UNIVERSITY DRIVE

MOBILITY IMPROVEMENTS PLANNING STUDY

Final Tier II Travel Demand Forecasting Methodology and Ridership Forecasting Report

Compiled Deliverable Items #63, 64, & 65

September 22, 2014

Prepared for:

broward MPO metropolitan planning organization

Prepared by:

HDR

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The purpose of this memorandum is to document the methodology that was be used to generate the ridership forecasts for the Tier 2 alternatives considered in the University Drive Mobility Study.

The proposed forecasting approach is similar to the method utilized for the Oakland Park Boulevard Transit Corridor Study. The methodology is based on the existing transit travel and demographic characteristics in the corridor.

The University Drive Mobility Study project team is following a two-tiered screening process to evaluate alternatives considered for the corridor. The Tier 1 screening reviewed a large number of alternatives recommended by the project team and partners and eliminated those from further consideration that did not meet the stated purpose and need for the project. By using the two-tiered approach, the Tier 1 screening reduced a large number of alternatives to the few alternatives that were analyzed in the Tier 2 phase. The Tier 1 evaluation was based primarily on a high level qualitative assessment based on readily available data. Alternatives that passed through the Tier 1 screening were refined and evaluated in detail in the Tier 2 phase. The alternatives that were recommended to be carried forward into Tier 2 phase for detailed analysis are:

- Baseline (minor improvements to existing service)
- Enhanced bus service without BAT lane
- Enhanced bus service with Business Access and Transit (BAT) lane
- Bus Rapid Transit (BRT) without BAT lane
- Bus Rapid Transit (BRT) with BAT lane

One of the evaluation tools to be used for the evaluation of Tier 2 alternatives is the simplified transit ridership estimating tool that is described in this memorandum. The alternative(s) that will pass through the Tier 2 screening will be analyzed in further detail using the region’s travel demand model, Southeast Florida Regional Planning Model (SERPM version 6.7).

2.0 SOUTH FLORIDA SIMPLIFIED TRANSIT MODEL (SFSTM)

This section describes the development, calibration and validation methodology for the South Florida Simplified Transit Model (SFSTM) to be used for the University Drive Mobility Study Tier 2 screening process. This is the same methodology that was used in the Oakland Park Boulevard Alternative Analysis. The SFSTM uses existing ridership patterns obtained from Origin-Destination surveys and network based transit assignment models to estimate ridership on new alternatives. This model can evaluate the ridership impacts of several service attributes such as fares, stop locations, headways, operating speeds and intermodal connectivity options.

I. BACKGROUND

The Federal Transit Administration (FTA) requires that the ridership forecasting models used for New Starts and Small Starts applications must grasp the current transit conditions, provide plausible forecasts for the alternatives, adequately support the purpose and need of the project, and should quantify FTA evaluation measures[1]. In many cases, especially for Small Starts projects and for projects that have a shorter time frame from planning to opening year, the FTA prefers that a simplified model based on data collected on the transit system in the corridor be used for forecasting transit ridership[2]. The methodology presented in this document largely follows the approach presented during the 2009 FTA New Starts travel forecasting workshop.

A simplified modeling approach is extremely useful for preparing short-term as well as long-term ridership forecasts. This approach expedites the forecasting process as this model takes a fraction of the processing computer time that the regional travel demand model takes. The use of a simplified approach is especially applicable in corridors with a robust transit market. These corridors are more likely to provide detailed and reliable observed data on route boardings, stop activities, travel behavior, and demographic information about the existing riders. Together these data enhance the ability of a simplified approach to more accurately estimate project transit boardings. The University Drive corridor is this exact type of corridor, and for these reasons, a simplified approach was adopted to forecast the ridership of the Tier 2 alternatives. Additionally, because there are fewer input variables used in the forecasting process, there are fewer forecasting uncertainties involved with the use of a simplified approach.

