate NEVs include:

- Rule-making, and code revisions to accommodate the use of golf carts and NEVs on the roadway network;
- Tunnels or bridges to connect the low-speed vehicle network across high-speed roadways
- Off-road trail access where trail capacity is sufficient for 3,000-pound gross vehicle weight
- On-street parking regulation modification to allow more efficient 90-degree parking on a parallel parking lane for NEVs under 8-ft in length.
- Off-street parking modifications that favor more efficient parking of narrower, more maneuverable and generally shorter NEVs.

NEV 90-degree parking in The Villages, Florida

As an example in Miami-Dade County, The Village of Key Biscayne specifically permits golf carts and NEV to use the Village roadway network in mixed traffic. It adopted the following rules:

1. The golf cart must be registered with the Village of Key Biscayne, and have a valid permit affixed to the golf cart.
2. Any person who drives a golf cart must possess a valid operator's license (not a restricted license) and be at least 16 years of age.
3. Any person who drives a golf cart must comply with all applicable state laws regarding the requirements and usage of safety belts and child restraint equipment.
4. Golf carts are not allowed on sidewalks, bike paths or beaches.
5. Golf carts are not allowed inside the Village Green or any other park within the Village, with the exception of authorized maintenance vehicles.
6. Any person who drives a golf cart must obey all local and state traffic laws, including parking regulatlons.
7. Golf carts are not allowed on Crandon Boulevard with the exception of traveling from one intersection to the next immediate intersection.
8. Golf carts may not carry more passengers than the maximum number for which the golf cart was designed.
9. Golf carts must be equipped with headlights and windshield if operated between the hours of sunset and sunrise.
10. Golf cart owners must comply with applicable state laws pertaining to insurance requirements and Village regulations provided for new registrations.

The Villages NEV Bridge of US-27 / US-441

NEV on off-road light duty bridge along multi-user trail

Tango NEV parked at 90-degrees in urban street

TPO
Miami-Dade Transportation Planning Organization

CAR SHARING

> ***"The automotive industry is undergoing a profound change that will completely reimagine mobility, says Michael Ronen, head of the Goldman Sachs Investment Banking Auto 2.0 team. The transformation of cars into electric and fully autonomous vehicles in the coming years, combined with the business model shift from car ownership to utilizing the shared economy will upend the auto industry, with implications for the finance, insurance and real estate sectors."***
> *Michael Ronen, Head, Goldman Sachs Investment Banking Auto 2.0 Team*

Car sharing defines a range of short-term, urban car rental programs in which vehicles are dispersed in unstaffed, public locations for use by prequalified mobility consumers with little or no reservation lead time. The vehicles may belong to a co-op form of organization, to the program of a non-profit, non-government organization, or the vehicles may be fleet assets of a commercial vendor for which users are prequalified customers.

The services are designed to meet various niche mobility needs of people in urban areas and thereby also enhances the range, utility, and share for other urban, alternative transportation modes. Having emerged from initial US market experimentation over a decade ago and more recently undergone significant growth and diversification, car sharing is now established in many metropolitan markets as a sustainable, unsubsidized transportation services by non-government operators. As it creates new mobility value networks, car sharing will continue to grow and play a large role in the advancement of sustainable urban transportation, and FLM transit-linked trips.

Car sharing operational characteristics are complimentary to increasing the deployment of a range of key sustaining transportation technologies including hybrid-electric vehicles (HEV), plug-in electric vehicles (EV), intelligent transportation systems (ITS), electric networked vehicle (EN-V) systems, and increased use of bus rapid transit (BRT), urban rail, and suburban rail transit as part of a menu FLM strategies. While supporting accelerated adoption of key components of sustainable urban transportation systems, it is the wide-spread adoption of three communication technologies that have supported the rapid growth of car sharing: the wide-spread adoption of smart phones; in-vehicle networked communication and GPS technologies; and the ability for car sharing operators to network to their vehicles' on board diagnostic data (OBD) link connectors to report vehicle availability status in real time.

Car sharing has its roots in numerous short-lived programs starting as far back as 1948, when a car share program was part of a housing cooperative in Zurich, Switzerland. Through the early 1980s, other limited car sharing programs were operated in France, Holland, Britain, and Sweden. In the US, the Mobility Enterprise program was run by Purdue University researchers from 1983 to1986, and in San Francisco, the Short-Term Auto Rental Service (STAR) pilot program operated from 1983 to 1985. In their current form, car sharing programs began in 1987 in Switzerland and a year later in Berlin, Germany.

Car Share Portland (Oregon) was the first large-scale US program to begin in 1988 as a transit-linked-FLM strategy. In 2001, Car Share Portland became part of Flex Car, a public-private partnership with King County Metro in the Seattle area, making Flex Car the first, multi-city program. Also during 2000, Zip Car was founded in Cambridge, Massachusetts, and would grow to become the largest US car sharing operator today. Zip Car merged with Flex Car in 2007, and became a public company in April 2011. During this time, many private companies, community-based organizations, and public private partnerships started national and regional car sharing programs. Some were short lived and are now closed, others were absorbed by larger companies. Today, region or national car share operators (CSO) operate a variety of delivery/business models. Systematic definition of the models is understood by defining first, components of the market.

Market components that describe car sharing from the demand side by an urban mobility consumer's access and location type:

Resident – No Personal Vehicle:

- Meeting regular transportation needs by a combination of walking, bicycling, transit or other high-density modes.
- Use car sharing for niche transportation needs such as weekend recreational and social trips.

Resident - Limited Access to Personal Vehicle:

- Part of households where there are fewer personal vehicles than there are individuals with mobility needs
- Daily travel needs are already met with established mode choices and travel patterns, but many of the occasional needs can also be met with the household vehicle.
- Use of a shared car is limited to times when occasional needs are different and coincide.
- May include college students that live near or on campus in co-living situations in which one or more members of the temporary household owns a car.

Resident - Economic & Personal Choice:

- Unlimited access to a personal vehicle but choose not to use their car in the short term, and/or decided to reduce their auto ownership in the long term by selling their car, or not replacing it at the end of a lease term.
- The owned vehicle is likely to be characterized by a high ratio of variable to fix costs; so it is either an older vehicle, or a vehicle that is inappropriately scaled to the owner's needs and too costly for regular use as a single-occupant vehicle. Based on surveys of car sharing participants in other programs, convenience, often cited as the "hassle of driving" is also a factor for the "choice" car sharing participant.

Employee:

- Have car sharing vehicle(s) available within walking distance from their place of work.
- Commute needs are already met; however, car sharing is used to meet day time errands, lunch, or other social trips.

Employer Program:

- Employees of an employer that has contracted with a CSO.
- Intended trip purposes are generally work related.
- To provide cost effective rates, the CSO includes in the contract the ability to get a double use from the vehicles by making them available to the CSO's public car sharing program before and after the workday.
- The trip purposes are work-related, and durations and trip length may be longer than for other day trip uses.

Hotel Based Visitor

- User is a visitor, whose purpose may be either business or tourist related.
- Visitor arrives in the area by intercity transportation (typically air or possibly rail), not urban transit.
- Decision factors may include:
    - prior membership in the car sharing organization;
    - relative costs of airport long-term rentals versus trip-duration car sharing;
    - convenient availability of car sharing vehicles;
    - cost of hotel parking;
    - cost of visit area parking;
    - inclusion of public parking as car sharing benefit;
    - walkability of the environment;
    - availability and effectiveness of transit or other alternative modes (such as bike sharing programs).

The most important part in defining car sharing models is by the characteristics that the programs have in common, including:

- Short-term rentals to members: Car sharing programs have a basic rate by the hour or ½ hour, and possibly discounted rates for longer periods.
- Neighborhood-based vehicles: Vehicles are located in publicly accessible parking lots or on-street locations called "pods" which are strategically located in close proximity to neighborhoods, employment centers, commercial districts, university campuses, military bases, and concentrations of residents with low personal vehicle availability.
- Streamlined reservations: Reservations are made by the CSO website or smart phone app with little advance, and available cars are picked up directly. Streamlining reservations is made possible by membership, for which users are pre-qualified.
- Personalized vehicle access: Members access vehicles with electronic membership cards or key fobs and a windshield mounted card reader.
- Inclusive service package: to provide an appealing pricing system, car sharing programs include fuel costs, insurance, roadside assistance, mileages up to a daily limit, and may include amenities such as on-board GPS navigation system, concierge service, and pre-paid on-street parking.

CAR SHARING MODELS

Car Sharing models are broadly identified as one of 5 types: 1) Pod Based 2-Way Car-Sharing; 2) Free Floating 1-Way Car Sharing; 3) Institutional Fleet Programs; 4) Station Cars; and 5) Peer-To-Peer. Some of the operational models respond to distinct market components, while some are designed to respond to multiple market segments.

1. **Pod-Based 2-Way Car Sharing**: Two-way car sharing has been and continues to be the dominant car sharing supply model. One or more vehicles are placed in a "pod" at a publicly accessible location for use by car sharing members that belong to the program. A program typically has many pods, with each being located based on residential density or commercial land use intensity, the availability of space, and other CSO-proprietary criteria. The pod must be placed within comfortable walking distance of the market that it is intended to serve. The salient feature is that the user must return the vehicle to the pod, and usage charges accrue until the vehicle is returned. Even down time while the vehicle is parked at the user's destination is

charged.

The 2-way pod model includes placements at specialized markets as well general public locations, including:

a) Residential Neighborhoods - target market is the nearby residential neighborhood(s)

b) Residential Multifamily Units - target market is the building or planned development

c) Commercial Districts - target markets are employees, commercial patrons, and adjacent residents

d) Transit Stations - If a commercial or mixed-use district includes transit stations, the pods may also augment transit trips by completing the last mile.

e) College Campuses - target markets are on-campus resident students: a market of early adopters, with occasional and flexible travel needs and low private vehicle availability.

f) Military Installations - target market is active duty personnel with characteristics similar to on-campus students.

g) Hotels - target markets are business and leisure visitors

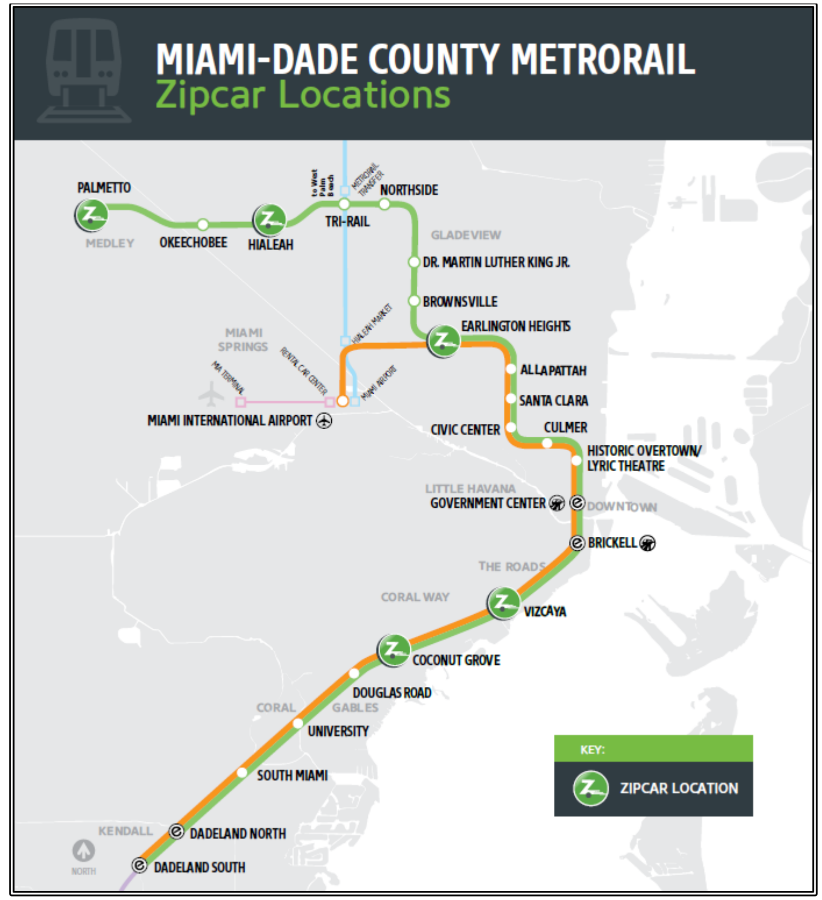
h) Airports - target markets are business and leisure visitors as a limited one-way service to facilitate flight changes.

The Pod-Based Car Sharing model is well suited as a transit-linked FLM strategy if spaces are reserved at the station; however, they meet the needs of more occasional users more than commuters.

Pod-Based Car Sharing at DART Light Rail Station with dedicated spaces Dallas, TX

***Transit-Linked, Pod-Based 2-Way Car Sharing in Miami-Dade County*:**

On August 25, 2017 Miami-Dade County and Zipcar, the world's leading car-sharing network, announced a new partnership to add Zipcars to five Metrorail stations, providing transit riders with on-demand access to vehicles parked at train stops. The partnership seeks to increase the number of sustainable mobility options throughout Miami-Dade County. Ten Zipcars are available for reservation along the green and orange lines at five Metrorail Stations: Vizcaya Station, Coconut Grove Station, Palmetto Station, Hialeah Station, and the Earlington Heights Station.



Miami Dade MetroRail Station Zip Car Locations

2. **Free-Floating 1-Way Car Sharing**: One-way car sharing is a more recent car sharing operational innovation; with deployment aggressively under expansion by the chief international CSO (Car 2 Go) that uses it. Vehicles are placed throughout a defined “home area”, typically in high visibility locations that are on-street. Members of the program rent the vehicle from the location of the nearest vehicle to their current location. The usage time and charges can be stopped at any destination within the home area by parking and signing out. From destinations outside of the home area, the user must return the vehicle to any location within the home area. Cars are initially and periodically “placed” as part of system maintenance; however, the chain of subsequent availabilities are based on relocation by consumers. The term, “natural gravitation” is used by the CSO to describe a geographic self-organizing phenomenon that the model exhibits when utilization is high. While vehicles are initially placed by the CSO in along busy corridors and high-density districts, after use the vehicles may be left for overnight periods on quiet neighborhood streets. The natural gravitation effect is that if utilization is high enough, vehicles will be in places where they are needed without managed placement.

   One of the major consumer advantages of this model in addition to one-way trip making is that the rental fee typically includes free on-street parking at any legal on-street space, metered or not. In the case of the Car-2-Go, the app for finding, reserving, and using the cars is also highly integrated with ride-sharing, and transit system schedules.

The Free-Floating 1-Way Car Sharing model is well suited to meet the needs of occasional transit riders and commuters. Although not essential, dedicated parking spaces at the station are beneficial.

Free-floating car share model, Car 2 Go, parked on-street in Wynwood, Miami is available for use. Car 2 Go exclusively uses Smart Cars (Car 2 Go is a part of Daimler AG). In 2017, Car 2 Go closed its Miami operation, but continues global expansion in other metropolitan areas.

3. **Institutional Fleet Programs**: As car sharing resources become more available in regional markets throughout the country, large businesses, local governments and government agencies have adopted car sharing as a tool to better meet internal cost and efficiency goals, while also enhancing social responsibility objectives and environmental sustainability goals. In some cases, government participation has been used to enhance initial program viability in new markets by providing a base minimum utilization for a CSO's local fleet. Employer programs work by guaranteeing a minimum weekday day use level for the program, while off-peak weekday and weekend use markets can grow for the residential or other markets.

The Institutional Fleet Car Sharing model is supportive of transit-linked FLM by providing mobility for the more varied daily at-work trips; however, it is not a direct FLM unless cars are visible and within short walking distance of the transit station.

4. **Station Cars:** In the same way as the fleet programs, station cars double-up on utilization by addressing two distinct markets. The shared transfer point for this car sharing approach is always a transit station, a property typically managed by a public agency. The station car models have also been successfully used with bicycles and low speed electric vehicles. There are two ways that a station car program may operate:

    a) A member of the program arrives at the transit station in the morning and uses a station car to complete her trip to work. At the work location, the station car is available as a car sharing vehicle to short term day users either through an employment center-based 2-way pod model, or through a fleet model. All short trips must be coordinated to assure availability at the end of the day for commuter members who reuse a station car to return to the transit station.

    b) An assigned commuter member of the program arrives at the transit station in the morning with the station car, and uses transit to complete the trip to work, the location of which is within walking distance of the destination transit station. At the origin transit station, the station car is available for short term day uses with the station location as the car-sharing pod. Both stations are co-located within walking distance of centers of employment and day commerce: a condition which should be typical for many high-density transit stations, especially heavy rail systems. At the end of the work-day, car day users are done, and the station car is available again for the commuter to go home. Typically, the commuter is an assigned program member with a long-term contract.

The advantages of station cars are higher utilization for the shared vehicles, increased mode share for the transit system, and the ability to integrate payments with transit passes; however, station cars require greater levels of management and coordination by a CSO, as well as the inclusion of additional programs such as guaranteed ride home.

The Station Car Sharing model is one of the best suited models for transit-linked commuter trips. Dedicated spaces, and a higher level of coordination and management is essential. This model can also be easily used with NEVs.

5. **Peer-To-Peer (PTP)**: PTP car sharing programs do not own or maintain vehicles. Members variously can be users or suppliers of vehicles, or both. Member-owners own, store and maintain personal vehicles that they make available for car-sharing user members. The PTP CSOs, utilizing principals of collaborative consumption (similar to Ebay or Craigslist concept of PTP with feedback), provide only network and intangible resources to manage and coordinate the PTP transactions and provide uniform insurance coverage. Pricing, schedules, pick-up and drop-off locations, refueling, and other conditions are set during individual transactions via the PTP network.

The Peer-To-Peer Car Sharing model is supportive of transit-linked FLM by providing potential FLM mobility trips; however, it is not a direct FLM with any visibility of cars or infrastructure at primary transit stations. Although PTP models promise to become major components of car sharing, for the purposes of FLM planning, PTP models have no identifiable infrastructure needs.

Transit Integration Trends

Car sharing is an expanding niche mobility mode that facilitates short-duration, occasional, urban trips. As a distinct urban transportation mode, it is best suited to accommodating very diverse, low-density (few people per vehicle) trips with high geographic dispersion in an urban area (doorstep to doorstep). This is part of the definition for FLM trip patterns.

Urban mass transit systems are best suited for the opposite characteristics: accommodating systematic and regular patterns of travel in high density vehicles, with low geographic dispersion.

These characteristics define a very complimentary potential between car sharing and transit systems, as car sharing can be used to accommodate the FLM for transit system users. In a similar way to other networks, when transit systems try to move away from trunk line services and accommodate service in low density, low utilization areas, the whole system suffers. Because of this, it should be expected that the growth of car sharing has and continues to be accompanied by transit integration.

Historically, integration of car sharing programs with regional transit services and properties has been in one of four forms:

1) Co-location of car sharing at transit stations (usually rail, both urban and commuter systems);
2) Transit fare ticketing and car sharing program discounts;
3) Transit pass and car sharing program billing integration;
4) Station car programs.

RIDE SHARING & TRADITONAL TAXI

TAXI:

A taxi, taxicab or cab is a vehicle for hire with a driver used by one or more passengers up to a small group, often for a non-shared ride. It is a business-to-consumer service model. Taxis convey passengers between locations of their choice. For other modes of public transit, or any other FLM modes where the vehicle is shared, the pick-up and usually the drop off locations are determined by the service provider. Traditionally, taxis charge flat rates or metered rates that include mileage, time, waiting time, and special access fees at certain destinations such as airports. Rates are typically regulated by local jurisdictions. In some locations, taxis are permitted to "cruise" and pick up passengers that hail them from the street side. Otherwise, they are called via a dispatcher to a customer whom uses a phone (voice communication), internet or smartphone app to call the taxi for pick-up.

Ride-Sharing occurs through two models:

CARPOOLING

Carpooling is the sharing of private vehicular journeys so that more than one person travels in a car. Vanpools are similar, with the only difference that a van is used to carry more passengers, and the van is often provided at a reduced monthly rate to the driver. Drivers and passengers offer or search for trips through an organizing medium. After finding a match they contact each other to arrange costs, meeting points and times.

Carpooling is commonly implemented for commuting but is also popular for longer one-off journeys. Carpool commuting is more popular for people who work in places with more jobs nearby, and live in places with higher residential densities.[39]

Carpooling is significantly correlated with transport operating costs, commute length, and social benefits such as time spent with others; however, carpooling is significantly less likely to be used by people who spend more time at work, older workers, and homeowners.

Carpooling is often incentivized, organized, and/or facilitated by government and non-government organizations (NGO). One of the primary car-pool organizers in the South Florida region is the South Florida Commuter Services (SFCS), that helps promote ride sharing options for commuters in Monroe, Miami-Dade, Broward, Palm Beach, Martin and St. Lucie Counties. Founded in 1988 by the Florida Department of Transportation (FDOT) as a public information office during the I-95 expansion, the SFCS program evolved to provide commuter information for facilitation of carpooling.

[39] Nathan Belz and Brian Lee. Composition of Vehicle Occupancy for Journey-To-Work Trips: Evidence of Ridesharing from the 2009 National Household Travel Survey Vermont Add-on Sample. Transportation Research Board 2012.

TRANSPORTATION NETWORK RIDESHARING / RIDE-SOURCING (Uber, Lyft, etc.)

Transportation Network Ride Sharing: (Uber, Lyft) are services that arrange one-time shared rides on very short notice. As a type of carpooling, it makes use of three communications innovations that have in recent years become ubiquitous:

- GPS navigation to determine a driver's route, the passenger's location and arrange the shared ride;
- Smartphones for a traveler to request a ride;
- Social networks to establish trust and accountability.

The network service coordinates these assets using shortest travel time optimization algorithms, and transfers payments between the driver and passenger.

Like carpooling, real-time transportation network ridesharing can serve areas not covered by a public transit system and can act as a demand-responsive, low capacity (in a single car) transit feeder service.

Some transportation experts call these services "ridesourcing" to clarify that drivers do not share a destination with their passengers, with the app simply outsourcing rides to semi-commercial drivers, similar to taxis except that the driver is ostensibly, not a full time professional driver. It has become controversial, often criticized for drivers lacking adequate regulation, insurance, licensure, and training. Opposition also comes from taxi companies and public transit operators for whom it is seen as an unfair and unregulated alternative that diminishes their market.

As an FLM strategy, the key issue is whether ride-sourcing complements or competes with public transit, and how to define systematic criteria for deciding whether it is substitution or complementary to transit.

From a consumer perspective, a survey conducted in the San Francisco Bay Area[40] questioned the distinctions between taxi and ride-sourcing. Although taxis and ride-sourcing share similarities, the findings show differences in users and the user experience.

- Ride-sourcing wait times are markedly shorter and more consistent than those of taxis.
- Ride-sourcing users tend to be younger, own fewer vehicles and more frequently travel with companions.
- Like taxis, it appears to both substitute for and complement public transit; the majority of ride-sourcing trips would have taken substantially longer if made by public transit.
- Impacts on overall vehicle travel are unclear.

As an FLM strategy, the key issue is whether ride-sourcing complements or competes with public transit, and how to define systematic criteria for deciding whether it is substitution or complementary to transit.

[40] Rayle, L., S. Shaheen, N. Chan, D. Dai, and R. Cervero. App-Based, On-Demand Ride Services: Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco. University of California Transportation Center, 2014.