The SFSTM utilized transit data collected in the corridor over the last few years, including the system-wide Broward County Transit (BCT) on-board survey data collected in 2010 and the boarding-to-alighting data collected on Route 2 and 102 in late 2012 and early 2013.

The key input data to be utilized in the development of the simplified model methodology is discussed below.

- BCT On-Board Survey Data: The 2010 BCT on-board survey data, in production to attraction (P→A) format, was used to develop a linked transit trip table by access mode (walk, park-and-ride and drop-off).
- The University Drive transit survey: This survey conducted in late 2012 and early 2013 was used to construct trip tables for Route 2 and Route 102 service. This trip table was merged with the trip table obtained from the 2010 BCT survey to make a complete trip table.
- Demographic Data: The simplified model uses year 2010 population and employment information from SERPM 6.7 model (ZDATA). The forecast year (2020) demographics were estimated by interpolating the 2010 and 2035 data and used to generate near term forecasts.
- Highway/Transit Networks: The 2010 (base year) highway and transit networks used were from SERPM 6.7. The transit routes along the corridor, the connecting routes and the community buses were coded in detail to reflect the existing year transit service. The access connections were verified and where appropriate, additional access connections were added to the major activity stops. This will be particularly important for the project scenarios that have limited-stop routes. Additionally, the transit speeds and travel times were also be calibrated to match the existing year service.

[1] FTA 2007 New Starts Travel Forecasting Workshop Presentations, St. Louis, MO.

[2] FTA 2009 New Starts Travel Forecasting Workshop Presentations, Phoenix, AZ (http://www.fta.dot.gov/12304_9547.html)

II. METHODOLOGY

In general, the simplified model estimates the impact of travel time and other service improvements on corridor boardings. Future trips are estimated based on summation of existing year trips (2012) and the estimated change in trips arising from population and employment growth and proposed transit service improvements along a corridor, or combination of both.

Projected trips = Existing trips + Change in trips

For estimating the change in trips due to land use or transit service changes, the simplified model estimates the new trips based on the magnitude of the existing trips. The projected trips are then assigned to the project transit network for forecasting the project boardings. The formula used for estimating the projected trips is provided below:

$$Trips_{project, I \rightarrow J} = (Trips_{existing, I \rightarrow J} + Trips_{existing, I \rightarrow J} * \textit{Elasticity} * \text{Change in transit impedance}_{I \rightarrow J}) * (1 + \%\ \text{Growth in activities at I and J})$$

where,

- I=origin zone, and J=destination zone
- Change in transit impedance $_{I \rightarrow J}$ =

  (Transit service levels $_{I \rightarrow J}$ for project / Transit service levels $_{I \rightarrow J}$ for existing conditions) – 1

- Transit service levels (or, travel cost in equivalent minutes) $_{I \rightarrow J}$ =

1.0*In-Vehicle Travel Time +
2.0*Wait Time +
2.0*Walk Times at I and J –
Mode bias in minutes to capture un-included attributes (following FTA guidance)

- Elasticity range = -0.20 to -0.50 (based on observed data on other transit systems around the country). The results presented in this document are based on an elasticity of -0.33. An elasticity of -0.33 means that the boardings will decrease by 0.33% for every 1% increase in the equivalent minutes of travel time. Similarly the boarding will increase by 0.33% for every 1% decrease in the equivalent minutes of travel time.
- % Growth in activities at I and J = % Growth in the summation of population at I and employment at J between the alternative scenario and the existing conditions.

The mode bias used in the methodology are based on recommendations provided by the FTA in the past on other New and Small Starts projects, and is described in **Table 1** below. The application of these factors is intended to account for the attributes that are not specifically considered as inputs to the model, such as schedule reliability, branding, vehicle comfort, stop/station amenities, real time information etc. All of these can encourage additional ridership but are not specifically accounted for in the model coding process.