TAXIS, CARPOOLING, AND TRANSPORTATION NETWORK RIDES-SOURCING SUMMARY FOR FLM

- Ride-sharing in any of its three delivery models are major components of transit-linked FLM planning.
- It is not clear that they complement or substitute for transit trips; however, as with other FLM strategies, this may vary depending on the primary transit mode and the length of the trip. For longer trips on faster primary transit modes, ride-sharing is more appealing as an FLM strategy. For shorter trips, and/or where primary transit modes run at slow travel speeds, high delay, and low travel time reliability, then ride-sharing morphs from FLM to a single mode unchained trip.
- Car sharing business models are self-supporting and work at a range of economies of scale with purported economic benefit to the community overall.
- They show evidence of supporting several public benefits, regardless of their impact on transit ridership. At minimum, they clearly have an impact on personal auto ownership in urban areas, which is an important objective. Whether they favorably impact mass transit is not well defined; however, since trips are point of origin to point of access, they reduce VMT and GHG for parking search, and reduce the area of a TOD that is inefficiently used for parking inventories.
- These models are very much self-supporting of mobility needs with little identifiable infrastructure or programmatic needs other than policy support, seamless information integration, and provision of safe pick-up and drop-off spaces at the primary transit station and throughout the station areas.

AUTONOMOUS VEHICLES

Autonomous Vehicle (AV) technology offers the possibility of fundamentally changing transportation. Equipping automotive vehicles with new technology will likely reduce crashes, energy consumption, pollution, and the cost of congestion. This technology is most easily conceptualized using a five-part continuum suggested by the National Highway Traffic Safety Administration (NHTSA), with different benefits of the technology realized at different levels of automation:

- Level 0: The human driver is in complete control of all functions of the car.
- Level 1: One driving function is automated.
- Level 2: More than one driving function is simultaneously automated, such as steering and acceleration, but the driver must remain constantly attentive.
- Level 3: All driving functions are sufficiently automated that the driver can safely engage in other activities.
- Level 4: The car can drive itself without a human driver.

How quickly AV will penetrate the market depends greatly on the level of automation. Levels 1 and 2 are already in use by innovators and early adapters and are progressing to the early majority. For Levels 3 and 4, where a driver relinquishes some or all control, there are still considerable barriers to adaption. Estimates for wide-spread acceptance range from 15 to 60 years. In a study conducted by the American Automobile Association, three-fourths of U.S. drivers reported feeling “afraid” to ride in a self-driving car. Only one-in-five people surveyed said they would trust an autonomous vehicle to drive itself. On the other hand, the survey revealed that consumer demand for semi-autonomous vehicle technology is high for reasons of increased safety, convenience, and stress reduction.

The benefits for general mobility include:

<u>Safety:</u> The Insurance Institute for Highway Safety (IIHS) estimated that if all vehicles had forward-collision and lane-departure warning systems, side-view (blind spot) assist, and adaptive headlights, nearly a third of crashes and fatalities could be prevented (IIHS, 2010). Level 4 AV systems would further reduce accidents.

<u>Mobility</u>: Level 4 AV technology would enable transportation for the blind, driving disabled, driving impaired or those too young to drive, providing these groups with greater independence, access to essential services and social integration.

<u>Traffic Congestion</u>: Level 3 or higher is likely to substantially reduce the cost of congestion at the system level by reducing traffic delay time, improving roadway network operational efficiency, and reducing inefficient vehicle platooning.

<u>Roadway Capacity</u>: Level 3 or higher can increasing the throughput (capacity) of existing roadways by reduction of vehicle spacing and delay time, and by allowing lane widths to be reduced, freeing additional cross-sectional width for additional vehicle lanes or supporting the development of a complete bike network with buffered bike lanes. Either way, the capacity of the roadway network is increased in terms of people trips. *This requires amended policy to realistically use people trips as the universal roadway capacity measure.*

<u>Energy and Emissions</u>: The overall effect of AV technology on transportation energy use, GHG emissions and other pollutants is to decrease them for internal combustion engine powered vehicles vis-

à-vis the effects to reduce congestion, delay time, and idling time. AV technology can also improve fuel economy by four to ten percent by accelerating and decelerating more smoothly than a human driver. For electric vehicles, the benefit is less since EV technology already reduces point-sourced emissions to zero. Even with this, AV technology decreases the use of stored battery energy and increases range for a given charge. From a systems perspective, AV technology will decrease the demand for transportation electricity, and if utility electricity generation can respond to this efficiency over the long term, then AV helps to reduce emissions for EV also.

AV Impact on Transit-Linked FLM Mobility: The impact of AV is expected to improve the viability of vehicular FLM among three Vehicular FLM strategies.

Park-and-Ride: for the FLM where a person simply prefers to drive their own car to a transit station and park, the presence of AV technologies would be increased safety and decreases costs. To the extent that widespread AV uses reduces travel time, there is a potential for increased FLM transit-linked trips by this strategy. In addition, the ability for the driver to become a "left-seat passenger" and engage in other more enjoyable or productive activities will also increase the potential for increase in FLM transit-linked trips by this strategy. A travel-market study among Millennials noted the importance of continuous and unbroken on-line connectivity as a key characteristic to induce preference for transit trip making.[41]

Ride-Sharing and Taxi: for ride-sharing as an FLM strategy, the impact of AV is similar to park-and-ride. The presence of AV technologies would be increased safety and decreases costs. To the extent that widespread AV uses reduces travel time, there is a potential for increased FLM transit-linked trips by this strategy. Further, the AV technology can be integrated into the ride-sharing network technologies to allow more seamless integration and greater efficiencies of time, cost, network congestion and emissions reduction as the AV assists in real time to pick shortest path, shortest time, and highest occupancy optimizations as the AV runs a FLM tour to and from the transit station.

Car-Sharing: is currently not as prevalent as ride-sharing, but is expected to become on par with ride-sharing with the penetration of AVs. The impact of AV on car sharing is the same as with one key addition: the ability to fully realize the potential for station cars. The presence of AV for car-sharing will: increased safety; and allow more seamless integration and greater efficiencies of time, cost, network congestion and emissions reduction as the AV assists in real time to pick shortest path, shortest time, and highest occupancy optimizations as the AV runs a FLM tour to the transit station.

Station Car: In addition to the benefits of AV on car-sharing models in general, the integration of AV into the Station Car FLM strategy has advantages that significantly increase its viability and potentially increase ridership at employment center transit stations. Without AV, the transit passenger arrives at the transit station in the morning and uses a station car to complete her trip to work. At the work location, the station car is available as a car sharing vehicle to short term day users; however, a high degree of employer integration, coordination and differential price strategy are necessary to assure that the car is back for the commuter's return trip home. In addition,

[41] Neela Sakaria and Natalie Stehfest; Millennials and Mobility: Understanding the Millennial Mindset and New Opportunities for Transit Providers; Transit Cooperative Research Program; Transportation Research Board, Washington DC, 2013.

the station car is only available for one FLM trip from the station, increasing the volume of station cars necessary to meet demand throughout the morning peak.

Level 4 AV makes it possible that the station car may return automatically, with or without a passenger to the station to pick up the next group of work-place FLM commuters. This significantly lowers the number of vehicles required, and significantly increases the utilization of the station car.

AV completes a viable provider/operator model for Station Cars at employment center stations to provide the best suited vehicular models for individualized, point-to-point transit-linked commuter trips. Dedicated spaces, management, and the provision of AV infrastructure is essential. Infrastructure and AV-exclusive lanes may be a critical component before wide-spread deployment of AV on the roads. This model is especially suitable for NEVs.

AV Infrastructure – What Governments Can Do

Connectivity of public infrastructure is key to supporting the development of the AV market, a more efficient AV-mobility network, and an efficient transit-linked FLM vehicular mobility network. Examples of how the "Internet of Things" (IoT) devices and networks are already being used to integrate mobility infrastructure include:

- Cloud or internet connected traffic lights dynamically adjust traffic patterns to relieve congestion.
- Vehicle-to-Infrastructure (V2I) equipment may vary depending on the location and the type of application being used. In general, V2I includes road-side equipment (RSE) that communicates with vehicles. A V2I-equipped intersection may include:
    - Roadside units (RSU) that operates from a fixed position and transmit data to vehicles, using direct short-range communication (DSRC) radio for safety-critical applications or interruptable technologies for other applications;
    - A traffic signal controller that generates the signal phase and timing (SPaT) message with allowable phase time remaining, that allows the AV to optimize speed, braking and acceleration;
    - A traffic management center that collects, strips identifiers, and processes aggregated data from the roads and vehicles.
    - Fiber optic or wireless communication links between RSE and the traffic management center;
    - Support functions, such as underlying technologies and processes to ensure that the data being transmitted are secure.
- Roadway Traveler Information Systems technology updates drivers on current roadway conditions—including delays, incidents, weather-related messages, travel times, emergency alerts, and alternate routes, to result in more efficient use of roadway capacity, less delay, and faster travel times.
- Within station areas, lane space may be dedicated specifically for AV station car uses along efficient paths between transit stations and major employment centers.

VEHICULAR FLM MODES SUMMARY

Planning for Vehicular FLM Pathways to the primary transit stations and facilities at the station should consider the following:

- Park-and-Ride and Kiss-and-Ride provide transit-linked trips at t average distances are greater than the 2-mile focus which is typically of concern for urban FLM. They have less benefit than other FLM strategies to improve commuter convenience, relieve congestion, reduce parking requirements in TODs, and reduce greenhouse gases. They should receive less priority among the FLM strategies in the long term.
- For the purposes of FLM, it is important that planning for station parking is holistically considered as an alternative to station area TOD, and that where a demand for parking is justifiable, design of the parking is integrated into the TOD and does not impede pedestrian, bicycle, board or skate modes.
- Drop-off and pick-up areas should be planned for kiss-and-ride, ride-sharing and taxis, but must also be carefully designed not impede pedestrian, bicycle, board or skate modes.
- Electric Vehicle (EV) Park-and-Ride should be encouraged because it has greater benefits in terms of non-point-source GHG emissions. To encourage greater adoption of EV, station park-and-ride facilities should locate sufficient EV charging spaces.
- Neighborhood Electric Vehicles (NEV) provide even greater benefit for park-and-ride and ride-sharing FLM trips than full size vehicles, and should be encouraged through policy, regulation, and prioritized roadway infrastructure and transit station parking.
- The Pod-Based Car Sharing model is well suited as a transit-linked FLM strategy if spaces are reserved at the station; however, they meet the needs of more occasional users more than commuters.
- The Free-Floating 1-Way Car Sharing model is well suited to meet the needs of occasional transit riders and commuters. Although not essential, dedicated parking spaces at the station are beneficial.
- The Institutional Fleet Car Sharing model is supportive of transit-linked FLM by providing mobility for the more varied daily at-work trips; however, it is not a direct FLM strategy.
- The Station Car Sharing model is one of the best suited models for transit-linked commuter trips. Dedicated spaces, and a higher level of coordination and management is essential. This model can also be easily used with NEVs, and is greatly enhanced as a viable and sustainable strategy with AV technology and infrastructure.
- Ride-sharing in any of its delivery models are major components of transit-linked FLM planning, but it is not clear that they complement or substitute for transit trips. For longer trips on faster primary transit modes, ride-sharing is more viable as an FLM strategy. For shorter trips, ride-sharing morphs from FLM to a single mode unchained trip.
- Ride sharing business models are generally self-supporting, and may support several public benefits, regardless of their impact on transit ridership, including: reduced auto ownership in urban areas, reduced VMT and GHG for parking search cruising, and reduction of parking inventory needed in compact TODs which can countervail pedestrian accessibility.
- Infrastructure and programmatic needs for ride-sharing include policy support, seamless information integration, and provision of safe pick-up and drop-off spaces at the primary transit station and throughout the station areas.

VEHICULAR FLM TOOL KIT

V1. PERSON TRIP CAPACITY METHODOLOGY

Goals

- Account for the impact of an array of new vehicular technologies and mobility delivery models, such as car sharing and ride sharing that affect the capacity of the transportation network in terms of the movement of people.
- Account for the impact of the use of the street infrastructure by other modes that contribute to the movement of people, particularly the increased use of bicycles and other personal mobility modes that share roadway infrastructure.
- Account for the benefit of new mobility innovations and modal investments to guide future investment priorities.

Actions

- Accurately survey vehicular occupancy on a statistically valid sample of roadways in Miami-Dade County.
- On the same roadway links and at the same times, survey pedestrian activity.
- On the same roadway links and at the same times, survey bicycle, and personal mobility mode activity.
- On the same roadway links and at the same times, obtain bus and rail transit ridership counts.
- Sum the person trips for each link.
- Develop a reproducible methodology to apply factors or other methods to estimate capacity of other roadway links.
- Re-survey at regular periods (2-3 years) to identify trends.
- Analyze the results over time to determine the impacts of different mobility investments on achieving goals.

Criteria

- Policy must be measurable with existing technology.
- Policy should be flexible to allow for new technology that can improve the efficacy and/or efficiency of counts.
- Adequate statistical geographic distribution of surveys.
- Adequate sampling to achieve statistical validity by type of infrastructure facility and types of development forms (CBD, compact urban development, general urban suburban, agricultural areas, others as appropriate).

Improvements

- Changes to County and municipal comprehensive plans
- Other policy changes

Timeframe

- Short term: In the short term, the policy needs the data collection and analysis to be performed to initialize methodologies as the baseline.
- Mid-term and On-going: Ongoing and periodic updates of surveys and counts to track trends and modify methodologies for the County mobility network in general.

Funding

- If policy amendments are part of EAR-based amendment cycle, then Florida Department of Economic Opportunity (DEO) funds may be applicable.

VEHICULAR FLM TOOL KIT

V2. TRANSIT STATION PICK UP & DROP-OFF

Goals

- Provide adequate, safe space to accommodate vehicles and other vehicular FLM options to pick-up and drop off passengers at primary transit stations.
- Assure that pick-up and drop-off are scaled according to mode and demand forecasts for vehicular transit-linked trips.
- Promote regional transit ridership by providing safe, secure, convenient and attractive pick-up and drop-off area that are directly connected to the transit station.
- Assure that vehicular pick-up and drop-off areas by design and/or operation do not impede or reduce the safety, convenience and attractiveness of pedestrian access to the transit station.

Actions

- Establish policy at comprehensive plan level regarding transit station design and include criteria for transit station pick-up and drop off.
- Apply policy when designing and constructing future transit stations.
- Apply policy when designing and constructing relevant changes to existing transit stations.

Criteria

- No street or driveway crossing between pick-up / drop-off stacking area and the transit station entrance.
- Adequate horizon year capacity for off-street queue and stacking.
- Bypass lanes to allow vehicles to safely pass another vehicle in drop-off or pick-up
- Design to minimize impact on pedestrian and bike access to station.
- Weather protection from curb to transit station entrance.

Improvements

- Changes to County and municipal comprehensive plans
- Other policy changes
- Inclusion of cost of improvements in funding plan
- Setting of criteria for station design contracts

Timeframe

- Short term: In the short term, the policy needs to be in place before funding applications and design scopes for transit stations.
- Mid-Term and On-going: Policies to be included in station design scopes. Stations are designed and constructed with adequate pick-up and drop-off criteria per the criteria above.

Funding

- Eligible FTA Programs for station design and construction:
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)

VEHICULAR FLM TOOL KIT

V3. STATION AREA PICK UP & DROP-OFF

Goals

- Provide adequate, safe space to accommodate vehicles and other vehicular FLM options to pick-up and drop off passengers through the Transit Station Area Core, or other dense, compact development station areas.
- Promote regional transit ridership and the use of more efficient vehicular modes, including ride-sharing and carpooling by providing safe, secure, convenient and attractive pick-up and drop-off locations through-out the TOD core area.
- Assure that station area vehicular pick-up and drop-off areas by design and operation minimize negative impacts to intersections, including safety of protected pedestrian phases
- Assure that station area vehicular pick-up and drop-off areas by location, design and operation do not block or impede the safe use of a continuous bicycle and pedestrian network in the station area.

Actions

- Establish policy at comprehensive plan level regarding transit station design and include criteria for transit station pick-up and drop off.
- Apply policy when designing and constructing future transit stations.
- Apply policy when designing and constructing relevant changes to existing transit stations.

Criteria

- No street or driveway crossing between pick-up / drop-off stacking area and the transit station entrance.
- Adequate horizon year capacity for off-street queue and stacking areas.
- Bypass lanes to allow vehicles to safely pass another vehicle in drop-off or pick-up.
- Design to minimize impact on pedestrian and bike access to station.
- Weather protection from curb to transit station entrance.

Improvements

- Changes to County and municipal comprehensive plans.
- Other transportation agency policy changes.
- Amendment of land development regulations for on-site pick-up and drop-off areas, dedications, and TOD station area bonuses.
- Implementation of policy and requirements as station area development and infrastructure improvements progress.

Timeframe

- Short term: In the short term, the policy and regulations need to be in place before infrastructure and station area real estate redevelopment.
- Mid-Term and On-going: Requirements and criteria to be included in private development orders and public infrastructure redevelopment.

Funding

- Private development requirements
- Infrastructure enhancement funds as applicable

VEHICULAR FLM TOOL KIT

V4. STATION CARS

Goals

- Provide cost efficient, car sharing programs for transit stations that are particularly focused on providing transit-linked, vehicular FLM trips at the lowest possible consumer cost.
- Assure that the transit-linked, vehicular FLM car sharing programs are cost-sustainable using higher utilization targets of station car programs.
- Promote regional transit ridership and the use of more efficient vehicular modes, including car-sharing delivery models that are cost efficient for transit consumers and sustainable for Car Sharing Operators (CSO).

Actions

- Identify potential market for initial car sharing service, and provide station area parking spaces for the operation at no cost to the CSO.
- Where station demand or design does not warrant or provide for spaces for a car sharing program, delay implementation. Early successes are important to future growth.
- Identify the long-term potential for a developed station car market, and reserve station area parking spaces for the operation at no cost to a CSO. This includes accounting for potential no-cost space dedication when calculating parking revenue for parking authority bonding purposes as applicable.
- Actively work with CSOs and major destinations within FLM station areas to provide station car services as needed with the implementation of SMART Corridor transit development.

Criteria

- Sufficient spaces for a viable program at transit stations.
- Implement station car program where demand forecasts suggest sustainability.
- Spaces to have signage to promote programs.
- Spaces in immediate walking distance of the station, preferable on-premises.

Improvements

- Parking spaces reserved for CSO-operated Station Car programs.
- CSO, and operator/owners of major destination or employment centers participating in SMART Corridor Station Car program(s).

Timeframe

- Short term: Work with CSOs to establish programs at existing high-capacity transit stations (MetroRail, South Dade Busway) where demand forecasts suggest long term viability.
- Mid-Term and On-going: Expand programs based on lessons learned from early implementations.

Funding

- CSOs
- Parking authorities – where spaces need to be reserved or set aside
- Major destination owners to participate in program and provide spaces.

VEHICULAR FLM TOOL KIT

V5. PLUG-IN ELECTRIC STATION CARS

Goals

- Provide a cost efficient, station car sharing program for transit stations to provide transit-linked, vehicular FLM trips at the lowest possible consumer cost using plug-in Electric Vehicles (EV).
- Assure that the station car sharing program is cost-sustainable via the higher utilization and reduced operational costs associated with off-peak, on-site electric recharging.
- Promote regional transit ridership and the use of more efficient vehicular modes, including car-sharing delivery models that are cost efficient and sustainable.

Actions

- Identify potential market for initial car sharing service, and provide station area parking spaces for the operation at no cost to the CSO.
- Identify the long-term potential for a developed station car market, and provide PEV charging parking spaces for the operation at no charge for parking space.
- Where station demand or design does not warrant or provide for spaces for a car sharing program, delay implementation. Early successes are important to future growth.
- Actively work with CSOs and major destinations within station areas to provide station car services as needed with the implementation of SMART Corridor transit development.

Criteria

- Sufficient spaces for a viable program at transit stations
- Implement station car program where demand forecasts suggest sustainability.
- EV charging spaces to have signage to promote program and be prioritized close to pedestrian entrances.
- Other siting location criteria include:
  - Close to existing electrical panel with sufficient power capacity.
  - Adequate lighting for security, convenience, and safety to read associated signs, instructions or controls.

Improvements

- Parking spaces with EV charging equipment reserved for CSO-operated EV Station Car programs.
- CSO, and operator/owner of a major destination or employer participating in SMART Corridor Station Car program(s)

Timeframe

- Short term: Work with CSOs to establish programs at existing high-capacity transit stations (MetroRail, South Dade Busway) where demand forecasts suggest long term viability.
- Mid-term and on-going: expand programs based on lessons learned from early implementations.

Funding

- CSOs
- Major destination owners to participate in program
- Parking authorities – where spaces need to be reserved or set aside
- US Department of Energy (USDOE) EV programs
- Florida Power & Light for promotions and coordination

VEHICULAR FLM TOOL KIT

V6. NEIGHBORHOOD ELECTRIC VEHICLE STATION CARS

Goals

- Provide the most technologically cost efficient, sustainable car sharing program for transit stations focused on providing transit-linked, vehicular FLM trips at the lowest possible consumer cost using Neighborhood Electric Vehicles (NEV).
- Assure that the transit-linked, vehicular FLM car sharing program is cost-sustainable via the higher utilization targets of station car programs, reduced operational and capital costs associated with NEVs and on-site refueling that is possible with EV.
- Promote regional transit ridership.

Actions

- Identify potential market for NEV utilization and NEV car sharing service in compact TODs, and provide prioritized station area parking spaces for the operation at no cost.
- Develop policy for NEV prioritized parking spaces and aisle dimensions.
- During station design, prioritize the location of sufficient NEV spaces with or without charging equipment. (NEV is more focused on short-distance FLM and charging may not be necessary for each parking layover.)
- Identify the long-term potential for NEV station cars in the station area, and reserve convertible priority space to convert from standard vehicle dimensions to NEV dimensions.

Criteria

- Sufficient prioritized space for general and station car NEV.
- Reserve standards spaces for conversion to prioritized NEV spaces.
- Implement station car program where demand forecasts suggest sustainability.
- NEV spaces to have signage and way-finding.

Improvements

- NEV priority parking spaces prioritized by location in the transit station parking facility.
- Additional NEV priority parking spaces with prioritized by location in transit station parking facility that are reserved for CSO-operated NEV Station Car or other car sharing models.
- Land use code changes to allow for prioritized NEV-scaled parking spaces at major destinations and employers in the station area.

Timeframe

- Short term: develop NEV parking standards. Work with CSOs to establish programs at existing high-capacity transit stations (MetroRail, South Dade Busway).
- Mid-Term and On-going: Implement car sharing standards, and expand NEV car sharing programs.

Funding

- CSOs
- Major destination owners to participate in program
- Eligible FTA Programs for station design and construction:
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)

VEHICULAR FLM TOOL KIT

V7. CAR SHARING PARKING POLICIES AND FEES

Goals

- Provide FLM coverage for occasional transit riders that are not part of commuter programs.
- Promote regional transit ridership for visitors and the use of more efficient vehicular modes, including car-sharing delivery models that are cost efficient for transit consumers and sustainable for Car Sharing Operators (CSO).

Actions

- Monitor the utilization of transit-linked car sharing programs implemented on August 25, 2017 at the MetroRail Vizcaya Station, Coconut Grove Station, Palmetto Station, Hialeah Station, and Earlington Heights Station.
- Survey to determine the number of MetroRail station car sharing trips that are transit linked or neighborhood based users.
- Review impact of other cities that convert on-street spaces for car sharing. *(San Francisco recently proposed reallocating 1,000 spaces citywide for car sharing.*)
- Determine impact of car sharing on transit ridership, auto-ownership, VMT, peak and of-peak trips, and use impact to inform transit station and station area policy regarding parking space allocations.