For the Tier 2 analyses, the mode bias were applied only on trips using the project service. A full mode bias was applied for trips using the project mode that do not require any transfer to other transit service to complete their trip. If a trip on the project service involved a transfer, half of the total mode bias amount shown in the table was applied. In addition, an in-vehicle travel time (IVTT) discount was also be provided based on the project mode as summarized below.

This paragraph provides an illustration on how mode bias constant and the IVTT discount were applied in the model. Let's assume an interchange which requires 60 minutes of travel on the local bus. If the travel time on this interchange on an exclusive lane with streetcar is 40 minutes, the IVTT discount will be 6 minutes (15% of 40 minutes) and this trip will have additional bias of 10 minutes (assuming no transfer is required to complete the trip). This means that the implied total travel time advantage for the streetcar over the local bus will be 36 minutes of IVT equivalent minutes (20 minutes travel time saving (compared to the local bus), 10 minutes mode bias and 6 minutes of IVTT discount).

Table 1 Proposed Mode Bias Constant and IVTT Discount

Mode Description	Mode Bias (minutes)	IVTT Discount
Baseline bus service	-	-
Enhanced bus service with*BAT lane	5	5%
BRT without *BAT lane	2.5	0%
BRT with BAT lane	8	10%

*BAT is abbreviation for Business Access and Transit lanes.

III. MODEL DEVELOPMENT

The Traffic Analysis Zone (TAZ) structure used in the regional travel demand model, SERPM 6.7, were used for the simplified model. A TAZ-to-TAZ transit trip table of the existing riders was obtained in a production to attraction (P→A) format using the BCT 2010 on-board survey data. While forecasting trips for the project alternatives, this trip table was modified at the TAZ-to-TAZ level based on the changes in the transit impedance described in the previous section. For example, if the transit service between two TAZs improves in an alternative, the transit impedance decreases. Based on the formula described in the previous section, this will result in an increase in trips for that interchange. The reverse is true if the transit service between two TAZs decreases.

The current version of the model has been developed using the travel demand modeling software, Cube version 6.0.1. Transit paths were developed for each zonal pair using PT path-builder in Cube Voyager using the BESTPATHONLY functionality. During the path-building process, in-vehicle travel time, initial wait time, transfer times and walk times were developed for each zonal pair (through PT's path-skimming process) for calculating the transit impedance. The weights utilized for these path costs to calculate the transit impedance were taken directly from the regional travel demand model (SERPM 6.7). They are within the ranges preferred by the FTA. This process was run for the existing conditions model (base model) and for the alternative scenario. Based on the relative changes in the two transit impedances, the change in trips were estimated for each zonal pair.

Once the new trip table for the alternative was obtained, it was assigned to the alternative scenario transit network using Cube PT assignment. Using this process, the boardings on the corridor routes were obtained.

IV. CALIBRATION AND VALIDATION

The simplified model was calibrated to reflect the travel times of the route and the transfers to and from other connecting routes. The validation process compared the boardings at the route-level for all routes in the study area and at the segment-level for the corridor route. As a part of the calibration exercise, the following steps were taken:

- The average travel time for the local bus Route 2 and express bus 102 were adjusted by direction and by time period (peak and mid-day) to match those in the public time tables.
- Similarly, the end-to-end travel times on the parallel routes and the transfer route were adjusted wherever necessary so that they are within reasonable limits compared to those from the public time table
- All access links, transfer links and egress links were checked for reasonableness and logic. Fare coding were also checked for all the bus routes in the study area.
- For a start, a 5-minute transfer penalty was added if the transit path required a transfer to another BCT route. This penalty was adjusted up or down until the model's estimate of transfer trips matched the observed transfers in the corridor with acceptable level of accuracy.
- The calibration targets for selected bus routes are presented in **Table 2**. The model was run several times by making minor adjustments to the network (walk coverage, zonal connections etc.,) until the transit assignment results for the study area bus routes approximately matched observed ridership.

Shown in **Table 3** are the model estimated trips versus the Calibration targets. As seen, for the base year, the model slightly overestimates ridership on Route 2 about 10 percent. On Route 102, the overestimation is higher, about 23 percent. Given that the daily observed ridership on Route 102 is rather small (about 1,000) to begin with, an overestimation of 23 percent is still considered to be acceptable for model calibration. For a number of other local routes in the study area, the model overestimates the aggregate ridership by about 15 percent. On three routes (Route 5, 12, and 34), the calibrated model underestimates the aggregate ridership by about 10 percent. Based on the base year model's performance in simulating the existing ridership, it was concluded that the calibrated model was ready to be used in forecasting ridership for future years.

Using the calibrated model, the impacts of several different types of improvements on the corridor boardings were examined using the forecast year land use and travel conditions. For the Tier 2 alternatives, the forecast year was 2020.

Several different alternatives were examined based on the following four broad categories. The categories included:

- Headway improvements
- Travel time improvements
- Types of service (Local, limited stop enhanced bus, BRT)

Table 2 Calibration Targets for SFSTM model

Route	Corridor	Daily ridership
02	UNIVERSITY DR	7,300
05	PEMBROKE RD	1,800
07	HOLLYWOOD/PINES BLVD	5,000
12	SHERIDAN ST / DAVIE RD / UNIVERSITY DR	2,100
16	STIRLING RD / PEMBROKE LAKES RD	1,100
22	BROWARD BLVD	5,000
28	MIRAMAR PKWY / HALLANDALE BCH BLVD	5,200
30	DAVIE RD / PETERS RD	2,700
34	SAMPLE RD	3,900
36	SUNRISE BLVD	6,100
42	ATLANTIC BLVD	2,500
55	COMMERCIAL BLVD	2,950
62	RIVERSIDE DR / NOB HILL / MCNAB / CYPRESS CRK	2,500
72	OAKLAND PARK BLVD	9,100
81	BROWARD / SR7 / OAKLAND PARK / INVERRARY	4,700
83	COPANS / ROYAL PALM RD	1,400
102	UNIVERSITY DR	1,050
56	SUNRISE LAKES BLVD	500

Source: HDR Engineering

Table 4 presents a brief description of the alternatives considered in the Tier II analysis.

The preliminary forecasts were developed with the following key assumptions:

- The travel times, stop locations and terminal points for the underlying local bus service are the same as those for the existing condition.
- All other local buses operated at the existing level of service.
- The existing BCT local bus fare was assumed for the project service.

- No new park-and-ride locations were assumed.
- For the BAT lane alternatives, it was assumed that the land use characteristics adjacent and near the station areas would be consistent with what was assumed in the 2020 demographic and land use forecasts. The impacts of potential redevelopment or economic benefits on the ridership were not analyzed as a part of this effort.
- The underlying highway network remains the same in all the alternatives.

Table 3 SFSTM Model Calibration Results

ROUTE	CORRIDOR	Observed ridership	PEAK HDWY	OFFPK HDWY	Model Line	Model Ridership	% diff
02	UNIVERSITY DR	7,300	20	30	M33L2BIN	8,064	10%
05	PEMBROKE RD	1,800	30	45	M33L5BI	1,589	-12%
07	HOLLYWOOD/PINES BLVD	5,000	20	40	M33L7BI	5,011	0%
12	SHERIDAN ST / DAVIE RD / UNIVERSITY DR	2,100	45	45	M33L12BI	1,776	-15%
16	STIRLING RD / PEMBROKE LAKES RD	1,000	30	60	M33L16BI	1,506	51%
22	BROWARD BLVD	5,000	15	15	M33L22BI	4,997	0%
28	MIRAMAR PKWY / HALLANDALE BCH BLVD	5,200	20	30	M33L28BI	6,341	22%
30	DAVIE RD / PETERS RD	2,700	20	20	M33L30BI	3,066	14%
34	SAMPLE RD	3,900	20	30	M33L34BI	3,663	-6%
36	SUNRISE BLVD	6,100	20	20	M33L36BI	6,837	12%
42	ATLANTIC BLVD	2,500	30	30	M33L42BI	3,005	20%
55	COMMERCIAL BLVD	2,950	30	30	M33L55BI	3,396	15%
62	RIVERSIDE DR / NOB HILL / MCNAB / CYPRESS CRK	2,500	40	40	M33L62BI	3,036	21%
72	OAKLAND PARK BLVD	9,100	15	15	M33L72BI	11,176	23%
81	BROWARD / SR7 / OAKLAND PARK / INVERRARY	4,700	20	30	M33L81BI	5,069	8%