Criteria

- Parking policy and allocations that respond to transit station area context, and goals.
- Use supply-demand relationships and costs to incentivize transit ridership by policy.

Improvements

- Allocation of car sharing parking spaces at transit station and throughout station area.
- Improved understanding of the correlation between car sharing and transit ridership, alternative mode use, auto ownership, county-wide VMT, peak and off-peak traffic volumes.

Timeframe

- Short term: begin monitoring usage, and survey transit-linked usage and other data at existing MetroRail car sharing program.
- Mid-Term and On-going: Allocate general parking spaces for car sharing use as appropriate.

Funding

- CSOs
- Major destination owners to participate in program
- Parking authorities – where spaces need to be reserved or set aside

VEHICULAR FLM TOOL KIT

V8. NEV PRIORITIZATION

Goals

- Support cost efficient, sustainable station area FLM mobility using Neighborhood Electric Vehicles (NEV).
- Support transit-linked, NEV FLM mobility that can improve transit utilization and improve station area mobility while reducing consumer costs, infrastructure costs and GHG emissions for vehicular mobility needs.

Actions

- Revise code or other regulations as pertinent to accommodate the use of golf carts and NEVs on the roadway network.
- Identify NEV barriers such as the highways or high-speed arterials, design and implement connections for the NEV low-speed vehicle network.
- Where possible, desirable and appropriate, develop off-road trails and pathways for NEV access that are sufficient for 3,000-pound gross vehicle weight.
- Modify on-street parking regulation to allow more efficient 90-degree parking on a parallel parking lane for NEVs under 8-ft in length.
- Modify off-street parking regulations to promote efficient and prioritized NEV parking.

Criteria

- Infrastructure and regulation that allow and promote NEV use in station areas.
- No reductions in traffic safety.
- No impacts to safety and convenience of pedestrian, bike and skate infrastructure.
- Parking and infrastructure changes as appropriate along roadways that: 1) have posted speed limits below 45 mph; and 2) low truck volumes.
- Where posted speed limits are below 45 mph, and 85th percentile speeds are above 45, investigate and remedy speeding through traffic calming or enforcement before permitting NEV use on these roadways.

Improvements

- Station area NEV pathway network
- Barrier crossings: bridges or tunnels for NEV
- NEV off-road pathways (may be used to avoid high-speed roads)
- NEV parking zones at 90-degrees
- Revised rules for 90-degree parking permissible for vehicles under 8 ft. length

Timeframe

- Short term: Amendments to regulations. Identification of future NEV pathways network (on-road and off-road).
- Mid-Term and On-going: Infrastructure improvements to cross barriers and develop off-road NEV network components.

Funding

- Eligible FTA Programs for rolling facilities for transit development:
  - Urbanized Area Formula Grants (5307)
  - Enhanced Mobility of Seniors and Individuals with Disabilities (5310)
  - Private development or P3

VEHICULAR FLM TOOL KIT

V9. AV Infrastructure

Goals

- Support increasing safety, sustainability and efficiency in the advancement of vehicular FLM technology in station areas though timely development of Autonomous Vehicle (AV) infrastructure.
- Support improved and more efficient transit-linked, FLM vehicular mobility that can improve transit utilization and improve station area mobility while reducing consumer costs, infrastructure costs and GHG emissions for vehicular mobility needs.

Actions

- Support ongoing development and implementation of AV infrastructure, including:
  - Cloud or internet connected traffic lights dynamically adjust traffic patterns to relieve congestion, using secure data transmissions
  - A traffic signal controller communicates to vehicles allowing the AV to optimize speed, braking and acceleration.
  - Traffic management centers
  - Roadway Traveler Information Systems technology to update drivers on current roadway conditions to result in more efficient use of roadway capacity, less delay, and faster travel times.

Criteria

- Use of safe, tested technologies
- Focus of AV technology is safety, efficiency and sustainability
- Focus of AV technology must be multimodal; therefore, balanced AV infrastructure technology to include:
  - Transit priority using pre-emption or other applicable models.
  - Pedestrian priority through provision of protected pedestrian phases with sufficient crossing time and short wait times.
  - Signal priorities do not preclude safety for bicyclists.

Improvements

- Cloud or internet connected traffic lights
- Vehicle-to-Infrastructure (V2I) equipment
- Roadside units (RSU) that transmit data to vehicles
- Signal controllers that generate signal phase and timing messages
- Traffic management center
- Roadway Traveler Information Systems technologies

Timeframe

- Mid-Term and On-going: Infrastructure improvements timed as technology is available and accepted in vehicles and infrastructure.

VEHICULAR FLM TOOL KIT

V10. TRANSIT STATION PARKING

Goals

- Provide adequate, safe space to accommodate vehicles and other vehicular FLM options for park and ride and car sharing operations (Toll Kit V4, Tool Kit V5, Tool Kit V6, Tool Kit V8)
- Promote regional transit ridership by providing safe, secure, convenient and attractive park-and-ride spaces that are directly connected or abutting the transit station.
- Design park-and-rides in a manner that does not countervail the pedestrian access goals of the transit station.
- Scale park-and-ride facilities with balanced consideration of the benefit of adjacent habitable development

Actions

- For each station area, perform a development and parking analysis to determine the optimum current and future parking requirement for various development scenarios.
- Design parking ramps to be convertible to other uses as needed if future parking demand decreases as TOD development increases. This requires preference for level parking trays with separate ramps for ascent and descent between levels.
- Design parking as structured parking above or below ground level.
- Design parking facility entrances away from pedestrian pathways.
- Analyze traffic to assure that peak period vehicle queuing or high-volume vehicular patterns do not interrupt pedestrian, bike or other non-vehicular pathways to the transit station.
- Include wayfinding to parking entrances.

Criteria

- Transit station design as context for parking design
- TOD context, including real estate value(s) of TOD area
- Development mix (residential, employment, live/work, destination retail, community retail)
- Construction costs for above-ground and below grade parking, including block size, development scale and their impacts to parking efficiency and cost per space
- Integration of NEV, EV, and car sharing parking and prioritization
- Pedestrian pathways design and entrances to station
- Location of ground level retail
- Weather protection from curb to transit station entrance.

Improvements

- Policy-level criteria and regulation implementation for parking quantity, location and design
- Design of station parking
- Construction of station parking

Timeframe

- Short term: Policy and land development regulation amendents
- Mid-Term and On-going: Development of parking

Funding

- Public -private partnerships (P3)
- Eligible FTA Programs for station design and construction
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)

TRANSIT FLM STRATEGIES

TRANSIT FLM OPTIONS

The Transit FLM modal group, like the Vehicular FLM modal group, comprises expanding strategies that are influenced by technological advances, delivery model innovations, and entry of private carriers into what was for the last 70 years a public service. The technologies that are important to the Transit modal group are:

- Smartphone-based, networked ride matching;
- Battery-electric propulsion; and
- Autonomous guidance

Transit FLM groups together different vehicle types, propulsion systems, guidance and business models, to form 4 strategies:

- Conventional Transit Services – Public Provider
- Micro Transit – Private Providers and some P3
- Advanced Group Rapid Transit (GRT) – Public Provider
- Aerial Cable Transit (ACT) – Public or Private Provider

Personal Rapid Transit (PRT) is sometimes considered a Transit FLM strategy; however, with characteristics that are so similar to the Vehicular FLM modal group, it is essentially similar to many strategies in the Vehicular Group.

The main similarities that distinguish the Transit FLM group are:

- Based on the use of larger, multi-passenger vehicles where people in the group do not know each other;
- Fixed routes or routes with dynamic route deviation, but not point to point demand-responsive;
- FLM user does not control schedule or alignment;
- For home-to-transit-station or transit-station-to-destination linked trips, travel is not direct and requires some walking on at least one end of the trip.

Throughout the Pedestrian, Bike, and Vehicular FLM Modal groups, point-to-point travel is a key characteristic. Transit FLM, as mode of mass mobility, does not strictly meet the criterion, and anticipates a short walk to meet the transit at the origin and/or destination side.

CONVENTIONAL TRANSIT CIRCULATORS & FEEDERS

Conventional transit is owned and operated by public agencies responsible for designing routes, purchasing vehicles, operating these vehicles, and maintaining them as a public service. In Miami Dade, the Department of Transportation and Public Works (DTPW) provides transit service throughout a 306 sq. mi. service area, including 34 municipalities, integrate among four modes: bus (Metrobus), heavy rail (Metrorail), automated people-mover (APM) (Metromover), and demnd-responsive Special Transportation Services (STS).

Metrobus is DTPW's fixed-route bus service, operating 96 routes seven days a week, 24 hours per day. Regular bus service is served by a fleet of 847 buses and two contracted routes with seven buses. The family of Metrobus services include local, circulator, limited-stop, express, and BRT (Bus Rapid Transit) services.[42]

> Local Bus Service: collects and distributes high-turnover ridership along arterials radiating to and from dense activity centers. This service type is characterized by frequent stops, short and moderate passenger trips, and slow average bus speeds over the course of an entire route.

> Circulator or Shuttle Bus Service: operates short route connections between activity centers, or as a feeder to provide a connection with another transit service. For DTPW, these routes include the Tri-Rail commuter rail shuttles in Miami-Dade County and short, local-area specific routes.

> Community Circulators: Twenty-seven of the local community circulators are municipal circulators which are People's Transportation Plan (PTP)-funded, with oversight by the Citizens' Independent Transportation Trust (CITT). These service types are characterized by frequent stops, more alignment deviations into trip generators, short passenger trips, and slow average bus speeds over the course of the route.

Limited-Stop Service: skips some stops and only serves designated high ridership bus stops along a route. With fewer stops, limited-stop routes have increased operating speeds when compared to local service. The MAX routes serve stops at major transfer points or approximately every one-half mile in the Miami Central Business District (CBD) to one mile in suburban areas along a route.

Conventional transit bus scaled for local or circulator services

[42] Miami Dade Transit Development Program (TDP), 2016

Transit Circulators

The range of average bus speeds in urban traffic is between and 7 mph and 15 mph depending on stop density, and traffic congestion. Since 2000, the median urbanized area of a million people or more has seen their average public bus speed drop from an average 13.6 mph to 12.7 mph, or about 6.6%[43] caused mostly by traffic-related delay.

Urban area local circulators in particular run slower with shorter bus stop spacing in the range of 500 (2 blocks) to 1,000 feet (4 blocks) between stops. While the increased number of stops increases transit accessibility, it decreases mobility transit performance. Each stop increases dwell time (at stop with doors open) and delay time (accelerating, decelerating and maneuvering in and out of traffic flow). Both traffic delay and stop dwell times also add to unreliability of scheduling since both have great variations depending on factors that are not controllable by the bus operator.

Using lessons learned from Pedestrian FLM, effective FLM mobility performance requires short travel times, safety, security and reliability. Within the 10 to 12-minute window that is apparent for the range of effective FLM to a transit station, these delay factors represent large potential deviations.

With these large sources of deviation present in typical fixed route transit circulators present, FLM transit bus operators must be able to respond dynamically to changing FLM user requirements and traffic conditions.

Unlike Micro Transit discussed in the next section, the public transit system operates in a complex financial and regulatory environment which constrains operational choices and the speed of response to changing mobility requirements. Some of these challenges include:

- Complex Decision-Making Process: the transit agencies must often employ an open and deliberative process for making operational decisions. For example, changing bus route alignments requires extensive outreach, technical studies, limitation to system service standards criteria and thresholds, public notice, and hearings. As a result, quickly responding to service needs on all corridors is a relatively difficult and lengthy process.
- Limited Funding: the transit agency requires extensive capital and operating subsidies to maintain daily operations. As operations and maintenance costs have escalated, funding has often remained inconsistent, resulting in more crowded and unreliable operations and decreased service scheduling.
- Regulatory Framework: decisions must be made within a complex regulatory framework which govern issues such as ADA access for vehicles, driver hiring and retention, work hours, service area and other related items. This regulatory framework permeates every decision from the simple act of hiring an employee to implementing complex service changes. This regulatory framework also makes it easier for an employee or patron to challenge service decisions through legal action or other similar efforts.

Because of these factors, conventional transit services are difficult to implement as FLM strategies that require operations focused on short precise alignments and schedules that require ability to dynamically react to demand, environmental factors, or destination and employer needs.

[43] National Transit Database, Federal Transit Administration, and City Observatory

New FLM transit service should be shared by non-public-sector providers to allow services that can respond quickly to the varied demands of FLM.

Still, where existing circulators or segments of regional routes in the transit system can serve as FLM in transit station area corridors, they should be supported with infrastructure improvements that can reduce the impacts of traffic delay and stop dwell times so that these routes proceed to the station as efficiently and effectively as possible.

Transit infrastructure improvements are recommended only for segments of the bus alignment that run through the station area TOD Core (¼-mile) and the TOD Transit Neighborhood (½-mile). Beyond this distance, the cumulative effect of delay and dwell times would leave the service to unreliable for effective FLM.

Infrastructure that is recommended for the existing DTPW Transit segments includes, as appropriate:

- Transit Signal Priority;
- Queue jumps and bottleneck bypasses;
- Exclusive bus lanes;
- Enhanced crosswalks with pedestrian protected phases in front of bus stop, on bus stops located as near side stops (near side stop or mid-block stop) (Pedestrian Toolkit P4, P5, P6, P7);
- Level-boarding bus stops with shelters, dignified seating, lighting, real-time information and ADA ramps for accessibility.

Bus Rapid Transit Raised platform bus stop that provides greater visibility, and the level-boarding platform improves passenger comfort and reduces stop delay time

MICRO TRANSIT

Micro Transit is an emergent public transit mode in some US cities. The defining characteristic is that they are privately owned and operated for profit. Routes may mirror public transit provider routes, offering different quality-of-service at different price points. Vehicles are typically vans, so it is not a ride-sharing vehicular FLM strategy; however, the vehicle size is smaller than the vehicles used by public agencies, and the service capacity and quality of service are distinct from traditional transit circulators. To varying degrees depending on the business models of the operators, the services are very responsive to demand with ability to easily change route characteristics.

Micro Transit picking up passengers

Micro Transit is currently in a nascent stage of market and service development, but as service models are tested and improved, they may have a significant impact on transit service delivery. Some current Micro Transit providers include:

Bridj: Boston, MA; Washington, DC; Kansas City, MO (ceased service); (starting service in Sydney, Australia)

Chariot: New York, NY; San Francisco Bay Area, CA; Austin – San Antonio, TX; Seattle, WA

Flex: San Francisco Bay Area, CA

Leap: San Francisco Bay Area, CA (no longer in business)

Loup: San Francisco Bay Area, CA (no longer in business)

Split: Washington, DC Split bought the Helsinki company that created Kutsuplus' algorithm

Via: New York, NY; Washington, DC; Chicago, IL; Arlington TX; West Sacramento, CA

Lift Line: many cities

Uber Pool: many cities

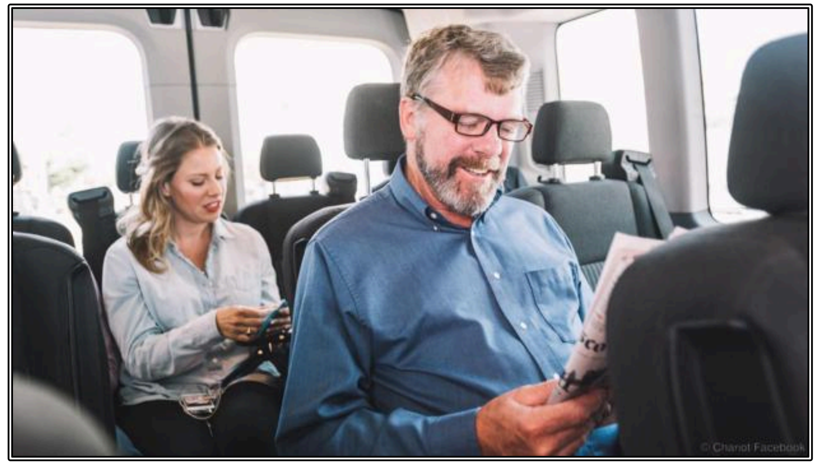
Common characteristics of micro transit include:

- High levels of flexibility: Since they do not have the funding or regulatory constraints that commonly affect public transit operators, Micro Transit can make quick service changes without an extensive public decision-making process. Micro Transit operators can respond to short or long-term travel behavior changes.
- Selective service offerings: Micro Transit providers have thus far focused on very limited parts of metropolitan area with limited routes, often the most productive ones.

- More amenities and services: While public transit buses are designed for ease of maintenance and high capacity, Micro Transit buses offer more space for riders, comfortable seats, wi-fi, USB outlets, lights, and more.
- Data: Dedicated app, real-time tracking and reservations, and a guaranteed seat are key consumer attractions, made possible with the use of big data on existing travel patterns to respond with service changes. Micro Transit also integrates smartphones into their operational decision making: Chariot allows prospective riders to crowdsource new routes or route deviations based on the number of sign-ups.
- Fares: Fares are typically higher than for the same origin/destination on public transit. Most operators do not currently provide discounts for youths, seniors, low income riders or other types of subsidies. Many offer monthly passes with varied access by zones and time of day. Many do have employer programs. The Bridj Kansas City service was subsidized to keep fare at $1.50 per ride.
- Drivers: Most Micro Transit operations use regular employees (W-2) as drivers, except Lyft and Uber, and Via. Via's drivers are also the owner of the vehicles. For Bridj in Kansas City, union-represented KCATA drivers operated the vans.
- Funding: Micro transit can raise capital funds in a variety of private capital markets.

Anecdotal evidence suggests that passengers using Micro Transit services view them positively; however, Micro transit operators do have difficulties.

- A disability advocacy group threatened legal action against Leap in 2015 alleging ADA violations, resulting in it discontinuing further operations.



Higher comfort is a key characteristic of Micro Transit services

Café-style interior of Leap 40-ft. bus, a Micro Transit service

- In many markets, actual ridership for Micro Transit continues to be limited compared to public transit. A service model that is effective for high productivity urban routes can be difficult to apply to suburban areas.
- Perception that they cater to the more affluent. By providing a premium private version of a public service, there is a risk that some agencies may enact barriers to limit Micro Transit service.
- Potential for Network Ride Share Companies (like Uber and Lyft) to increasingly offer similar type services. Shared ride systems like Uber Pool and Lyft Line already offer discounted fares based on shared riders. These services increasingly operate like Micro Transit: in San Francisco, Lyft Line's "Hot Spots" encourage passengers to congregate at select intersections in exchange for discounted fares as a means of making operations more transit-like. Uber and Lyft have recently been experimenting with their own version of shuttle service in select cities.

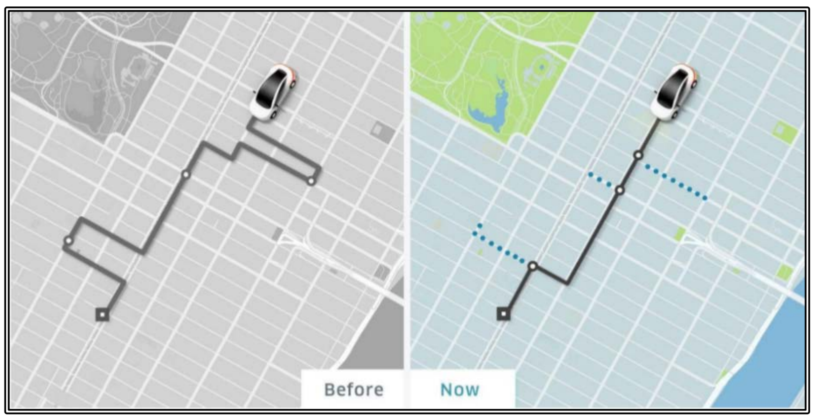


Diagram showing Uber Pool concept compare to regular Uber service

Micro Transit Complementary Synergies with Traditional Transit

A potential synergy for Micro Transit is to provide FLM service in locations where traditional public transit agency service is not feasible. Micro Transit could also provide additional service along selected corridors where the public transit vehicles are at capacity. For example, in San Francisco, many of the Micro Transit providers are operating vehicles along the most-congested over-capacity routes, complementing rather than replacing existing service.

The promise of Micro Transit efficiencies and service delivery attracts transit operators to run pilot programs. In Los Angeles, Metro issued a request to the private sector to team with Metro to design, implement and evaluate a new service based on Micro Transit concepts. Unlike a standard bus, the service will follow turn-by-turn instructions from a navigation system that uses live traffic conditions and real-time requests for picks-up and drops-offs to generate the most efficient possible shared trips for Metro customers. The service will be used for short trips under 20 minutes in duration in defined service zones, and utilize vehicles that are smaller than traditional transit vehicles. The new service is designed to be intuitive, user-friendly, and encourage the use of multiple modes of public transportation.

The benefits that Micro Transit brings are: 1) smart software that formulates routes and generates pick-up spots in real time; 2) right sizing of vehicles; 3) route flexibility, following patterns of demand to fill seats. Software can also allow integration of Micro Transit services with public transit schedules.

With a selective focus toward multiple pick-up and drop-off at the transit station, Micro Transit is beneficial as an FLM strategy that is more efficient than ride sharing. It can serve high-trip generators, and more dispersed patterns, and will probably have greater success within compact development parts of the station area.

ADVANCED GROUP RAPID TRANSIT

Advanced Group Rapid Transit (GRT) is a technology of transit using small automated vehicles operating on dedicated guide way network. It provides direct or nearly direct origin-to-destination connections, and typically operates on demand. Vehicles accommodate individual or small groups, and may at times be called people movers; however, he emphasis for FLM is more on the lower capacity vehicles that operate at grade, with at-grade stations that are consistent with FLM roles in SMART Corridor TOD station areas.

Connexxion Parcshuttle Rivium Kralingse, Rotterdam, Holland

The smallest GRT, at 4-passenger capacities are sometimes called Personal Rapid Transit (PRT). AV technology is changing the operational model to allow these vehicles to enter mixed traffic for all or part of the route, which reduces the cost and complication of a continuously dedicated right-of-way alignment. AV is also changing the operational model of vehicular transit in manners that allow shared vehicles to operate more like public transit.

Underscoring the trend that AV is changing shared vehicular and transit strategies to create a continuum of AV FLM, a study conducted at Florida Atlantic University[44] compared two hypothetical scenarios with the current bus transit system of Ann Arbor, Michigan for a typical fall weekday in 2013. One scenario consisted of an automated car-sharing / taxi system that allows only one rider at a time, and the other consisted of a similar automated system that allows ride-sharing for up to four passengers in a "shared-ride" scenario. The two automated, car-sharing scenarios were modeled on simulated transit passenger travel demand data. All three scenarios were then compared for their level of service, cost, greenhouse gas emissions, and congestion impacts. The automated ridesharing service could provide a higher level of service at lower cost and lower GHG emissions than the current bus system. The best transit system of the future would take advantage of both the flexibility of automated car-sharing and the capacity management capabilities of transit within a coordinated system.

Two self-driving buses began trial service in August 2016, on the public roads of Helsinki, Finland. The Easymile EZ-10 electric mini-buses, capable of carrying up to 12 people, will roam the open roads of Helsinki and negotiate mixed-traffic.

Connexxion ParcShuttle, Rotterdam, Holland

The Connexxion Parc Shuttle is Level 4 AV GRT system that runs regular service in Rotterdam, Holland. It provides FLM linkage from the Kralingse Zoom Metro Station and car park to the Rivium Business Park, and makes additional stops.