83	COPANS / ROYAL PALM RD	1,400	30	40	M33L83BI	1,996	43%
102	UNIVERSITY DR	1,050	30	30	M33L2BrzBI	1,289	23%
56	SUNRISE LAKES BLVD	500	45	45	M33L56BI	149	-70%
		64,800				71,966	11%

Source: HDR Engineering

Table 4 Description of Tier II Alternatives

Alternative	Elements
Silver	No Build/Committed Projects
Orange	Bicycle/Pedestrian/ CMS Focused Alternative A
Yellow	Bicycle/Pedestrian/ CMS Focused Alternative B
Green	Yellow Alternative + Limited Stop Service All Day
Blue	Yellow Alternative + Higher Frequency Local Bus Service + Limited Stop Bus Service All Day
Red	Yellow Alternative + Higher Frequency Local Bus Service + Limited Stop Bus Service All Day - Operating in Curb Lane as BAT Lane
Indigo	Yellow Alternative + Local Bus Service + Higher Frequency Bus Rapid Transit Service All Day
Magenta	Yellow Alternative + Local Bus Service + Higher Frequency Bus Rapid Transit Service All Day - Operating in Existing Curb Lane as BAT Lane from Griffin Rd - Westview
Violet	Yellow Alternative + Local Bus Service + Higher Frequency Bus Rapid Transit Service All Day - Operating in New Curb Lane as BAT Lane from Griffin Rd - Westview

Source; HDR Engineering

The daily ridership forecasts generated from the SFSTM model for all the Tier II alternatives are presented in **Table 5**. In the Silver alternative, there is no improvement in the transit service. This alternative will serve as the No Build alternative against which all the Build alternatives will be compared and evaluated. As shown in **Table 5**, the forecast year ridership on Route 2 under the No Build scenario is projected to be 8,150 boardings and on Route 102, about 1,600 boardings. The total corridor ridership would be about 9,750 boardings a day. In the Yellow and Orange alternatives, the off-peak service on Route 2 is improved from 30 minutes to 20 minutes. As a result, the ridership on Route 2 increases to 9,200. Since there are several transfers taking place between Route 2 and Route 102, the ridership on Route 102 also increases slightly in this alternative.

Under the Green alternative, the peak service on Route 2 is reduced while the service on Route 102 is extended all day. As seen in **Table 5**, the increase in service on Route 102 causes the ridership to more than double in the Green alternative when compared to the Silver alternative.

In the Blue alternative (Enhanced Bus), there is a significant improvement in level of service on Route 102 (20 minute headway, all day). The local service , Route 2 is operated at 30 minute headway, all day. As seen in **Table 5**, the total ridership in the corridor under this alternative is projected to increase to about 11,050 boardings a day.

Under the Red alternative, both Route 2 and Route 102 would be operating at 20 minutes headway, all day. At several stations that are common to both these routes, passengers would see an effective headway of 10 minutes throughout the day. This high level of service increases the corridor ridership to 12,200 boardings a day.