The system was fully operational in early 2006. Each battery-electric bus has seats for 12 and a maximum capacity of 20 with standees. The buses run segregated from pedestrians and other traffic on a

44 T

mostly 2-lane dedicated guideway of 1¼ miles with 5 stops. A short section of guideway crossing a bridge is 1-lane only, and is shared by vehicles going in both directions. The guideway crosses roads at 'level crossings' at two points. On the approach to these, the ParkShuttle buses activate lights and barriers to stop crossing traffic, and have priority.

The system operates like a horizontal elevator: users call a bus by pressing the button at a stop, and press another on the bus to indicate which stop they wish to travel to. The bus will automatically take the most direct route, which means it can turn around at an intermediate point on the alignment to change direction unless another call is received that will prevent it. Passengers use regular public transport tickets, including chip cards, transfers and season tickets.

Buses travel at up to 15 mph, and are equipped with obstacle detectors to stop automatically in case pedestrians or other obstructions are found on the track. The system operation is managed from a control center.

The system has 6 buses available at peak times, 3 at non-peak when the others are recharged. The system does not run during the night. The capacity is 480 passengers/hour in the peak and carries a total of about 2,200 passengers per day. The average waiting time is about 1½ minutes at peak times, and 3 minutes in off-peak times. The travel time is typically 5 to 7 minutes. The system includes dynamic passenger information in the form of waiting times and is monitored for security using CCTV cameras in the vehicles and along the guideway. Vehicle storage and recharging takes place automatically in a garage overnight. The system cost of 2.1-million Euro[45] (about $2.8-million, 2006 USD

For the purposes of FLM, the critical aspects of the Advanced GRT are that is particularly well suited to short trips in a 1 to 2-mile range. From the user's perspective, trips are point-to-point direct and demand-responsive, yet the system can accommodate intermediate stops like a limited circulator. Wait time is short, average speed is enhanced by limited demand-responsive stops, and signal priority. It is ideally complimentary to high capacity transit for fulfilling mid-level capacity FLM mobility between the transit station and major destinations with some intermediate locations in between. It can significantly enhance ridership potential on the transit corridor.

Connexxion Parcshuttle Rivium Kralingse, Rotterdam Holland

[45] David Jeffrey, University of Southampton, England Connexxion Parc Shuttle Case Study, 2009.

AERIAL CABLE TRANSIT

Aerial cable transit (ACT), common in resort areas, is taking a growing role in urban applications to supplement urban transit systems in particular settings where their benefits are well suited. They are implemented worldwide as people movers, interconnecting with bus and rail at intermodal transit centers.

Urban Aerial Cable Transit

An ACT system consists of one or two fixed “track cables”, one “haulage” loop of cable, and a number of passenger cabins (also called “gondolas”) attached to the haulage rope by grips. Propulsion is electric and located at a terminal station. There are two types:

1. Aerial tramways are reversible systems with a cabin shuttling back and forth between two end terminals (the haulage cable reverses direction). The cabin on these systems can be from small to very large, sometimes over 100-person capacities.
2. Gondola lifts are continuous systems, where cabins are attached onto a circulating cable that moves continuously, and travel in two directions is simultaneous on a loop. Typically, the cabins are smaller, accommodating small groups (4-6 people), and spaced for short headways (and wait times).

Both systems share certain limitations and advantages that are unique to ACT.

- ACT provides direct origin-to-destination connections – stops are only at the terminal stations.
- The total length of the system is limited.
- Alignment does not require at-grade street space or land, but does require air rights.

The continuous type gondola system can achieve very high throughputs because of short headways and little stop delay. Capacities can be in the range typical for BRT.

They are very well suited as an FLM strategy to high trip generators on the employment / destination side of trip, with point-to-point, short travel time, and short wait time. The unique benefits of ACT include:[46]

- Automation: ACTs are fully automated with redundant, fail-safe electronic monitoring and control systems for optimal safety.
- Right of Way: Operating in exclusive aerial ROW's, ACTs are separated from roadways, intersections, sidewalks and bikeways: safety is greater, congestion is minimized, transit time is reliable.
- Headways: Wait times are short. Gondola system's “walk up and board” feature assures there are multiple vehicles in stations ready for boarding at all times.

[46] ECO-Transit LLC, 7830 W Alameda Ave., Suite 103, Denver, Colorado 80226

- Capacity: With frequent vehicle arrivals/departures, passenger capacities range from 2,000 to 5,000 people/hour per direction.
- Speed: ACT travels at 10 to 18 mph speeds, but with short headways and no traffic congestion delay, average route speed is greater than most surface transit modes.
- Mobility: ACT are ADA compliant with wide cabin doors, level boarding platforms and vehicle floors; in most cases wheelchairs can board with no special procedures or stopping the system.
- Vehicles: Cabins typically range in size from 10 to 35 passengers and offer seating and standing.
- Amenities: Cabins can be equipped with wifi internet, intercom, closed circuit TV, lighting, heating, air conditioning and bike racks.
- Impact: Minimal right-of-way footprint and infrastructure relocation result in short, 12 to 18-month construction times. Neighborhoods are less impacted during construction and in the long term.
- Sustainability: Electrically powered, air and noise pollution are minimized. On board vehicle power is solar/battery and main electric motive power can use renewable sources.
- Cost: ACT capital costs and annual O&M costs are significantly less than most surface rail or fixed guideway people movers. System life cycles are 30 to 50 years, depending on annual operating hours and preventive maintenance.

In 2016, the Miami-Dade MPO conducted the Aerial Cable Transit Feasibility Study[47] to identify the potential for ACT to be used in corridors in Miami-Dade County where potential transportation projects have been adversely impacted by either the high cost of right-of-way or the lack of available right-of-way. The study team evaluated the feasibility of implementing ACT systems in Miami-Dade County for short distances of from one to three miles as an extension of the existing rapid transit network to various activity centers identified by the Miami-Dade MPO, including: Florida International University (FIU), Miami Intermodal Center (MIC), Marlins Park/Little Havana, the Health District, Downtown Miami, Port Miami and South Beach.

The conclusions of the report settled on three possible connections:

FIU-Dolphin Station:

While this alternative has the greatest level of stakeholder interest and support, overall evaluation was low due to the length and complexity of the route (evaluated with cabins without climate control)

Marlins-Downtown:

With its short length and two-station arrangement, and its economic characteristics, market opportunities, and technological risks, the alternative’s overall evaluation is high. Technological risks related to climate control would be mitigated by short trip lengths. The option links a major parking facility with the Miami CBD and the CBD with a major entertainment venue and resurgent cultural district.

Downtown-Port Miami:

This alternative lacked support by a key stakeholder, and the service design suffers with respect to economics and markets. The short system with three stations would be relatively expensive to build and operate. Its western leg would essentially duplicate a parallel Metromover route.

[47] Jacobs Engineering, RG Consultants LLC of Eco-Transit Technologies, CH Perez & Associates; *Aerial Cable Transit Feasibility Study*, Miami-Dade MPO, Miami, Florida February 2016

For the purposes of FLM, the critical aspects of the ACT are that is particularly well suited to short trips in a 1 to 3-mile range, in a point-to-point pattern easily connecting one point to the primary transit station, with very short wait time, good average speed, and high capacity. While rarely is ACT suitable for the backbone of a major transit corridor, it is complimentary to high capacity transit for fulfilling high-capacity FLM mobility to major destinations.

Aerial Cable Transit is ADA compliant

Aerial Cable Transit requires minimal right-of-way footprint and infrastructure relocation

TRANSIT FLM TOOL KIT

T1. TRANSIT SIGNAL PRIORITY

Goals

- Promote regional transit ridership by providing for short and highly reliable connecting transit travel times within the station area TOD Core (¼-mile) and TOD Neighborhood (½-mile).
- Induce sustainable FLM transit travel to primary transit stations by demonstrably improving time and reliability of travel along pathways to the transit station.

Actions

- Identify critical path intersections where transit signal priority changes can have the greatest effect on travel time and reliability of existing transit routes that stop at the primary transit station.
- Perform traffic operations analysis to determine impacts of transit prioritization on vehicular, bike and pedestrian movement through the intersections.
- Collect accident data at specific locations.
- Provide alternatives analysis for transit signal priorities for implementation.
- Develop a station area prioritized strategic plan to progressively implement signal modifications.

Criteria:

- Roadway number of lanes
- Presence of left turn lanes and phases
- Presence of right turn lanes with permissive turns
- Roadway design speed
- Roadway existing and horizon year vehicular volumes
- Roadway existing and horizon year bike volumes
- Intersection existing and horizon year pedestrian crossing volumes
- Existing and forecast transit vehicle usage
- Planned pedestrian crossing or signal enhancements (Tool Kit P4, Tool Kit P5, Tool Kit P6, Tool Kit P7)
- Programming of other projects
- Needed, planned or programmed signal replacement

Improvements

- Addition of transit signal priority treatment:
  - Passive Signal Priority
  - Active Signal Priority

Timeframe

- Mid-term & on-going: data collection, study and implementation.
- Improvements should be prioritized for the most effective improvements to come first, focusing on critical path analysis.
- Timing changes can be programmed with signal replacements, or with development traffic mitigation plan implementations.

Funding

- Eligible FTA Programs for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)
- Coordination with regular program of signal replacements.

TRANSIT FLM TOOL KIT

T2. QUEUE JUMPS AND BOTTLENECK BY-PASSES

Goals

- Promote regional transit ridership by providing for short and highly reliable connecting transit travel times within the station area TOD Core (¼-mile) and TOD Neighborhood (½-mile).
- Induce sustainable FLM transit travel to primary transit stations by demonstrably improving time and reliability of travel along pathways to the transit station.

Actions

- Identify critical path roadway intersections where signal by-pass lanes can have the greatest effect on travel time and reliability of existing transit routes that stop at the primary transit station.
- Identify intersections where right-of-way cross-sections make queue jump or bottleneck by-pass lanes feasible and practicable.
- Perform traffic operations analysis to compare the benefits of the transit by-pass lanes versus signal prioritization alone (T1).
- Perform traffic operations analysis to determine impacts of the queue jump lane with associated signal modifications on vehicular, bike and pedestrian movement through the intersections.
- Collect accident data at specific locations.
- Provide alternatives analysis for queue jump or bottleneck by-pass lanes for implementation.
- Develop a station area prioritized strategic plan to progressively implement queue jump or bottleneck by-pass lanes.

Criteria:

- Cross-sectional width of right-of-way
- Roadway number of lanes
- Presence of left turn lanes and phases
- Presence of right turn lanes with permissive turns
- Roadway existing and horizon year vehicular volumes
- Roadway existing and horizon year bike volumes
- Intersection existing and horizon year pedestrian crossing volumes
- Existing and forecast transit vehicle usage
- Planned pedestrian crossing or signal enhancements (Tool Kit P4, Tool Kit P5, Tool Kit P6, Tool Kit P7)
- Programming of other projects

Improvements

- Addition of transit queue jumps and bottleneck by-passes: short bus-only lanes near congested intersections that allow a bus to pass through a signal in advance of competing traffic. They can include adding a "bus only" green light in advance of the general traffic green light. The objective is to allow buses to go to the front of the line at intersections when waiting for a signal to change.

Timeframe

- Mid-term & on-going: data collection, study and implementation.
- Improvements should be prioritized for maximum effectiveness

Funding

- Eligible FTA Programs for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)
  - Bus and Bus Facility Formula Grants (5339)

TRANSIT FLM TOOL KIT

T3. EXCLUSIVE BUS LANES

Goals

- Promote regional transit ridership by providing for short and highly reliable connecting transit travel times within the station area TOD Core (¼-mile) and TOD Neighborhood (½-mile).
- Induce sustainable FLM transit travel to primary transit stations by demonstrably improving time and reliability to the station.

Actions

- Identify critical path intersections where exclusive bus lanes can have the greatest effect on travel time and reliability of existing transit routes that route stop directly at the primary transit station.
- Perform traffic operations analysis to determine impacts of the addition of exclusive bus lanes, the reduction of vehicular lanes, and integration with bike lanes is present.
- Provide alternatives analysis for types of bus lanes, demarcation, separation, and time-of-day application.
- Develop a station area prioritized strategic plan to progressively exclusive bus lanes as required.

Criteria:

- Roadway number of lanes
- Presence of left turn lanes and phases
- Presence of right turn lanes with permissive turns
- Roadway design speed
- Roadway existing and horizon year vehicular volumes
- Roadway existing and horizon year bike volumes
- Intersection existing and horizon year pedestrian crossing volumes
- Existing and forecast transit vehicle usage
- Programming of other projects
- Needed, planned and/or programmed roadway or underground infrastructure work

Improvements

- Addition of exclusive bus lanes: can be as simple as designating a traffic lane for buses only, or can be as involved as building an exclusive bus guideway apart from the street. The particular design used may vary and must be dependent on traffic studies that include pedestrian and bike facility needs, and alternative analyses particular characteristics and limitations of each setting.

Timeframe

- Mid-term & on-going: data collection, study and implementation.
- Improvements should be coordinated with programmed roadway or underground infrastructure work.
- Improvements should be coordinated with land development relative to trip generation and site access.

Funding

- Eligible FTA Programs for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)
- Coordination with capital improvement program (CIP) for possible cost savings.

TRANSIT FLM TOOL KIT

T4. LEVEL BOARDING TRANSIT AREA BUS STOPS

Goals

- Promote regional transit ridership by providing for short and highly reliable connecting transit travel times within the station area TOD Core (¼-mile) and TOD Neighborhood (½-mile).
- Induce sustainable FLM transit travel to primary transit stations by demonstrably improving time and reliability of travel along pathways to the transit station.

Actions

- Identify existing and future bus stop locations in the station area TOD Core (¼-mile) and TOD Neighborhood (½-mile).
- Inventory bus stops along routes, location, including sidewalk width, and current level of amenity.
- Identify existing and future bus vehicle level-boarding criteria
- Develop standard designs for level bus boarding shelters that are suitable for existing and future year vehicle purchases, requiring:
  - more complete coverage at street side and sidewalk
  - steps and/or ADA accessible connection to sidewalk
  - electricity and lighting
  - dynamic transit schedule and transfer information
  - wayfinding information to transit station and key locations
- Identify program of implementation, prioritizing new stops based on feasibility and utilization.

Criteria:

- Location of stop
- Width of sidewalk
- Sidewalk infrastructure and amenity levels
- Programming of other projects
- Programmed roadway or underground infrastructure work
- Utilization: number of boardings / debarkings

Improvements

- Level boarding station area bus stops with shelters, dignified seating, lighting, real-time information and ADA accessibility
- Level boarding bus stop at primary transit station with direct covered connection to transit station.

Timeframe

- Mid-term & on-going: Data collection and prioritization.
- Improvements should be prioritized for feasibility and for highest volume stops first.
- Improvements should be coordinated with relative pedestrian FLM sidewalk enhancements. (Tool Kit P3, Tool Kit P11)
- Improvements should be coordinated with land development relative to other sidewalk enhancements.

Funding

- Eligible FTA Programs for transit development:
  - Urbanized Area Formula Grants (5307)
  - Bus and Bus Facility Formula Grants (5339)

TRANSIT FLM TOOL KIT

T5. LEVEL BOARDING TRANSIT STATION BUS STOP

Goals

- Promote regional transit ridership by providing for safe, secure and comfortable transit transfer connections to the primary transit platform.
- Induce sustainable FLM transit travel to primary transit stations by improving safety, security and convenience of transit transfers to the station.
- Allow all forms of transit, public and private to use the transit station bus stop.

Actions

- Identify existing and future bus stop needs for the primary transit station, depending on primary transit mode and station design.
- Needs include:
  - Number of routes, frequency and vehicle size / type
  - Number of routes using station for a lay-over area
  - Number of pull-out bays
  - Passing lane to avoid bottlenecks
  - Safe access to and from the roadway network
  - Security
  - Proximity of rest and wash-up facilities for drivers
- Identify existing and future bus vehicle level-boarding criteria
- Develop standard designs for level bus boarding transit station connections that are suitable for incorporation into new transit station designs.

Criteria:

- Primary mode
- Location of Transit Station
- Transit Station design
- Number of Routes, public and private
- Anticipated utilization (number of transfers)

Improvements

- Level boarding transit station bus transfer platforms that are safe, secure, convenient and dignified for persons of all ability.

Timeframe

- Mid-term to Long-Term: designed and implemented with the transit station.

Funding

- Eligible FTA Programs for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)
  - Bus and Bus Facility Formula Grants (5339)

TRANSIT FLM TOOL KIT

T6. MICRO TRANSIT

Goals

- Provide efficient alternatives to public transit to provide complete FLM mobility in station areas.
- Promote regional transit ridership by increasing the variety of efficient transit alternatives to complete FLM mobility in station areas.
- Reduce the cost of FLM mobility to consumers requiring or preferring vehicular mobility.
- Integrate public transit and micro transit as complementary components in a mobility network.

Actions

- Review policy and legislative barriers to allowing Micro Transit, and modify to permit and control private micro-transit providers as complementary components of the public transit system.
- Review policy and legislative barriers to allowing Micro Transit to use public bus stops for the purpose of minimizing duplication of bus stop pull-out areas, and to allow more seamless integration of Transit FLM mobility from the consumer perspective.
- Work with providers to coordinate routes.
- Work with providers to coordinate transit information across smart phone apps.

Criteria

- Location and origin/destination of public transit routes
- Capacity and utilization of public transit routes
- Schedule of public transit routes

Improvements

- Changes to County and municipal policy and regulations, as appropriate
- Coordination with Micro Transit private providers
- Agreements with private Micro Transit providers
- Development of information sharing across apps
- Space for Micro Transit vehicles at transit station transfer
- Space for Micro Transit vehicles at other bus stops

Timeframe

- Short term: policy implementation, coordination, agreements and information sharing.

Funding

- Private providers of Micro Transit services.

TRANSIT FLM TOOL KIT

T7. ADVANCED GROUP RAPID TRANSIT (GRT)

Goals

- Provide efficient public transit alternatives that meet user needs between the primary transit stations and high trip generator destinations or employers.
- Promote regional transit ridership by increasing the overall convenience, speed, and reliability of transit FLM alternatives.
- Reduce the cost of transit between the transit station and major employers and destinations.
- Reduce the cost of FLM mobility to consumers by more effective transit.
- Provide highly-visible signature transit to help promote regional transit use.
- Increase the use of shared parking and reduce redundant transit station area parking, thereby increasing the amount of developable floor are in the station area.

Actions

- Define existing and future major generators and major employment centers within the transit station area.
- Pursue shared parking agreements where applicable.
- Define efficient and productive pathways that are feasible for use of narrow automated vehicles.
- Define specific technology to use that is reproducible and will be supported for future implementations.
- Perform infrastructure analysis for control, signal integration and determine other needs.
- Perform traffic operations analysis to determine impacts of bus lanes, mixed traffic operation, and integration with bike lanes.
- Develop control center that is scalable for future expansion of GRT systems in other station areas.
- Design, develop and build advanced GRT system, concurrently with primary transit station development.

Criteria

- Location, distance and ridership potential for destinations.
- Relative parking capacities at transit station and destinations.
- Feasibility of exclusive right-of-way along pathway(s).
- Land use and development along pathway(s).
- Forecast capacity and utilization.

Improvements

- Advanced, autonomous Group Rapid Transit system with exclusive right-of-way, shared ROW, signal priority at intersections, AV roadside equipment (RSE), and a scalable control center.

Timeframe

- Mid to Long Term: develop, design and build concurrent with primary transit station.

Funding

- Eligible FTA Programs for transit development:
  - Urbanized Area Formula Grants (5307)
  - Fixed Guideway Capital Investment Grants (“New Starts”, 5309)

TRANSIT FLM TOOL KIT

T8. AERIAL CABLE TRANSIT (ACT)

Goals

- Provide efficient public transit alternatives that meet user needs between the primary transit stations and high trip generator destinations or employers.
- Promote regional transit ridership by increasing the overall convenience, speed, and reliability of transit FLM alternatives.
- Reduce the cost of transit between the transit station and major employers and destinations.
- Reduce the cost of FLM mobility to consumers by more effective transit.
- Provide highly-visible signature transit to help promote regional transit use.
- Increase the use of shared parking and reduce redundant transit station area parking, thereby increasing the amount of developable floor are in the station area.
- Provide high-capacity FLM mobility at minimal impact to roadway capacity and communities.

Actions

- Define existing and future major generators and major employment centers within the transit station area, and identify or develop support for terminal location.
- Design primary transit station for ACT terminal integration.
- Define pathway based on cost, distance minimization, straight horizontal path, and minimal disturbance to land uses below, and prohibitions as appropriate to FAA requirements.
- Define specific technology to use that is reproducible and will be supported for future implementations.
- Perform infrastructure analysis for support, control, and determine other needs.
- Design, develop and build ACT system, concurrently with primary transit station development.

Criteria

- Location, distance and ridership potential for destinations.
- Feasibility analysis, as performed for 2016 ACT study.
- Land use and development along pathway(s).
- FAA clearance zones.

Improvements

- Advanced, autonomous Aerial Cable Transit (ACT) system with terminals, and direct connection to SMART Plan transit station.

Timeframe

- Mid to Long Term: develop, design and build concurrent with primary transit station.

Funding

- Eligible FTA Programs for transit development:
  - Fixed Guideway Capital Investment Grants ("New Starts", 5309)

CASE STUDIES

PURPOSE & PROCESS

In coordination with the SAC two case study locations for implementing FLM strategies along the SMART Corridors, were selected to test the applicability of the Tool Kits.

In September 2017, the TPO provided direction toward the selection of the case studies: the selection process included:

- Prioritize the SMART Plan North Corridor and South Corridor: select one location on each corridor;
- Use existing MetroRail or Busway stations for proposals;
- Use the Toolkit to make short-term recommendations that are reasonably implementable;
- Focus on providing good opportunities for FLM options at existing high-trip generator employers and destinations.

This analysis documents the procedures needed to perform a station area FLM plan for a specific purpose, destination or employment center, and can be used for developing other FLM plans.

The recommendations for each case study include the application of the developed FLM Tool Kits and a set of recommendations in specific locations for the various modes, with the goal of eliminating gaps or barriers to ridership.

A list of 4 proposals was provided to the TPO with a limited data collection and analysis. The list included:

NORTH CORRIDOR

NORTHSIDE PLAZA

Northwest corner of NW 27th Avenue and NW 79th Street

Based on field visits, this shopping center is a very busy center of daily needs retail and services activity for the local community. It is approximately 1/3 mile from the existing MetroRail Northside Station and along the alignment of the future North Corridor transit. We are not aware of any current redevelopment plans. As a first-last mile case study, the modal focus would be primarily pedestrian and bike, with walkability and bike facility urban design improvements as the primary strategies.

MIAMI DADE COLLEGE, NORTH CAMPUS

Southwest corner of NW 27th Avenue and NW 119th Street

Main entrance at NW 113th Street

As a major educational institution, MDCC is a major employment trip generator and major non-residential destination. It is directly along the alignment of the future North Corridor transit; however, the campus in its existing development configuration has an empty space barrier to the 27th Avenue potential alignment. Depending on station location, the un-occupied barrier would range from just under ¼-mile to ½-mile. That the land is under the singular management of MDCC is a benefit for implementation. As a first-last mile case study, the modal focus would be primarily pedestrian and bike, with walkability, bike facility, land use and urban design improvements as the primary strategies.

OPA LOCKA DOWNTOWN AND TRI-RAIL CONNECTOR

West side of NW 27th Avenue and Ali Baba Avenue

The edge of Opa Locka's downtown area is directly along the alignment of the future North Corridor transit. The City is focused on revitalizing its downtown, and the triangular area has a fine, small-block grid structure, good pedestrian infrastructure potential, and street terminations that define a classic "garden city" TOD compact area. Despite this, there is a need for urban design improvements to complete the infrastructure. Not only is there existing development with good redevelopment potential, but there is the existing intermodal connection to the Opa Locka TriRail Station 2/3 mile from the NW 27th Avenue alignment. As a first-last mile case study, the modal focus would be primarily pedestrian and bike, with walkability, bike facility, land use and urban design improvements as the primary strategies.

CAROL CITY COMMERCIAL AREA

Northeast and Southwest corners of NW 27th Avenue and Miami Gardens Drive (NW 183rd Street)

The northwest shopping center comprises general retail and services for the local community. The southwest corner is not active and is being remarketed. It is along the alignment of the future North Corridor transit; however, the current configuration presents a significant barrier and detractor to pedestrian connections from future transit. As a first-last mile case study, the modal focus would be primarily pedestrian, with walkability urban design improvements as the primary strategies.

SOUTH CORRIDOR

BAPTIST HOSPITAL

South of Kendall Drive (SW 88th Street) with main entrance at SW 89th Avenue

As a major medical center, Baptist Hospital is a major employment trip generator and major non-residential destination. It is directly along the Kendall Corridor alignment; however, the connection to the existing Dadeland South MetroRail Station, part of the South Corridor, is of interest as a first-last mile initiative for rapid transit connections to the south and north. The main entrance of Baptist Hospital is 1-¾ miles from the Dadeland South Station. Baptist Hospital is already experienced as a transportation participant with a circulator to the South Miami MetroRail Station and with South Florida Commuter Services for a car pool program. As a first-last mile case study, the modal focus would not be pedestrian, but primarily focused on shared-use station cars, a more direct circulator to the Dadeland South Station, and bicycle.

FRANJO TRIANGLE COMMERCIAL AREA

South of the intersection of South Dixie Highway (US-1) and SW 97th Avenue to Quail Roost Drive (SW 186th Street)

This triangular area of land contains an agglomeration of general and regional retail and services in the Perrine community and Cutler Bay. Although along the Busway alignment, the traffic along US-1 presents a significant pedestrian and bike barrier, effectively increasing pedestrian impedance for connecting to the South Corridor. As a first-last mile case study, the modal focus would be primarily pedestrian and bike, with walkability and bike facility urban design infrastructure improvements as the primary strategies, with potential to incorporate land use strategies.

SOUTH DADE CENTER / SOUTHLAND MALL

South east of South Dixie Highway (US-1) and the intersection with the Florida's Turnpike, and north of SW 211th Street

The shopping center is a viable center for regional employment, shopping and educational services. The mall land is also the subject of future town center plans for Cutler Bay. Although along the Busway alignment, the traffic along US-1 presents a significant pedestrian and bike barrier, effectively increasing pedestrian impedance for connecting to the South Corridor. As a first-last mile case study, the modal focus would be primarily pedestrian and bike, with walkability and bike facility improvements as the primary strategies. As a planned TOD, there is also the possibility to incorporate first-last mile strategies into the TOD plans, designs and future infrastructure.

NARANJA

TOD plan on the east side of South Dixie Highway (US-1) at approximately Bauer Drive (SW 264th St.)

The Naranja Town Center area has little existing non-residential development; however, it is the subject of a prior Miami-Dade County planning study to develop it as a TOD. Although along the Busway alignment, US-1 presents a significant pedestrian and bike barrier, effectively increasing pedestrian impedance for connecting to the South Corridor. Different from other site suggestions, Naranja is suggested as a good potential clean-slate for redevelopment with first-last mile strategies built in. As a first-last mile case study, the modal focus would be primarily pedestrian and bike, with walkability, bike facility, land use and urban design improvements as the primary strategies; however, it could also serve as a complete first-last mile case study for all multi-modal first-last mile strategies including transit and shared vehicles into the outlying agricultural and low-density areas.

FINAL CASE STUDY LOCATIONS:

The initial list of 8 locations was narrowed down through meetings with the TPO staff, and 4 alternatives were presented to the SAC on October 12, 2017 for determination of 1 location for each corridor.

The four locations that were presented to the SAC included:

North Corridor:

- Northside Plaza
- Miami Dade College, North Campus

South Corridor:

- Kendall Health District
- South Dade Civic Center

At this time, the TPO staff and SAC agreed that one of the case studies would test the currently in-development Accessibility GIS Model proposed for application to the Miami Dade TPO Long Range Transportation Plan (LRTP) to score, map and test accessibility based on existing conditions and proposed modifications. While the Accessibility Model is multimodal, in its current development as applied to Miami Dade GIS, it is best applied to pedestrian analysis; therefore, one of the Case Study locations was selected to focus on Pedestrian FLM. The other case study was evaluated to work through a decision framework to apply the FLM Tool Kit as provided in this study. The final determination for case studies was:

North Corridor:	**North Dade College**	**FLM Tool Kit**
South Corridor:	**South Dade Civic Center**	**Accessibility Model**

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FLM CASE STUDIES

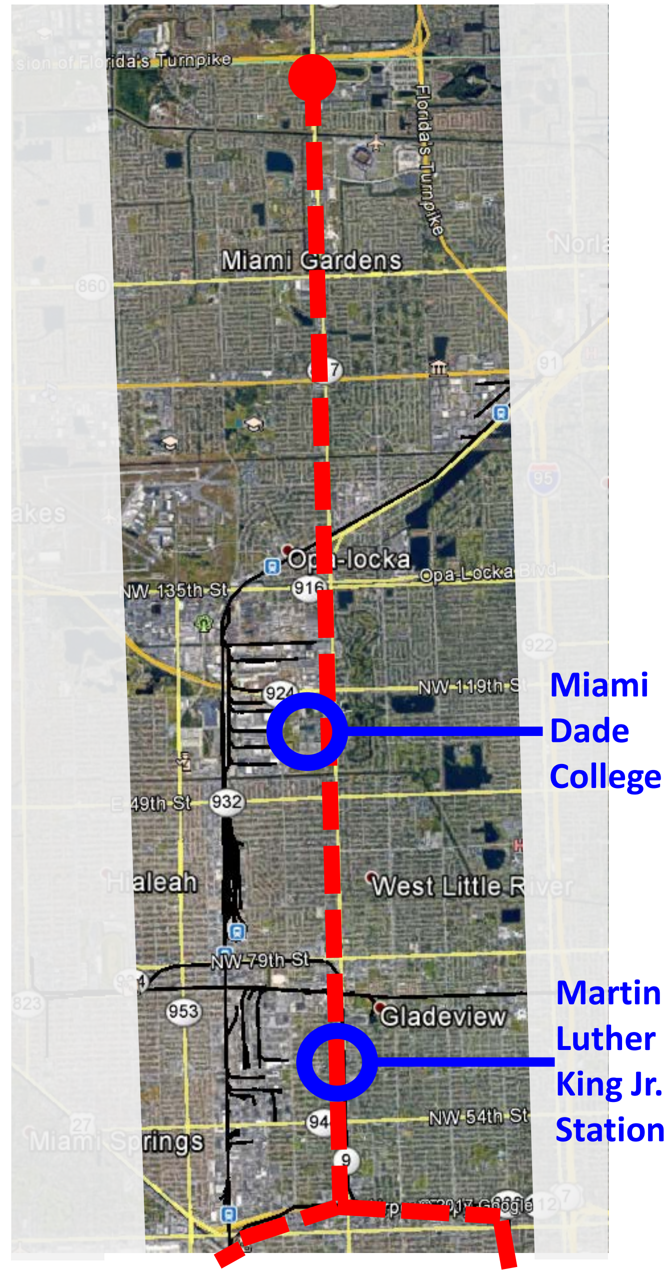
NORTH CORRIDOR:
MIAMI DADE COLLEGE, NORTH CAMPUS to DR MARTIN LUTHER KING METRORAIL STATION

TIME HORIZON: SHORT -TERM

MIAMI-DADE COLLEGE, NORTH CAMPUS
Southwest corner of NW 27th Avenue and NW 119th Street
Main entrance at NW 113th Street

As a major educational institution, MDCC is a major employment trip generator and major non-residential destination. The campus is situated on 245 acres of land on the it is directly along the alignment of the future North Corridor transit; however, the campus in its existing development configuration has an empty space barrier to the 27th Avenue potential alignment. Depending on station location, the un-occupied barrier would range from just under ¼-mile to ½-mile. That the land is under the singular management of MDCC is a benefit for implementation. In the long term, a North Corridor primary transit station would be located near to the campus, and presumed to be in the area along NW 27th Avenue between NW 119th Street and NW 113th Street. For long-term FLM strategies, with short and walkable distances between the station and the campus, the modal focus would be primarily pedestrian and bike, with walkability and bike facility improvements as the primary strategies.

This case study is to examine a short-term, implementable strategy.



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DR MARTIN LUTHER KING JR METRORAIL STATION

6205 NE 27th Avenue and 62nd Srtreet

The Dr. Martin Luther King Station Miami Metrorail Station opened for service on May 19, 1985, and serves the Brownsville and Liberty City neighborhoods of Miami. The station is served by the MetroRail Green Line, which provides rapid transit service to 22 stations (the MIA Station requires transfer to the Orange Line) on a 24.8-mile heavy rail electrified line. The system operates on an elevated guideway with transfer points to:

- Tri-Rail regional commuter rail service at the Tri-Rail Station,
- MetroMover CBD people mover at Government Center Station
- South Miami-Dade Transitway at the Dadeland South Station.

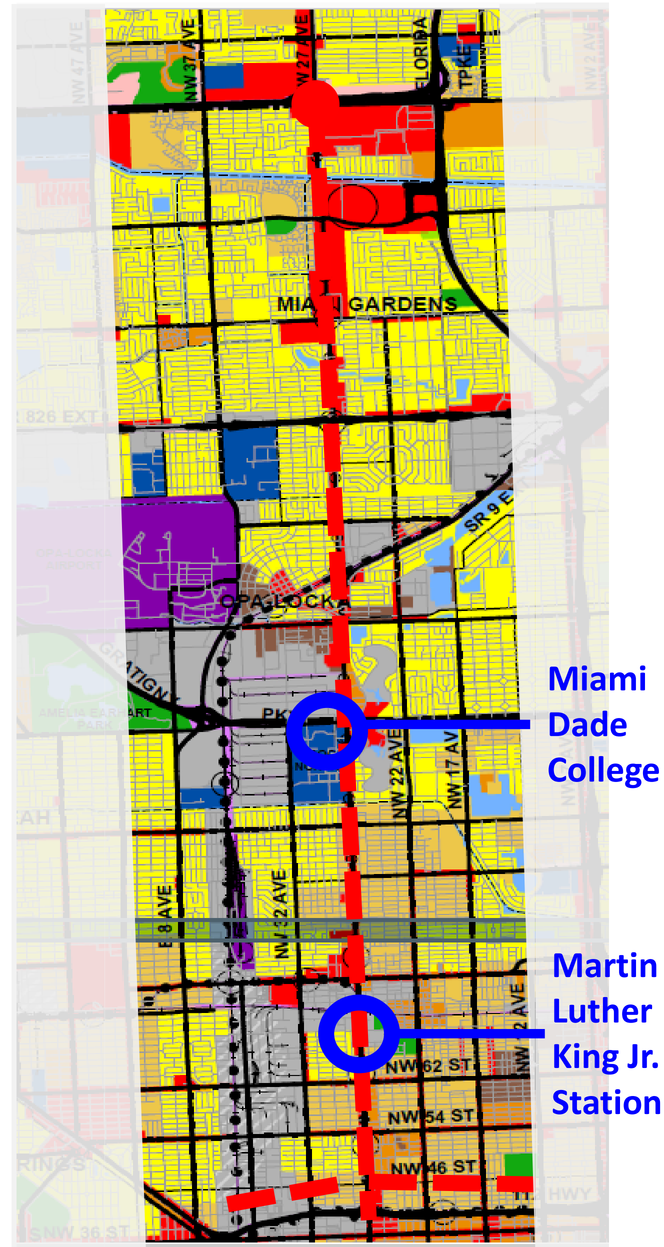
The MetroRail fleet includes total fleet of 136 heavy-rail cars, 75 ft. long, each with a capacity of 166 passengers (76 seated, 90 standing).

Passenger service with 4-car trains (664 capacity per train) starts at 5:00 a.m. from the terminal stations and ends with the last train arriving at the terminal station at 12:48 a.m. The Green Line operates at 10-minute headways during the peak AM and PM travel times, and off-peak headways of 15 minutes. Weekend and holiday Green Line service operates with headways of 30 minutes.

Total hourly rail capacities at the Station are:

Weekday Peak	10-min. headway	3,984 pass.
Weekday Off-Peak	15-min. headway	2,656 pass.
Weekend and Holiday	30-min. headway	1,328 pass.

The Dr. Martin Luther King Station Miami Metrorail Station would also be a part of the North Corridor of the Miami-Dade SMART Plan.



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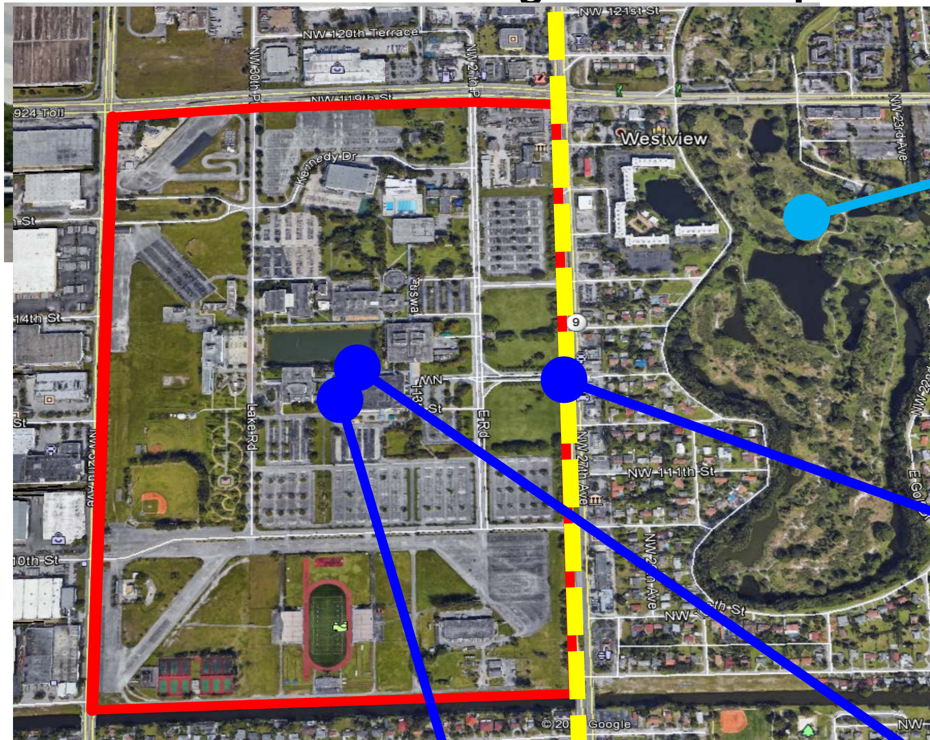
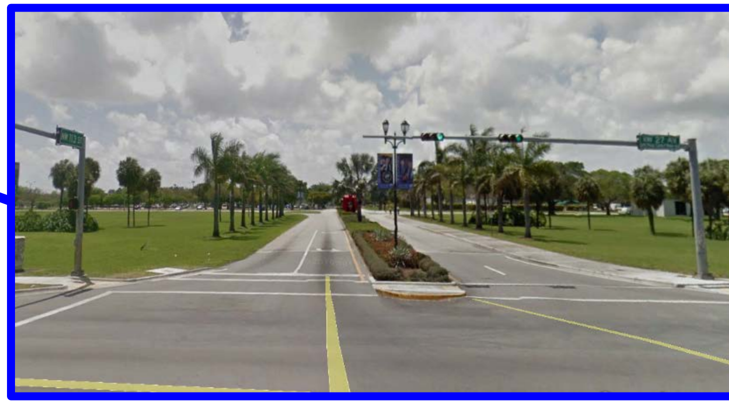
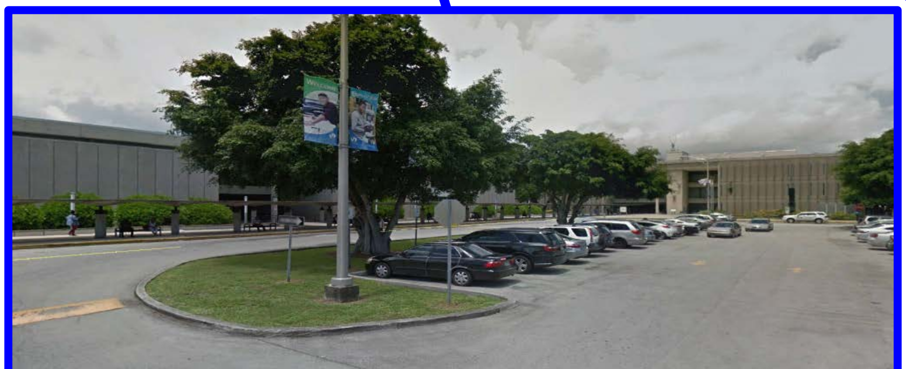
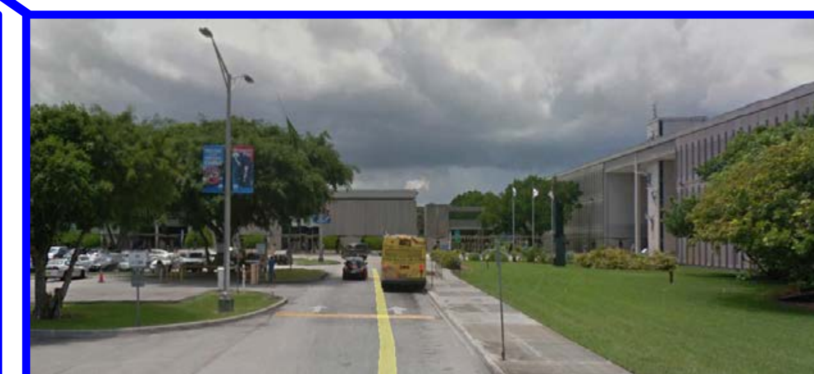
Miami Dade College North Campus



Proposed (future) Westview Business Park
(400,000 s.f. retail, 1.6-million s.f.







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DR. MARTIN LUTHER KING STATION RIDERSHIP PROFILE

Station Ridership Characteristics

Station ridership data, ridership trip characteristics, and ridership demographics data was collected to define the likelihood of utilization for different modal solutions. While is a numerical forecast methodology in the literature for car sharing based on dependent Pearson correlation coefficients for area demographics[48], there are no simple, developed and applicable models for all FLM modal groups. The basic concepts of correlations, if not the numerical relations ships are generally agreed on:

Age has correlations particularly to pedestrianism and bicycle use; however, for this analysis it is used as a prequalifier to remove non-working or college age transit users that board and debark at this station.

Other than pedestrian modes, the use of other FLM and shared resource mobility is correlated to: household size; 1-person households; vehicle(s) per household; person(s) in household without vehicle access, and household income.

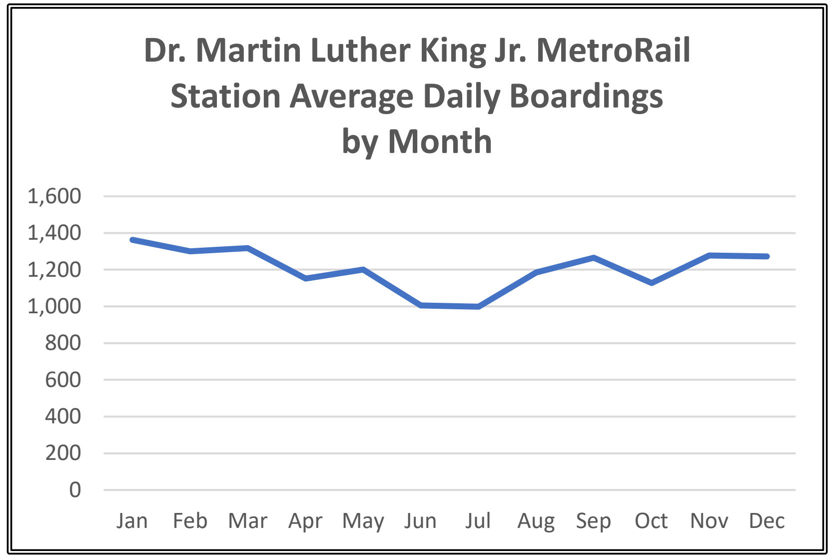
For transit-linked trips, survey travel mode to train is used as an indicator of potential FLM modal group split. Among the modal groups, there are significant differences in travel time, convenience, wait time and reliability, and cost to consumer.

Household income is used to qualitatively approximate demand response prioritization to modal groups based on cost to consumer.

Where possible, trip purpose can be used to identify the station's markets for certain destinations. In this case, the predominant market purpose would be home-based school trips and work-based school trips.

Based on the most recent ridership year for which data is available for the station, from September 2016 through August 2017 boardings at the station[49], are:

Dr. Martin Luther King Jr. MetroRail Station	
Average Daily Boardings	1,205
Weekday	1,423
Saturday	793
Sunday	660
Holiday	857



[48] Christine Celsor and Adam Millard-Ball; Where Does Carsharing Work? Using Geographic Information Systems to Assess Market Potential, Transportation Research Record, Washington DC, 1992.

[49] Miami Dade County DTPW Ridership Technical Reports: September 2016 through August 2017.

Of the 1,205 annual average daily boardings, 895 are passengers over 18 years of age. Among this prequalified group of college-age persons and persons likely in a college workforce, the following characteristics are identified:

Trip Purpose:

- 9% are home-based-school trips
- 1% are work-based-school trips

Household Vehicles:

- 36% have no vehicle in their household
- Average vehicles per household person is 0.34
- Average people in household without a car is 1.99

Household Income:

- Over 75% low-income households

Mode to MetroRail:

- 29% walk to MetroRail
- 48% take a bus to MetroRail
- 7% carpool to MetroRail
- 1% bike to MetroRail

- Based on MetroRail rider characteristics, only up to 10% of riders are likely using the station to go to MDC.
- Transit connections are favored by existing MetroRail riders, and existing bus routes provide good service,
- Household income and auto ownership patterns do not indicate good probability of car sharing program success
- A station-based bike sharing program does not initially appear to have strong potential; however, consumer costs are low, initial capital costs are low, operating costs are lower than transit, and a bike sharing program may be beneficial to the station area community.