The Indigo alternative involves converting the existing Route 102 to a Bus Rapid Transit service, running at 15 minutes headway, all day. The peak service on Route 2 will be reduced from 3 buses an hour to 2 buses an hour. The SFSTM model incorporates a positive bias factor for the BRT mode that captures the unquantifiable aspects of that mode. As a result, the model projects the BRT ridership would be in the order of 6,600 which is more than four times the ridership on Route 102 in the Silver alternative. However, the reduction in peak service on Route 2 has a significant negative impact on local bus ridership. The net effect shows the corridor would have a total ridership of about 11,600 boardings a day.

Both Magenta and Violet alternatives are similar to the Indigo alternative with one exception: The BRT would be operating in Business Access Lane (BAT) from Griffin Road to Westview. The BAT lanes would offer some travel time savings which causes the projected ridership in the corridor to increase to about 12,100 boardings.

The ridership results indicate the estimated model sensitivities are close to the lower end of the range observed among other transit systems in the country. The main observation from this analysis is the Tier 2 alternatives, for the forecast year conditions, are projected to produce anywhere from 3 percent to 25 percent more boardings in the corridor in comparison to the No Build conditions. For those alternatives having a medium (3 to 7 years) and long (greater than 10 years) implementation timeframe, the daily corridor ridership is projected to be about 11,000 to 12,000 riders.

Table 5 2020 Ridership Forecasts for Tier II Transit Alternatives

Alternative	Silver (Existing)	Yellow & Orange	Green	Blue (Enhanced Bus)	Red (Enhanced Bus)	Indigo (BRT)	Magenta (BRT)	Violet (BRT)
Real-Time Arrival Info & Easycard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bus Stops Closer to Intersections	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Complete Bus Stop Amenities	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 2 (local/Enhanced bus)	20 – peak 30 – off	20 – peak 20 – off	30 – peak 30 – off	30 – peak 30 – off	20 - peak 20 – off	30 – peak 30 - off	30 – peak 30 - off	30 – peak 30 - off
Route 2 Split at West Regional	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 102 (limited/BRT)	30 –peak only	30 – peak only	30 - all day	20 - all day	20 - all day	15 – all day	15 – all day	15 – all day
Route 102 Serves West Regional	No	No	No	Yes	Yes	Yes	Yes	Yes
Route 2 Ridership	8,150	9,200	6,350	5,700	7,700	5,000	5,400	5,400
Route 102 Ridership	1,600	1,700	3,700	5,350	4,500	6,600	6,700	6,700
Daily Ridership (2020)	9,750	10,900	10,050	11,050	12,200	11,600	12,100	12,100
Increase from Silver Alternative		1,150	300	1,300	2,450	1,850	2,350	2,350

Source: HDR Engineering

3.0 SUMMARY AND CONCLUSIONS

The simplified approach was used for developing the project forecasts for University Drive Mobility Improvement Study. This method was chosen over the traditional travel demand model as it makes use of the existing ridership and demographic characteristics of the corridor, and provides reliable short-term (e.g., 10 years or less) forecasts. The University Drive Transit Corridor is a good fit for the simplified approach as this corridor has robust transit boardings and reliable data available on existing ridership and demographic characteristics.

A preliminary set of test alternatives were examined to analyze the impacts of different types of improvements on the corridor boardings. The results imply travel time improvements have a relatively low impact on the boardings. The ridership in the corridor is sensitive to the location and the number of stops on the project service as it determines the accessibility of the service to the corridor riders. The corridor ridership also appears to be very sensitive to peak period level of service on local service, Route 2.

For the alternatives with a short (0 to 3 years) implementation timeframe (Yellow, Orange and Green), the model projects about 10,000 to 11,000 boardings in the corridor in 2020. For Blue and Red alternatives which have a medium implementation timeframe (3 to 7 years), the projected corridor ridership is in the order of 11,000 to 12,000 riders a day. For long term alternatives (Indigo, Magenta and Violet), the model projects approximately the same level of ridership as the medium terms alternatives, about 11,000 to 12,000 ridership a day. The boardings estimated by the simplified model for the proposed improvements are close to the lower bound of the sensitivity range observed on other transit systems in the country.