Dr. Martin Luther King J. Station Metrorail FLM Market Assessment								421
parameter	value	percent	Walk Potential	Bike Potential	Vehicle Ride Potential	Vehicle Drive Potential	Transit Potential
Weekday Boardings (Sep 2016 - Aug 2017)	1,423	2%	-	-	-	-	-
Weekend Boardings (Sep 2016 - Aug 2017)	727	3%	-	-	-	-	-
Avg. Annual Daily Boardings	1,205	2%	-	-	-	-	-
MetroRail Passenger Household Composition						Sample = 462	
Passengers Age 19 & Over	895	74%	895	895	895	895	895
Passengers Age 16 to 18	219	18%	219	219	219	0	219
Passengers Under Age 16	91	8%	91	91	91	0	91
Passenger Average Household Size	3.01	-	-	-	-	-	-
Passenger in 1-Person Household	107	9%	-	-	-	-	-
Passenger in 2-Person Household	198	16%	-	-	-	-	-
Passenger in 3+Person Household	900	75%	-	-	-	-	-
MetroRail Passenger Auto Ownership							
No Vehicle	431	36%	-	-	-	-	-
1 Vehicle	342	28%	-	-	-	-	-
2 or more vehicles	433	36%	-	-	-	-	-
Average Vehicles per Household	1.02	-	-	-	-	-	-
Vehicles per Person in HH	0.34	-	-	-	-	-	-
People in HH without Car	1.99	-	-	-	-	-	-
MetroRail Passenger Work Trip Travel Mode to Train							
Drove Alone (5)	23	2%	-	-	-	17	-
Carpool (3)	89	7%	-	-	89	-	-
Metro Mover (6)	16	1%	-	-	-	-	16
Tri-Rail (7)	3	0%	-	-	-	-	3
Metro Bus (8)	579	48%	-	-	-	-	579
Bike (4)	10	1%	-	10	-	-	-
Walk up to 3 Blocks (1)	277	23%	277	-	-	-	-
Walk More than 3 Blocks (2)	76	6%	76	-	-	-	-
Other	133	11%	-	-	-	-	-
Distance for FLM Analysis							
to Miami Dade College, North Campus	2.75 miles		-	-	-	-	-
Walk FLM Shift for (up to 3 blocks)	-	-	-277	4	34	7	231
Walk FLM Shift for (more than 3 blks)	-	-	-76	1	9	2	63
Net FLM Modal Potentials (distance & mode)			0	16	132	26	892
MetroRail Passenger Trip Purpose Pairs							
Home-Based Work	435	33%					
Home-Based Medical	27	2%					
Home-Based School	114	9%	0	1	11	2	77
Home-Based Shop / Rec / Other	415	31%					
Hotel-Based Work	7	1%					
Hotel-Based Medical	0	0%					
Hotel-Based School	0	0%					
Hotel-Based Shop / Rec / Other	0	0%					
Work-Based Medical	0	0%					
Work-Based School	13	1%	0	0	1	0	9
Work-Based Shop / Rec / Other	60	5%					
Net FLM Modal Potentials for Station (distance & mode)			**0**	**2**	**13**	**3**	**86**
MetroRail Passenger Household Income (check to assure number of mid-high income gretater than vehicle FLM)						responses = 93	
Less Than $10,000*	311	26%					
$10,000 - $15,000	311	26%					
$15,001 - $20,000	156	13%					
$20,001 - $30,000	220	18%					
$30,001 - $40,000	91	8%					
$40,001 - $60,000	78	6%					
$60,001 - $80,000	13	1%					
$80,001 and Over	26	2%					
Average Household Income							

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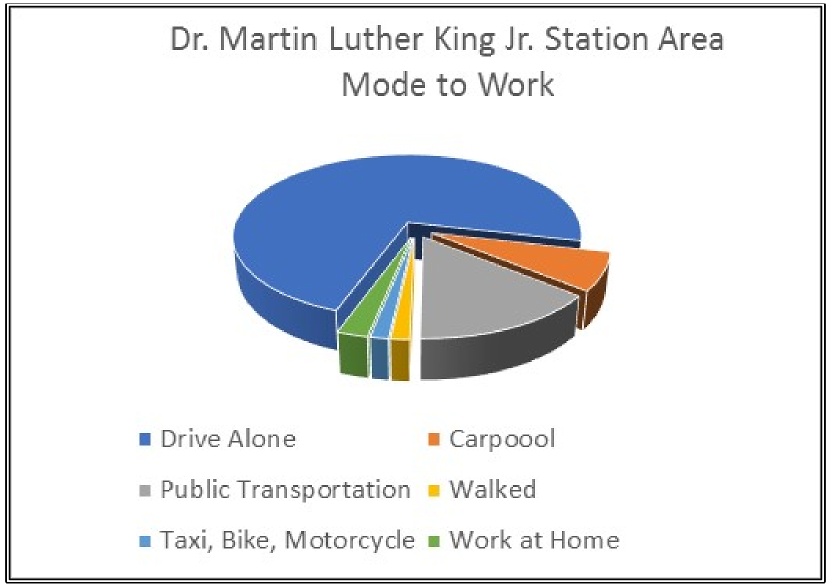
Station Area Characteristics

In addition to station user characteristics, trip characteristics and demographic data was collected for the station area. Important to establishing two markets for station shared mobility strategies, the neighborhood potential to use mobility resources for non-transit-linked trips is key to establishing economically sustainable FLM sharing strategies.

For these purposes, data was obtained from the American Community Survey (ACS) for the station area surrounding the Dr. Martin Luther King Jr. MetroRail Station. Data is based on parsing for census tracts Census tracts 90.03, 10.04, 15.02, 17.01, and 18.01.



The pertinent findings are summarized below.

- 30% of population is under18 years of age
- Median age is 32.8
- Of those over 16 and in the workforce, 42% are employed
- Average HH Income is low: $23,593
- Households with no vehicles is 9.4%
- Yet, most trips to work are drive alone
    - Drive alone 74%
    - Public Transportation 15%
    - Carpool 7%
    - Taxi, Bike or Motorcycle 1%
    - Walk 1%
    - Work At Home 2%

FLM CONNECTION DISTANCE   2.75 miles

EXISITING MOBILITY CONNECTIONS

<u>Pedestrian Connections:</u>

There are sidewalks on both sides of NW 27th Avenue from the Dr. Martin Luther King Station Miami Metrorail Station to the NW 113th Street Entrance of the Miami Dade College Campus

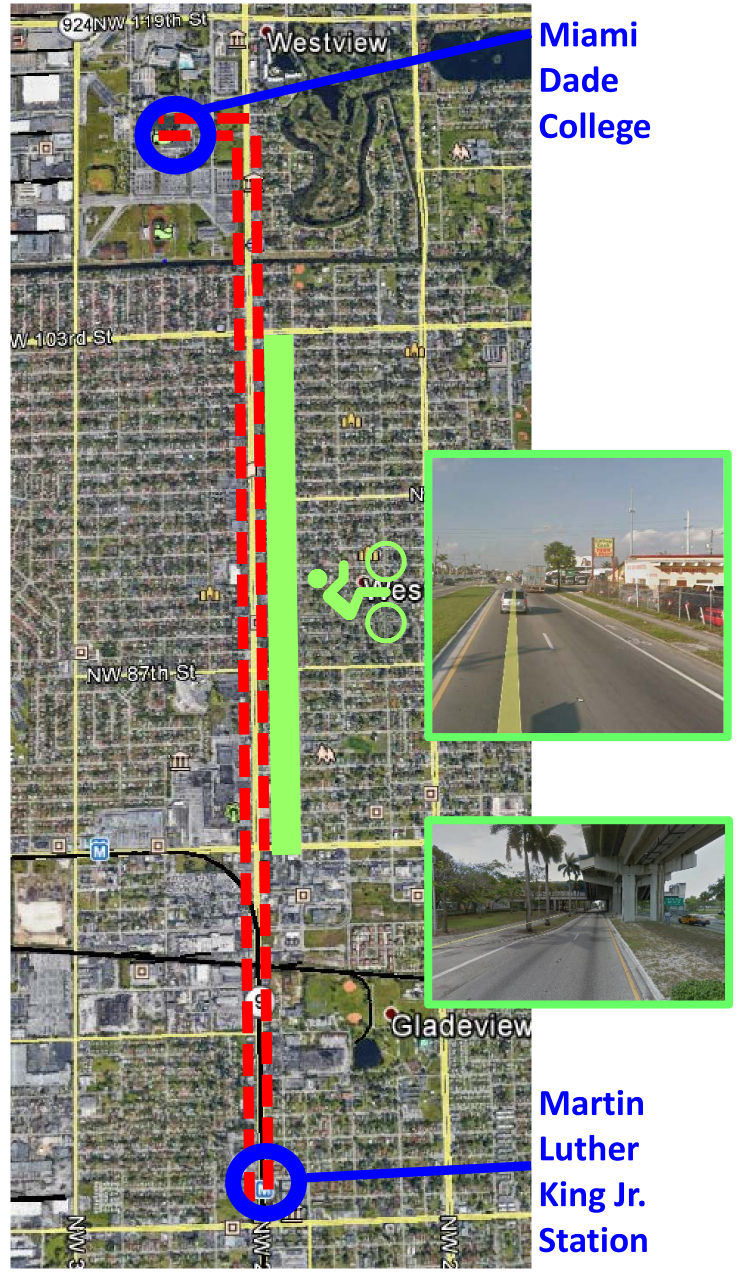
The condition of sidewalks is generally minimal:

- Continuous on both sides of NW 27th Avenue.
- 5-foot widths, generally directly along the curb line.
- Along some blocks, there are 3-foot wide planting strips separating the sidewalk from the traffic lanes.
- No parking lane to protect pedestrians.
- There is no significant pedestrian-oriented development along the path, and in many locations the sidewalks abut auto-oriented, semi-industrial uses. In some places, chain-link fence is at the outside edge of the sidewalk, leading to a very unattractive and insecure condition.
- There are crosswalks on most intersections; however, ADA-ramps are not on all intersections, and pavement markings are minimal and generally worn.
- There are no protected pedestrian phases at the 8 signalized intersections (NW 75th St., NW 79th St., NW 87th St., NW 95th St., NW 96th St., NW 103rd St., NW 110th St., NW 113th St.) An average delay time of 16 minutes should be expected.
- There is a railroad crossing between NW 73rd St. and NW 74th St.

Pedestrian walk time without signal time delay is estimated to be 61 minutes, based on the MUTCD-accepted pedestrian speed of 2.7 mph. With traffic delay, walk time would be at least 1-hour, 17-minutes. This is too long for pedestrian FLM.

FLM CONNECTION DISTANCE 2.75 miles

EXISITING MOBILITY CONNECTIONS



<u>Bicycle Connections:</u>

There is a bike lane along NW 27th Avenue from the north side of the intersection with NW 96th Street to the south side of NW 103rd Street.

- The bike lane is continuous on the northbound side of NW 27th Avenue in this segment
- There is not a continuous bike lane on the south-bound side.
- Bike lane is not buffered or protected
- Bike lane does not continue south of NW 96th Street to the Station
- South of NW 96th Street, NW 27th Avenue:
  - 4 through lanes, separated by a median that also contains the supports for the Metrorail tracks.
  - In this segment, the travel lanes are 11-ft. wide and cannot be narrowed.
  - There is no room on the sidewalks for a shared path.
- North of NW 103rd Street, NW 27th Avenue:
  - has 6 through lanes, separated by a median with left-turn lanes.
  - In this segment, the travel lanes are wider than 11-ft. wide and may be narrowed to make space for bike facilities on both sides of the NW 27th Avenue leading into the campus.
- Campus Driveway on NW 113th Street
  - There are no bike facilities or paths along the street

Human-powered bicycle time without signal time is estimated to be 14 minutes. With an E-bike, travel time would be about 8 minutes. These are slightly long, but acceptable ranges of time for FLM

FLM CONNECTION DISTANCE 2.75 miles

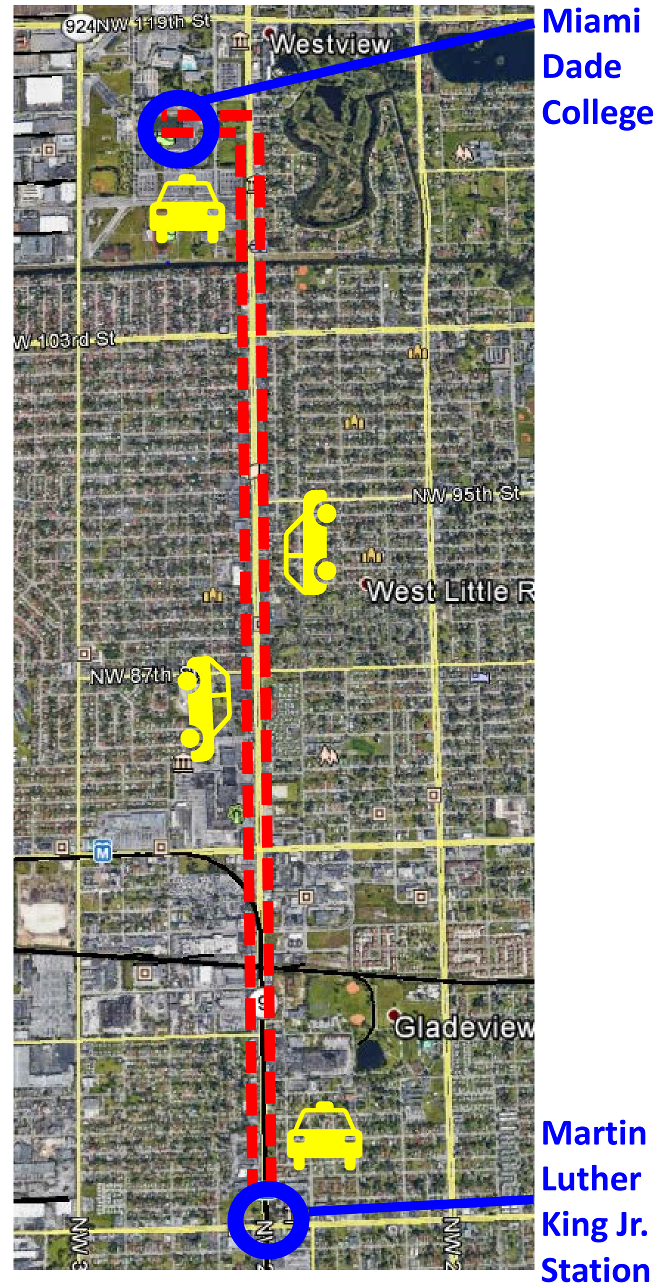
EXISITING MOBILITY CONNECTIONS

<u>Vehicular Connections:</u>

NW 27th Avenue is a 1-mile section major arterial, maintained by FDOT.

- South of NW 96th Street:
  - 4 through lanes, separated by a median that also contains the supports for the Metrorail tracks.
  - In this segment, the travel lanes are 11-ft. wide
  - Posted speed limit is 35 mph
  - There are 4 signalized intersections (NW 75th St., NW 79th St., NW 87th St., NW 95th St.)
  - There is a railroad crossing between NW 73rd St. and NW 74th St.
- NW 96th Street to NW 103rd Street:
  - 4 through lanes, separated by a median with left-turn lanes
  - Posted speed limit is 35 mph
  - There are 2 signalized intersections (NW 96th St., NW 103rd St.)
- North of NW 103rd Street, NW 27th Avenue:
  - has 6 through lanes, separated by a median with left-turn lanes
  - Posted speed limit is 35 mph
  - There are 2 signalized intersections (NW 110th St., NW 113th St.)
- Campus Driveway on NW 113th Street
  - 4 through lanes, separated by a planted median.

Using vehicular modes, travel times are 5 minutes in the off-peak times. At peak periods, travel time varies, but is expected in the range of 10 to 15 minutes with delay.



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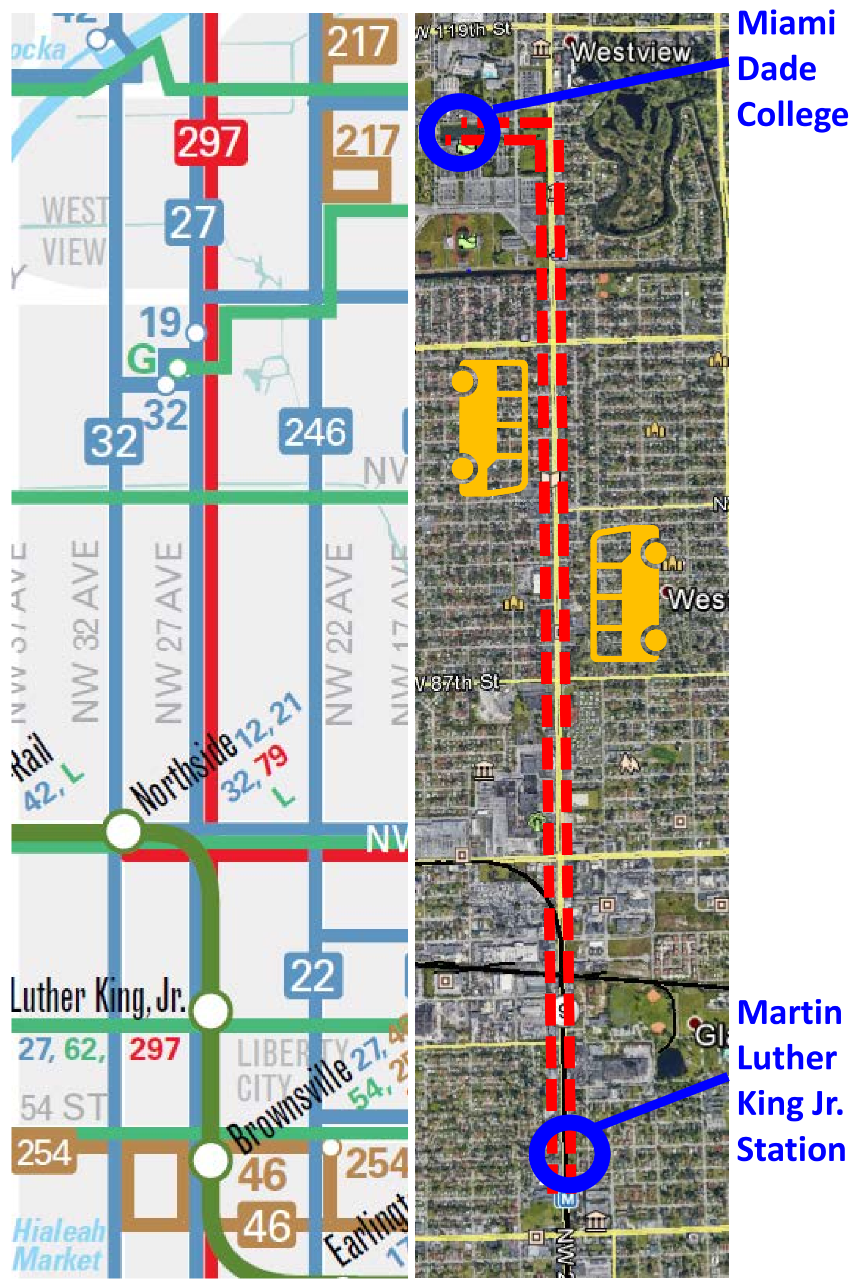
FLM CONNECTION DISTANCE 2.75 miles

EXISITING MOBILITY CONNECTIONS



Transit Connections:

There is transit FLM service from the Dr. Martin Luther King Station to Miami Dade College, North Campus:

Route 27

- Regular route stopping at the Martin Luther King Station
- Provides with direct service to MDC, weekdays and Saturdays

	Headway	Travel Time
Weekday Peak	15 min.	13-15 min.
Weekday Off-Peak	15 min.	13-15 min.
Weekday Night	30-60 min.	12 min.
Saturday	20 min.	13-15 min.
Sunday	30 min.	13-14 min. + walk

- Bus schedule not dynamically coordinated with Metrorail.

Route 297, 27th Avenue Orange MAX

- Max route stopping at the Martin Luther King Station
- Provides direct service to MDC on weekdays and Saturdays

	Headway	Travel Time
Weekday Peak	15 min.	12-15 min.
Weekday Off-Peak	30 min.	12 min.
Weekday Night	no service after 7:30pm at MLK	
Saturday	no Saturday service	
Sunday	no Sunday service	

- Bus schedule not dynamically coordinated with Metrorail.

There are adequate and convenient transit connections between the Martin Luther King Jr. Station and the Miami Dade College, North Campus. Public transit FLM would be duplicative; however, the development of Micro-Transit services should not be precluded.

NORTH CORRIDOR SHORT TERM FLM TOOL KIT

B11. Small Station Based Bike Sharing Program with destination racks at MDC:

- County to work with private vendors
- Human-powered bike, about 14 minutes
- E-bike, about 8 minutes
- Bike sharing can benefit low-income community for other neighborhood bike-sharing trips

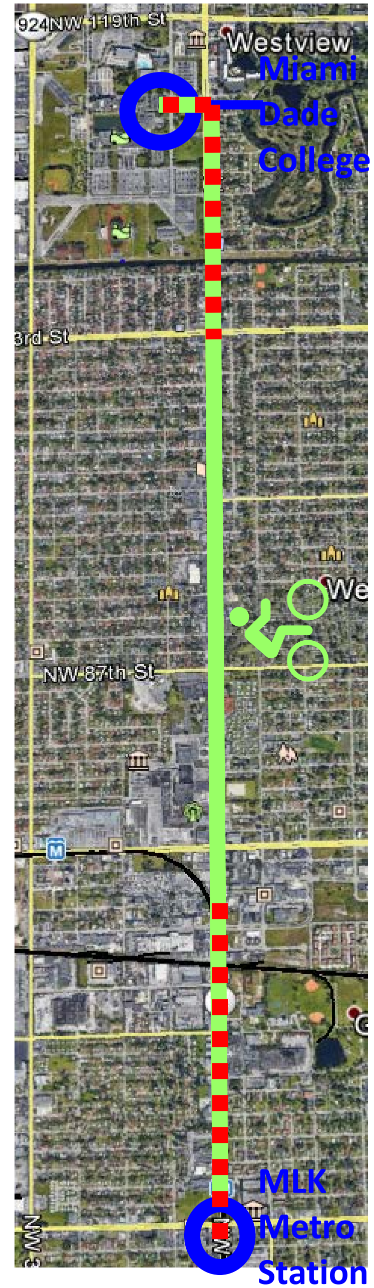
B5. Complete and improve bike lane along NW 27th Avenue from Dr. Martin Luther King Jr. Station to MDC, North Campus:

- Existing bike lane improved as buffered land to protect bikes from high speed traffic
- Space is limited in roadway and in MetroRail median; however, and protected underline path should be investigated further.
- From 103rd Street north to the campus, extend protected bike lane

B4. Reduce vehicular travel lane widths for additional width to allow for buffered bike lanes where possible

- NW 27th Avenue has posted 35 mph limit
- Bike lanes should be buffered or protected
- North-bound lanes are 12' wide
- South-bound lanes are 11' wide in some places
- Under MetroRail, lanes are 11' wide

B7. Signal Operations at NW 27th Avenue and NW 113th Street improved to allow safe crossing of intersection from bike lane on north-bound lanes into campus



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T6. Micro Transit Demonstration Program: While there are adequate and direct transit connections between the Martin Luther King Jr. MetroRail Station and the MDC Campus, privately provided Micro Transit service can offer distinct advantages over regular transit, including:

- Flexibility and demand sensitivity, allowing Micro Transit services to optimize both the vehicle loads and passenger experience in terms of:
  - Passenger wait time
  - Coordination with MetroRail arrival and departure
  - Travel time by providing direct routing when possible
  - More on-board amenities and services, such as more space, comfortable seats, wi-fi, USB outlets, and lights
- A dedicated app with real-time tracking, reservations, and a guaranteed seat;
- Use of aggregate app data (ID-stripped) for more responsive service planning;
- Monthly passes;
- Fares: While fares are generally higher for un-subsidized Micro Transit operations, a holistic approach should be used for cost evaluation. While the public transit fare is $2.25 and $.060 for a transfer from rail, (discounted fares at $1.10 and $0.30 respectively), the actual cost of an unlinked passenger trip on MetroBus is $4.18.[50]. Whether loaded or empty, each revenue hour of service costs $132.88. the 46% subsidy level is still a cost to the community; therefore, the higher cost of MicroTransit may be compared to actual costs. There are examples of transit agencies working with Micro Transit companies to subsidize trips and coordinate with public transit. Two recent examples are in Kansas City and Los Angeles.

Description:

The Micro Transit Demonstration Program would be a dynamically-routed, on-demand transit designed to provide near door-to-door rides, for:

- Transit station to destination (Last Mile FLM)
- Community service (First Mile FLM) to the transit station.

The program would provide:

- Real-time ride matching, and
- Dynamically routed service, allowing some deviation but optimizing between wait/walk time for the next passenger and travel time for on-board passengers.
- Small vehicles for 4 to 12 passengers:
  - 12-passenger vans
  - 6-passenger minivans
  - NEVs (6 to 8 passengers) as an alternative
- Implement as a demonstration program, or pilot project to expand FLM throughout Miami-Dade SMART Corridors.

Criteria:

- Operate within a 1½ to 2-mile radius from the Dr. Martin Luther King Jr. MetroRail Station to maintain fast trips and short wait times.
- Other stations may be included in the service area.

[50] Average operating expense (not capital) per unlinked Metrobus passenger trip, reported in 2014, source: FTA National Transit Database 2014 Agency Profile

- Maintain a maximum pick-up time of 10 minutes from time of request, and monitor to identify the utilization correlation of shorter wait times (with expanded program and more vehicles).
- Carefully monitor time reliability, and identify the correlation on utilization of higher reliability sigma ratings.[51]
- Initially provide service from 6:30 am to 7:00 pm on weekdays.
- Initial operation with 3 vehicles at minimum.

Actions to include:

- Review policy and/or legislative barriers to allowing Micro Transit, and modify to permit and control private micro-transit providers as complementary components of the public transit system.
- Work with providers to coordinate transit information across smart phone apps.
- Work with providers to develop both van-based and NEV Micro Transit as cost-efficient alternative within the short FLM range and travel time range.
- Seek public funding support for a pilot program to develop the market.
- Monitoring and evaluation program to holistically determine the effectiveness of Micro Transit for the consumer, for the County in terms of cost and sustainability efficacy, and to identify consumer preferences for expanded Micro Transit FLM in the SMART Corridors versus other FLM strategies and regular transit.

Monitoring and evaluation data collection is a critical and primary objective of the pilot program. Whether a particular pilot program succeeds or not in the short term, the lessons learned from the pilot program are of more value to County-wide FLM and SMART Plan support.

Chariot Micro Transit van (private operator)


Joy Ride NEV Micro Transit, Tallahassee, Florida

[51] Sigma rating refers to the yield or the percentage of defect-free service. (Ref. to Six Sigma)

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FLM CASE STUDIES

SOUTH CORRIDOR:
SOUTH DADE CIVIC CENTER to
SOUTH DADE TRANSITWAY

TIME HORIZON: SHORT -TERM

FLM NEEDS: ACCESSIBILITY

The 220-acre triangle of land with the north apex described by the south of the intersection of South Dixie Highway (US-1) and Florida's Turnpike (SR-91), south to the Black Creek Canal. This area, although positioned as the civic center for South Dade, is cut off from interaction with the community that is serves by three physical barriers:

- South Dixie Highway
- Florida's Turnpike
- Black Creek Canal

ACCESS VERSUS MOBILITY

The South Dade Civic Center interacts with the larger South Dade community from a mobility perspective, via direct service by Busway routes and vehicular travel; however, it is cut off from the immediate communities of Cutler Bay, Goulds and Perrine from a perspective of access. The emphasis of this case study is to improve the pathway from the perspective of access, and therefore, the primary emphasis is on pedestrian travel initially.

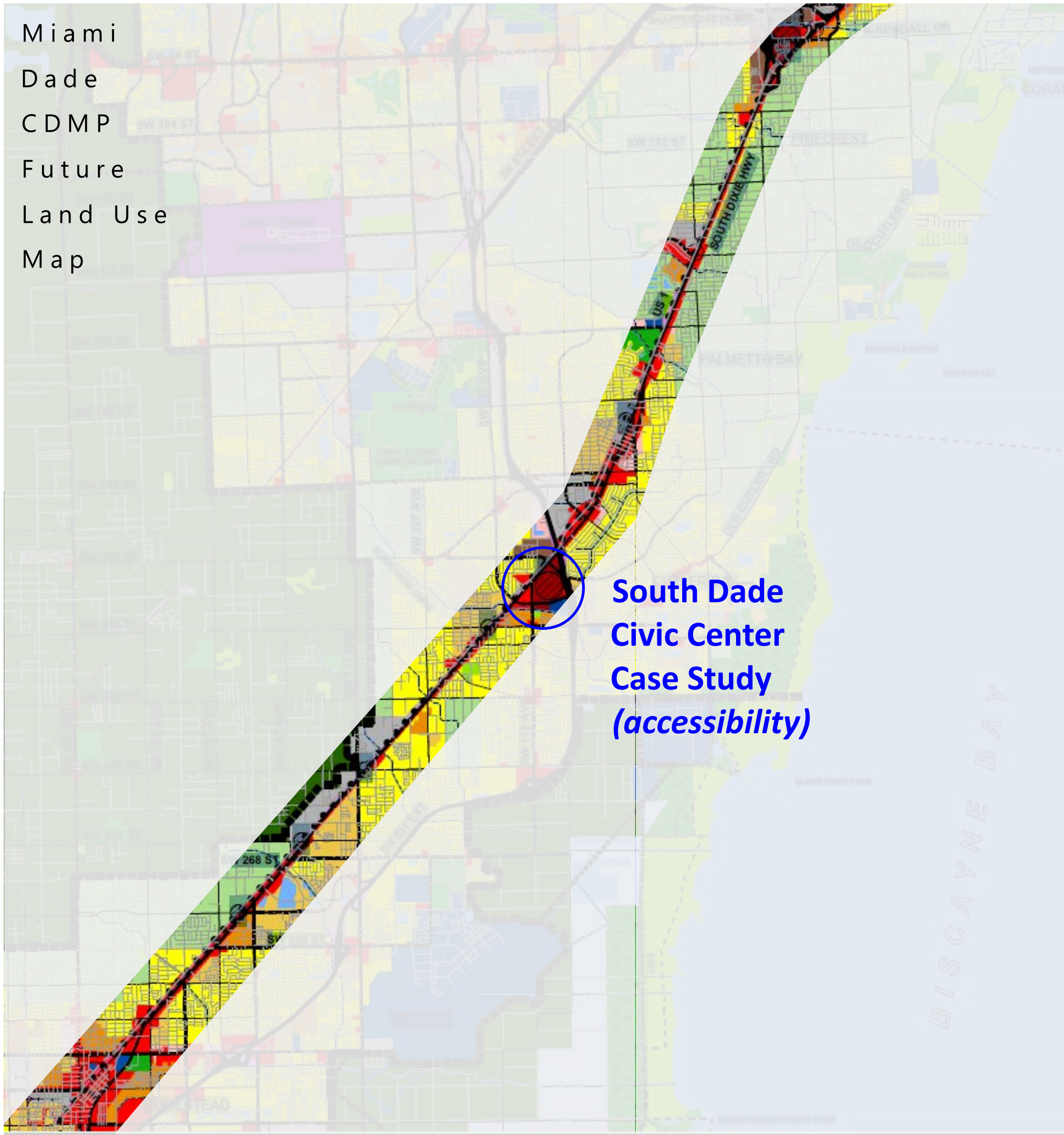
Access is the ability to meet a person's daily needs with a minimum of travel and cost.

Mobility is the ability to get around by a variety of means.

The Pathway is the infrastructure to reduce distance and time from origins and destinations to the primary transit station, improving the user experience in more quantitative ways. It mostly focuses on mobility, but also considers access with context specific improvements extending to and from the primary transit stations.

Around the perimeter of the Southland Mall, either on the South Dade Busway, Allapattah Road (SW 112th Avenue), or SW 211th Street, 10 DTPW Routes, and one municipal circulator stop:

- Busway Local, Route 31: stops on Allapattah Rd and SW 211th St.
- Busway MAX, Route 38: stops on Allapattah Rd and SW 211th St.
- Busway Express, Route 34A: Busway only
- Busway Express, Route 34B: stops at South Dade Gov't Ctr.
- Route 1: stops on Allapattah Rd and SW 211th St.
- Route 35: stops on Allapattah Rd and SW 211th St.
- Route 52: stops on Allapattah Rd and SW 211th St.
- Route 70: stops on Allapattah Rd and SW 211th St.
- Route 137: stops on SW 211th St.
- Saga Bay Max, Route 287: stops on
- Cutler Bay Local, Route 200: stops on SW 211th St.



Location of South Dade Civic Center Case Study along the South Dade Transitway Corridor

Aerial View of South Dade Civic Center

EXISTING CONDITIONS AND FUTURE PLANNING

The shopping center is a viable center for regional employment, shopping and educational services. The Shopping Center is served directly by South Dade Transitway buses, including Route.

This area is also the location of the current and future Cutler Bay Town Hall. South of SW 211th Street, and just north of the canal are located the South Dade Government Center and District Court, South Dade Reginal Library, and the South Performing Arts Center. The County continues to invest in this area, and was the subject of the Cutler Ridge Master Plan (CRMP) that was performed through an extensive charrette process in 2002. The CRMP was adopted by the Board of County Commissioners (BCC). Subsequently the BCC approved and adopted the Cutler Ridge Metropolitan Urban Center District (CRMUCD) as the land use ordinance (Sec.33-284.99.23 – 99.30) that implements the plan.

The Cutler Ridge Master Plan district, located on the east side of the South Dade Busway and US-1, is the triangular-shaped area of 220 acres that is the subject of this FLM Case Study.

The goal of the Cutler Ridge Master Plan was to create a framework to develop Southland Mall's underutilized land and outparcels into a recognizable center for the community, and complement the County's investments along SW 211th Street. There are four groups of recommendations:

1. Private redevelopment: Southland Mall, Sears, and the out-parcels together contain approximately 1,119,000 square feet of retail and other commercial space on approximately 100 acres of land. The CRMP recommends redeveloping the mall vacant spaces in concert with the mall's reconfigurations as a pedestrian-friendly mixed-use redevelopment, incorporating retail and business uses, possibly residential uses or other flex space. The Master Plan does not include in its recommendations estimate build-out in terms of additional square feet of commercial space or number of residential units; however, the core area of the redevelopment will be permitted to 10 to 12 stories. The periphery of the mall area will be developable to 3 stories of residential at 52 dwelling units per acre or 60 with purchase of Severable Use Rights.

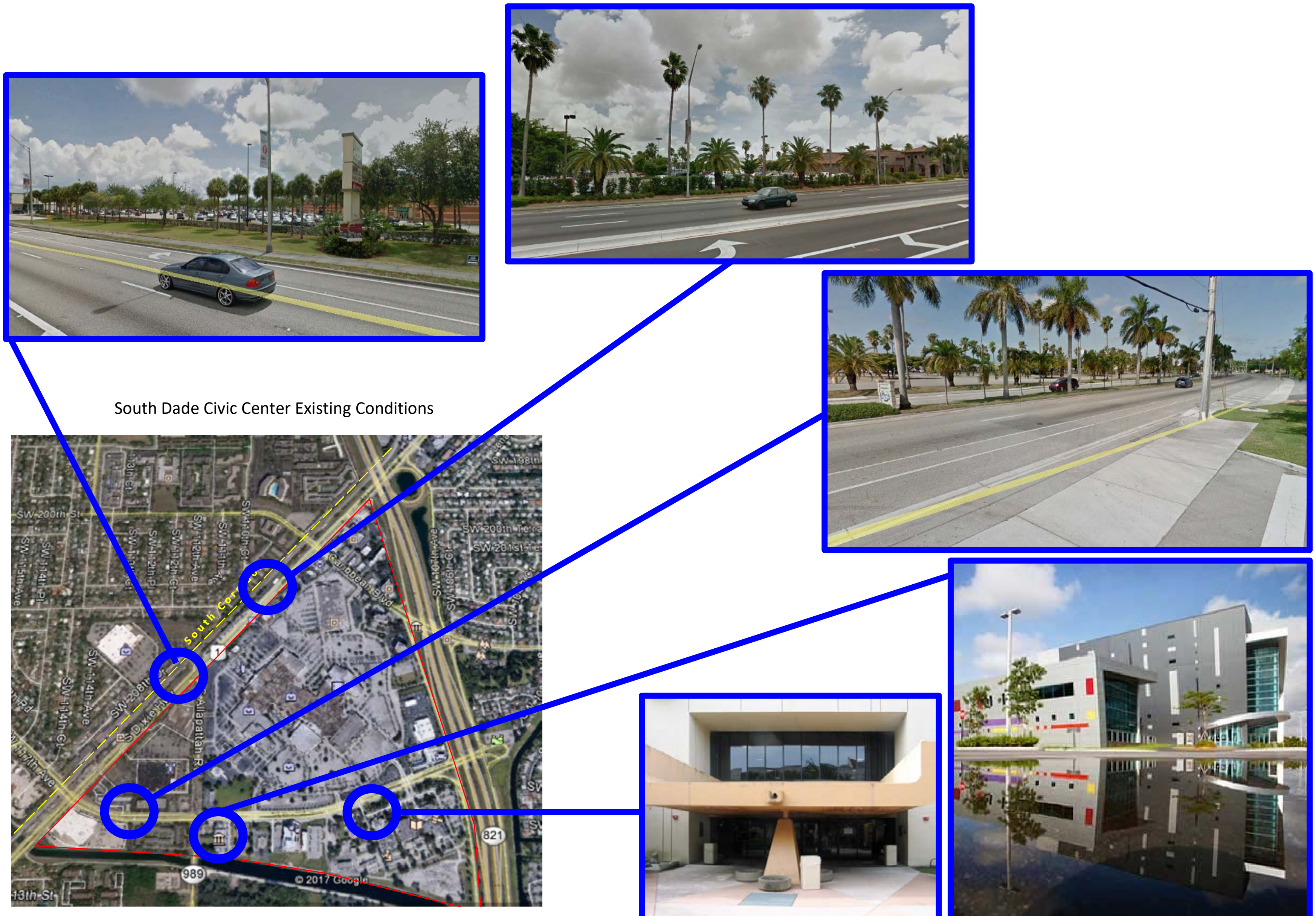
2. Public redevelopment: The South Dade Government Center is located on the south side of SW 211th Street, at the southeast corner of the Cutler Ridge Metropolitan Area. It includes 156,000 square feet of office and public meeting space on the 12.5-acre site. The site includes expansive surface parking which is shown in the Master Plan as built environment. Abutting and to the west of the Government Center, is the Library, South Dade Performing Arts Center, and Fire Rescue Station site. The CRMO shows the 28,000 square-foot regional library and the fire station to be redeveloped and integrated with the future development.

   The South Dade Performing Arts Center (SDPAC) is a 1,000-seat, multistory performance space, that includes an orchestra pit, performance support facilities, administrative spaces, and outdoor plaza and performance spaces.

   West of the SDPAC was proposed for joint venture development of approximately 400 to 500 market-rate, transit -oriented mixed-use development of residential units at 52 to 60 dwelling units per acre, with ground floor retail, complete sidewalks and parking in the interior of the blocks.

3. Regulatory Improvements: Cutler Ridge Metropolitan Urban Center District (CRMUCD) as the land use ordinance (Sec.33-284.99.23 –99.30) that implements the plan.

4. Public Infrastructure Improvements.



South Dade Civic Center Existing Conditions

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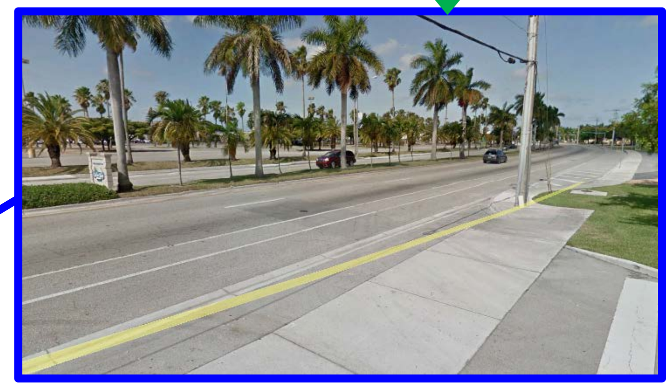

South Dade Civic Center Future Plans

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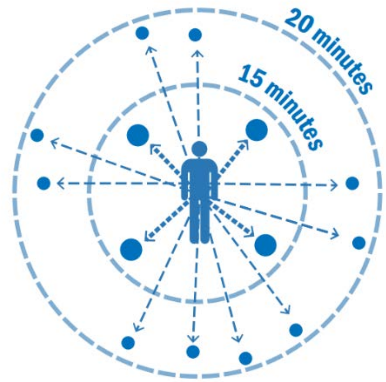
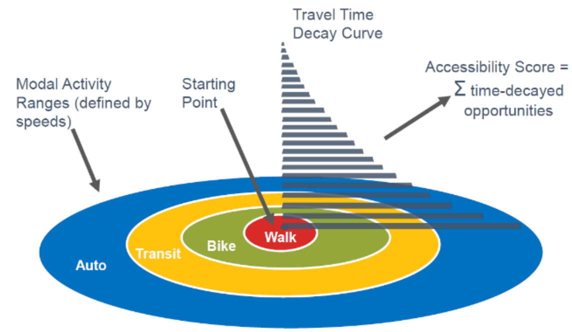
METHODOLOGY: GIS-BASED ACCESIBILITY MODEL

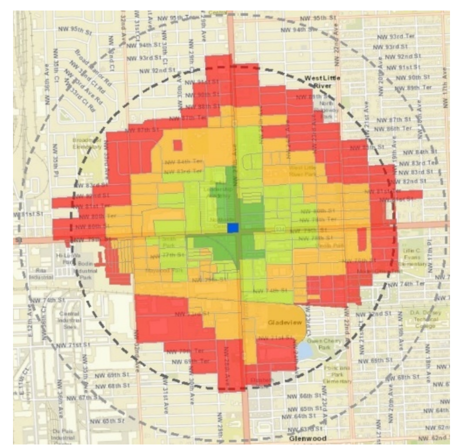
The South Dade Civic Center FLM Case Study uses a different methodology to develop recommendations for first and last mile improvements. By consensus of the Study Advisory Committee and the Miami-Dade TPO staff, this case study has been analyzed to apply a trial of the Accessibility Model by Renaissance Planning.

The Accessibility model is a GIS-based tool that analyzes accessibility based on land use and infrastructure characteristics, and develops an accessibility score.

- Accessibility is measured as the number of destinations reachable by a given set of origins in a given travel time.
- Destinations can be defined as jobs, non-residential establishments, populations, households, etc.
- Smaller- grained development in an area provides greater access for equivalent levels of development, since it generally provides more opportunities with greater geographical dispersion.
- Consistent with the findings of this study, a decay curve is used to change the likelihood that a destination is accessible, the further it is from the origin.
- The GIS-based method uses the actual street grid to calculate distances and convert to time.
- Lack of infrastructure or low-quality infrastructure is proxy-factored as additional delay or a barrier (inaccessibility).
- The model is developed for walk, bike, transit, and automobile modes.
- The accessibility score is developed for a location based on the sum of places within the area that are accessible by one or all of the modes.







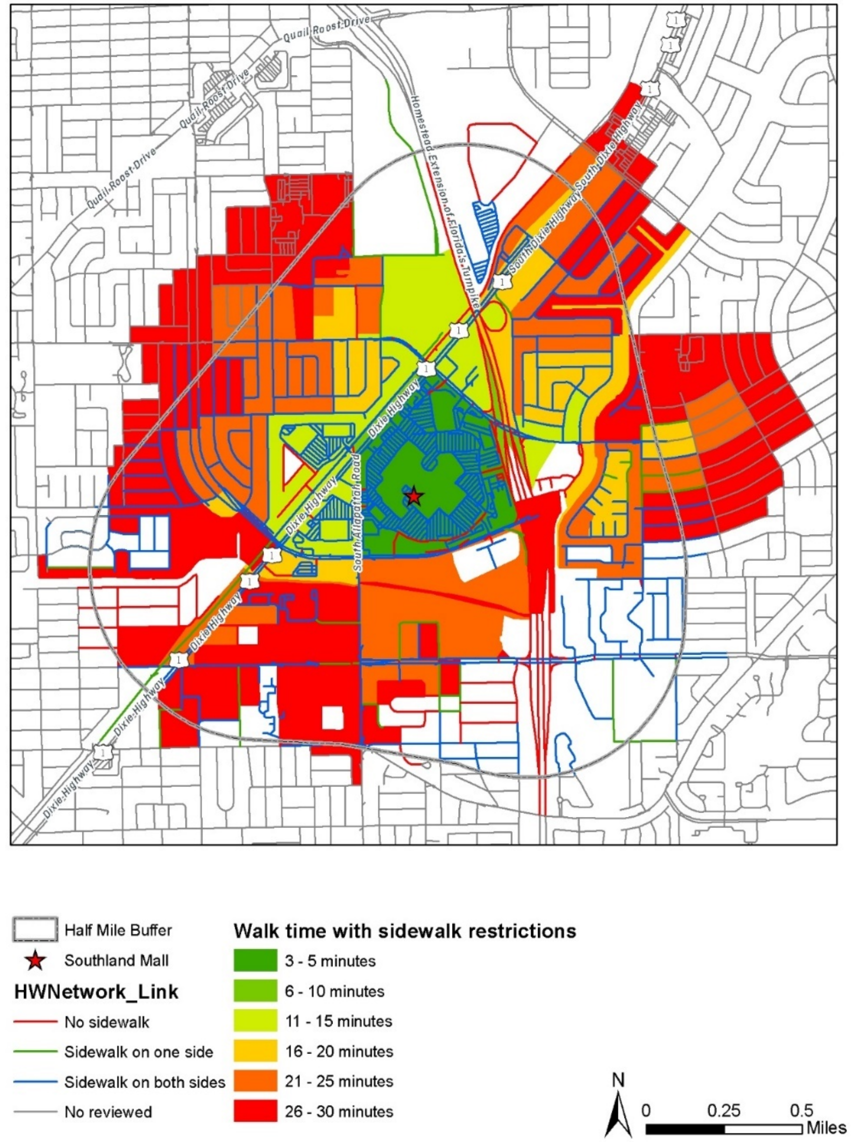
While the accessibility model is developed for walk, bike, transit, and automobile mode, it is in process of being fully calibrated for Miami-Dade County.

For the South Dade Civic Center area, only pedestrian accessibility was performed based on the presence of sidewalks on one or both sides of the street, and crosswalks of any functional condition. The presence of signal pedestrian phases was not included in the analysis.

The first scenario was modelled with the following assumptions:

- Links without sidewalks are not traversable;
- To simulate partial inaccessibility, links with sidewalks on one side has a discounted walk speed applied to them;
- Links with sidewalks on both sides were considered traversable at full speed;
- The cumulative number of jobs that are accessible to the South Dade Civic Center centroid (Southland Mall Main West Entrance) were calculated and categorized by walk times.
- The cumulative population that are accessible to the South Dade Civic Center centroid (Southland Mall Main West Entrance) were calculated and categorized by walk times.

Tabular results are shown below and mapped at right.



Restricted sidewalks

Time Band	Population	Jobs
Less than 5 minutes	0	1,180
5 to 10 minutes	197	1,246
10 to 15 minutes	2,699	1,717
15 to 20 minutes	6,309	2,358
20 to 25 minutes	10,472	3,553
25 to 30 minutes	18,198	4,153

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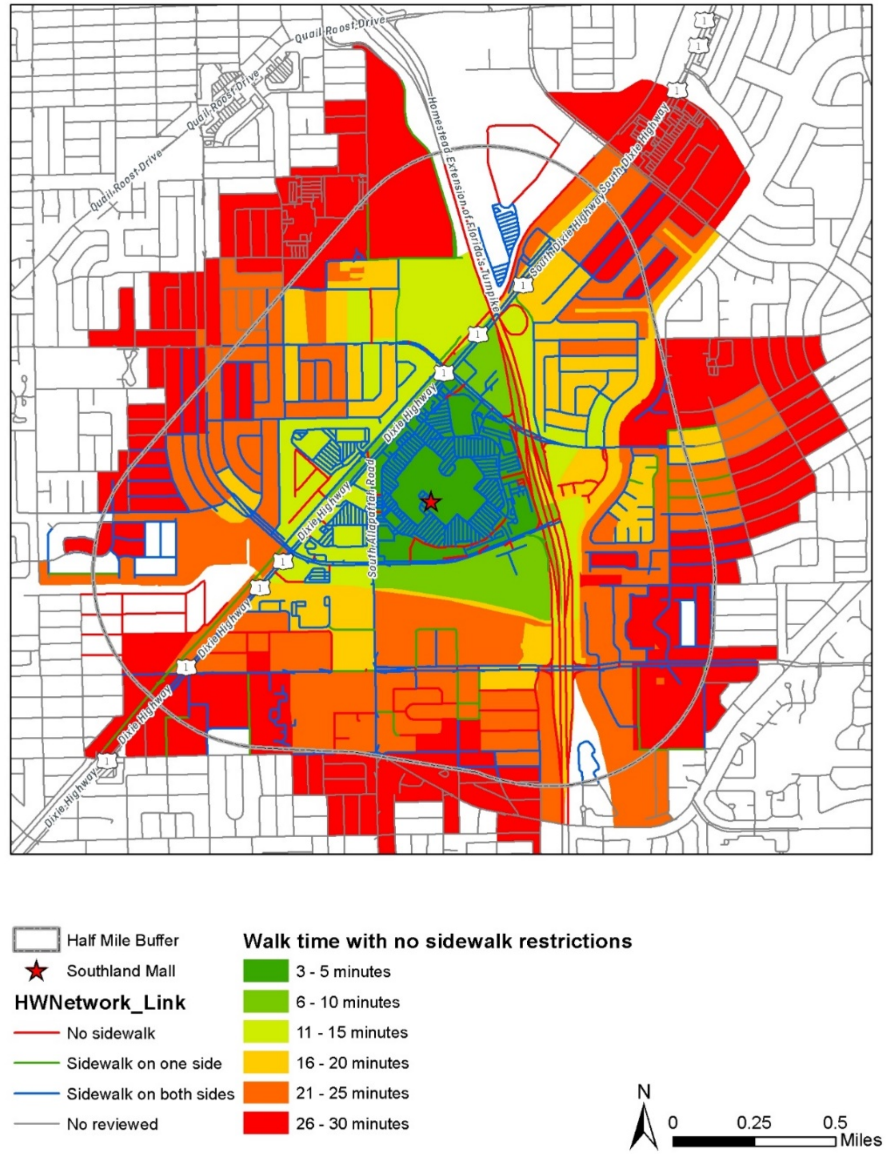
The second scenario was modelled with the following assumptions:

- Links without sidewalks are not traversable;
- ***Links with sidewalks on one or both sides were considered traversable at full speed – no discounting;***
- The cumulative population and jobs that are accessible to the South Dade Civic Center centroid were calculated by walk times.



Restricted sidewalks

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15 to 20 minutes	6,309	2,358
20 to 25 minutes	10,472	3,553
25 to 30 minutes	18,198	4,153

Unrestricted sidewalks

Time Band	Population	Jobs
Less than 5 minutes	0	1,180
5 to 10 minutes	584	1,638
10 to 15 minutes	3,323	2,466
15 to 20 minutes	9,834	2,996
20 to 25 minutes	16,892	3,945
25 to 30 minutes	24,822	5,621

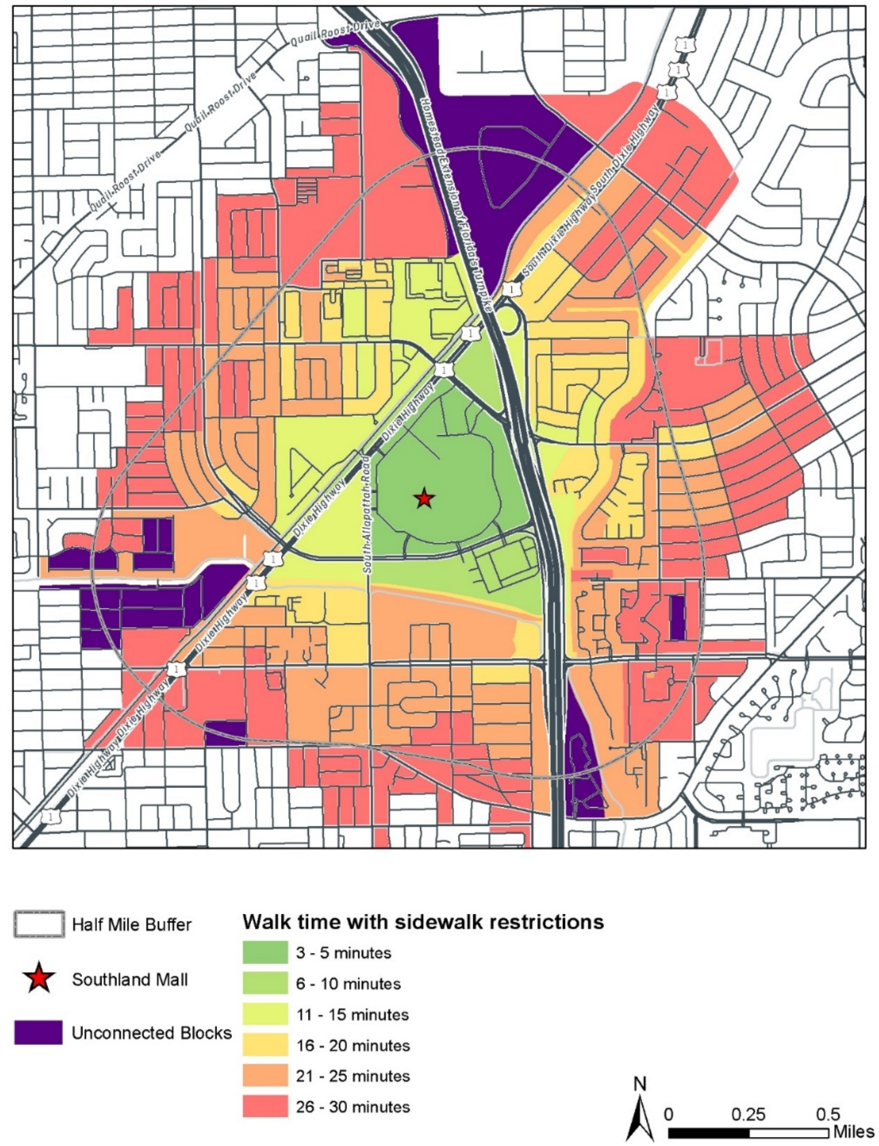
Unrestricted - Restricted Delta

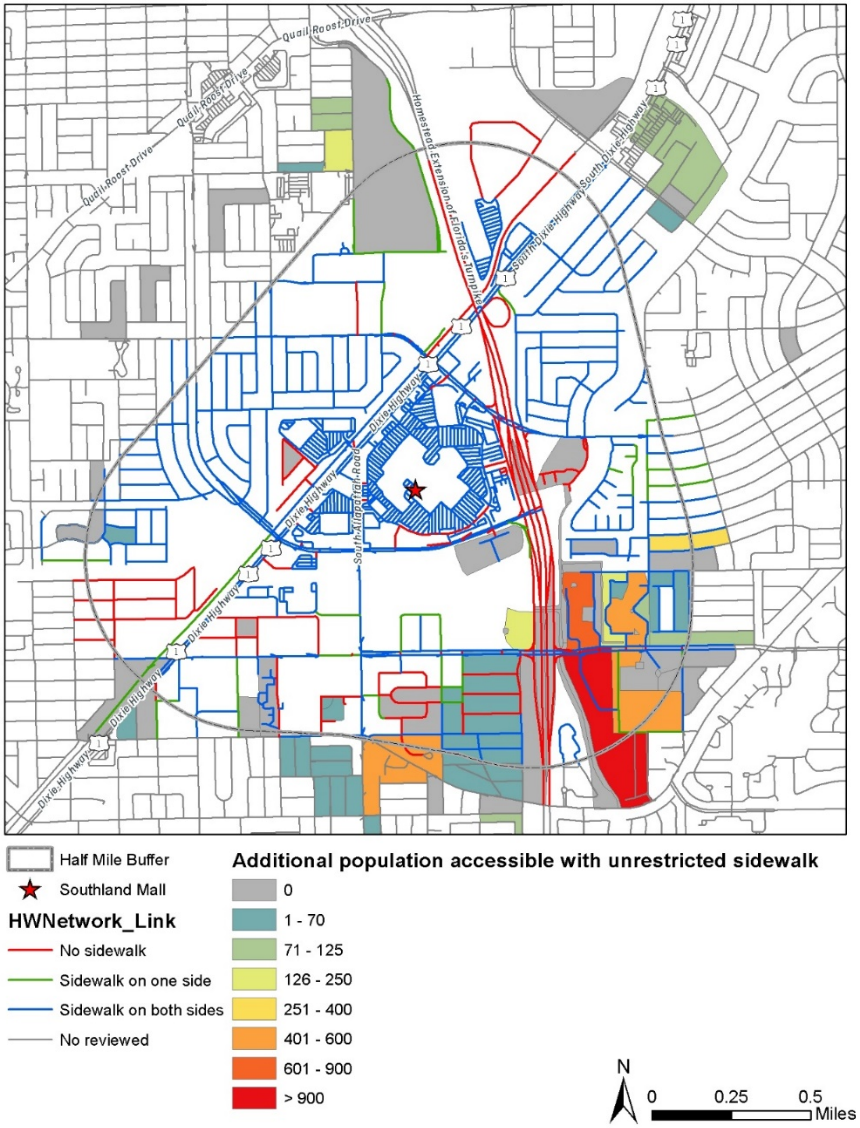
Time Band	Population	Jobs
Less than 5 minutes	0	0
5 to 10 minutes	387	392
10 to 15 minutes	624	749
15 to 20 minutes	3,525	638
20 to 25 minutes	6,420	392
25 to 30 minutes	6,624	1,468

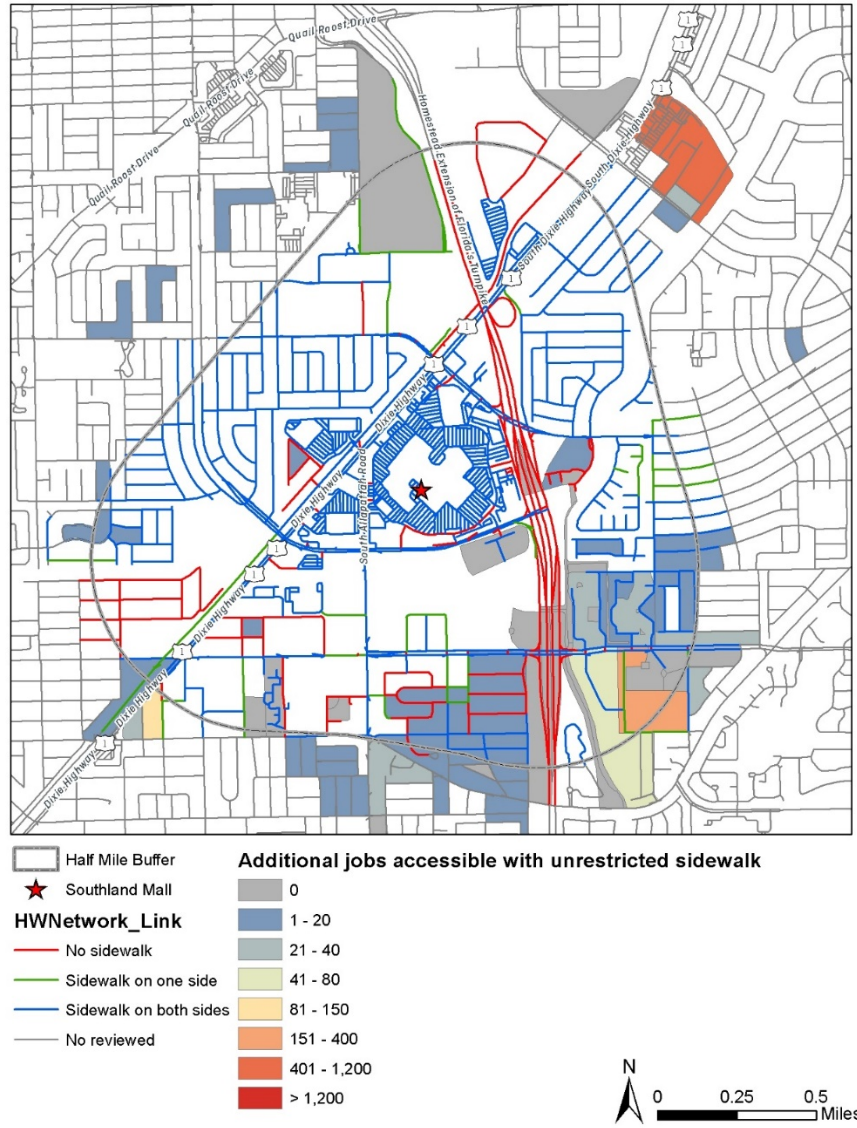
The connectivity impact of the presence of sidewalks on both sides of the street is then evaluated for blocks lacking walk access in both restricted and unrestricted scenarios. Unconnected blocks are identified (purple color).

- A population of 1,370 live in inaccessible blocks that are within a ½-mile radius (Station Neighborhood) of the South Dade Civic Center centroid at the mall.
- The additional population that is accessible with unrestricted sidewalks is shown in the map on the next page on the left.
- A population of 3,270 jobs are in inaccessible blocks that are within a ½-mile radius (Station Neighborhood) of the South Dade Civic Center centroid at the mall.
- The additional employment that is accessible with unrestricted sidewalks is shown in the map on the next page on the right.
- The location and aggregation of inaccessible blocks makes clear the impact of the roadway barriers, and to a lesser extent, the impact of the Black Creek Canal barrier.
- For the purpose of FLM, blocks in the red, orange and yellow shaded areas are also inaccessible by pedestrian mode, and should be addressed through a free-floating bike sharing program that allows bikes to stay overnight in low-density residential neighborhoods.

The analysis looked first at curing the pedestrian critical paths as first priorities.







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South Dade Civic Center Short Term FLM Tool Kit

Critical Paths 1st - Barriers

Northwest Barrier:

P7. Mid-Block Crosswalk (Busway)

P5. Enhanced Crosswalk (US-1)

P8. Signal Operations

- Enhanced crosswalk at the Mall entrance across US-1 with adequate protected pedestrian phase
- Pedestrian actuated crosswalk linked to Busway times signals to cross Busway
- Textured pavement or zebra stripe markings
- Enhanced illumination and/or pavement illumination

P4. Adequate Sidewalks

- Through parking lot drives in Mall property
- Along Busway west side
- Path through to SW 111th Avenue

East Barrier:

P11. Barrier Bridge

- Pedestrian path across canal, from Cutler Ridge Boulevard to SW 212th Street End, near the water pipe.

Analys

South Dade Civic Center Short Term FLM Tool Kit

Completing the Pedestrian Network

P2. Transit Access Pedestrian Audit *(detailed existing pedestrian infrastructure audit)*

P4. Adequate Sidewalks (red links):
- Through Mall parking lots
- Western entrance to mall from SW 211th Street
- SW 103rd Avenue south of Caribbean Boulevard
- SW 207th Street, west of SW 103rd Avenue
- SW 112th Avenue, north of SW 200th Street
- SW 214th Street, east of US-1
- SW 215th Street, east of US-1
- SW 115th Avenue, from SW 216th Street to SW 214th Street
- SW 114th Avenue, from SW 216th Street to SW 214th Street

P5. Enhanced Crosswalks:
- Others to be identified with additional work from Transit Access Pedestrian Audit (P2)

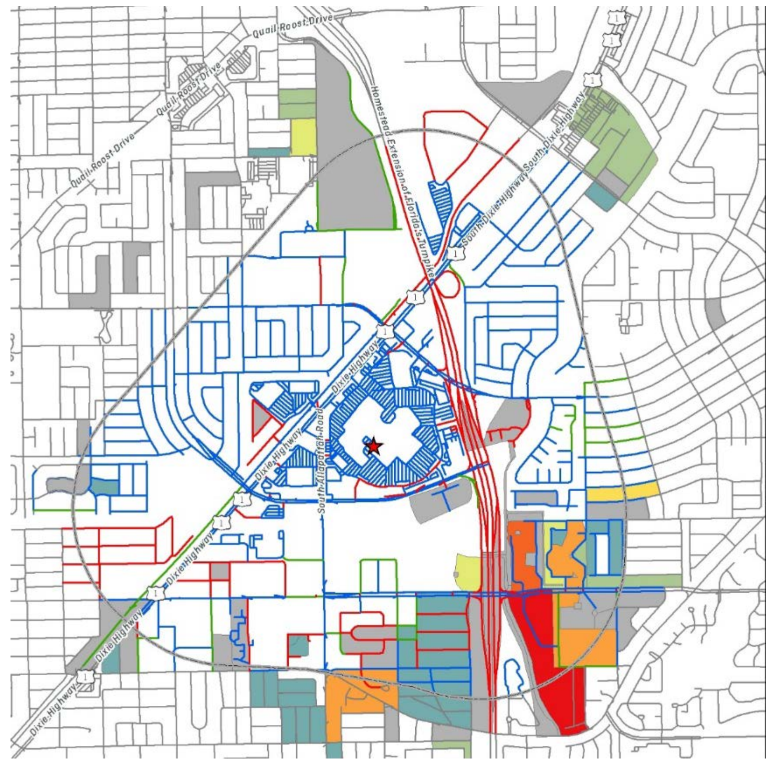
P8. Signal Operations:
- To be identified with additional work from Transit Access Pedestrian Audit (P2)

P9. Pedestrian Lighting:
- To be identified with additional work from Transit Access Pedestrian Audit (P2)

P11. Barrier Bridges:
- Pedestrian path across canal, from Cutler Ridge Boulevard to SW 212th Street End, near water pipe.

P12. Pedestrian Amenities:
- within the core area

P13. Way Finding
- Perform separate study – requires Transit Access Pedestrian Survey



South Dade Civic Center Short Term FLM Tool Kit

Completing the Bicycle Network

B2. Transit Access Bicycle Audit *(detailed existing bicycle, skate and board infrastructure audit)*

B11. Small Station Based Bike Sharing Program with destination racks at the Southland Mall, Busway Stations and other destinations:

- County to work with private vendors
- Rack-based bike share models are effective for destination areas
- Alternative that is more effective in residential areas are free-floating bike share models.
- Bike sharing can benefit low-income community for other neighborhood bike-sharing trips

B5. Complete and improve bike lane and bike path gaps:

- Complete areas gaps in bike lanes
- Improve bike lanes to buffered or protected bike facilities where roadway speeds, traffic volumes, heavy vehicle mix, and other operational characteristics warrant.

South Dade Civic Center Short Term FLM Tool Kit

Connecting Transit & Centralizing the Station

T6. Micro Transit Demonstration Program: While there are many potential transit connections in the vicinity of the South Dade Civic Center, thee is at the current time a lack of a coordinated central station at a comfortable and accessible location. At the current time, the Southland Mall does not provide access to large buses or official park-and-ride space.

There is a possibility that centralization for route transfers and the early development of a South Dade Civic Center station may be developed with the smaller, lighter and less industrial vehicles used by a Micro Transit provider, including full size vans, minivans, and NEV. The accessibility study has led to recommendations to connect work places and residents to a central station location, which for the purpose of analysis and consistency with planning was located centrally at the main west entrance to the Southland Mall. To complete the accessibility, a connecting Micro Transit system needed.

Micro Transit used in this case study provides a set of unique advantages over large-vehicle transit circulators and uncoordinated stops.

- ***Greater potential to be consistent with the requirements of the Southland Mall to allow transit up to the front door.***
- Flexibility and demand sensitivity, allowing Micro Transit services to optimize both the vehicle loads and passenger experience in terms of:
  - Passenger wait time
  - Coordination with MetroRail arrival and departure
  - Travel time by providing direct routing when possible
  - More on-board amenities and services, such as more space, comfortable seats, wi-fi, USB outlets, lights, and more.
- A dedicated app with real-time tracking, reservations, and a guaranteed seat.
- Use of aggregate app data (ID-stripped) for more responsive service planning.
- Monthly passes
- Fares: While fares are generally higher for un-subsidized Micro Transit operations, a holistic approach should be used for cost evaluation. While the public transit fare is \$2.25 and \$.060 for a transfer from rail, (discounted fares at \$1.10 and \$0.30 respectively), the actual cost of an unlinked passenger trip on MetroBus is \$4.18.[52]. Whether loaded or empty, each revenue hour of service costs \$132.88. the 46% subsidy level is still a cost to the community; therefore, the higher cost of MicroTransit may be compared to actual costs. There are examples of transit agencies working with Micro Transit companies to subsidize trips and coordinate with public transit. Two recent examples are in Kansas City and Los Angeles.

Description:

The Micro Transit Demonstration Program would be a dynamically-routed, on-demand transit designed to provide near door-to-door rides, for:

[52] Average operating expense (not capital) per unlinked Metrobus passenger trip, reported in 2014, source: FTA National Transit Database 2014 Agency Profile

- Transit station to destination (Last Mile FLM)
- Community service (First Mile FLM) to the transit station.

The program would provide:

- Real-time ride matching, and
- Dynamically routed service, allowing some deviation but optimizing between wait/walk time for the next passenger and travel time for on-board passengers.
- Small vehicles for 4 to 12 passengers:
  - 12-passenger vans
  - 6-passenger minivans
  - NEVs (6 to 8 passengers) as an alternative
- Implement as a demonstration program, or pilot project to expand FLM throughout Miami-Dade SMART Corridors.

Criteria:

- Operate within a 1½ to 2-mile radius from the Southland Mall main entrances to maintain fast trips and short wait times.
- Other stations may be included in the service area.
- Maintain a maximum pick-up time of 10 minutes from time of request, and monitor to identify the utilization correlation of shorter wait times (expanded program and more vehicles).
- Carefully monitor time reliability, and identify the correlation on utilization of higher reliability sigma ratings.[53]
- Initially provide service 6:30 am to 7:00 pm on weekdays.
- Initial operation with 3 vehicles at minimum.

Actions to include:

- Review policy and/or legislative barriers to allowing Micro Transit, and modify to permit and control private micro-transit providers as complementary components of the public transit system.
- Work with providers to coordinate transit information across smart phone apps.
- Work with providers to develop both van-based and NEV Micro Transit as cost-efficient alternative within the short FLM range and travel time range.
- Seek public funding support for a pilot program to develop the market.
- Monitoring and evaluation program to holistically determine the effectiveness of Micro Transit for the consumer, for the County in terms of cost and sustainability efficacy, and to identify consumer preferences for expanded Micro Transit FLM in the SMART Corridors versus other FLM strategies and regular transit.

Monitoring and evaluation data collection is a critical and primary objective of the pilot program. Whether a particular pilot program succeeds or not in the short term, the lessons learned from the pilot program are of more value to County-wide FLM and SMART Plan support.

Chariot Micro Transit van (private operator)

Joy Ride NEV Micro Transit, Tallahassee, Florida

[53] Sigma rating refers to the yield or the percentage of defect-free service. (Ref. to Six Sigma)