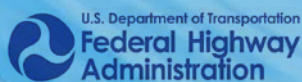
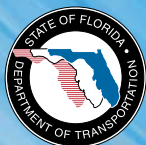


Final Report Bus Toll Lane Concept Feasibility Study

July 2013



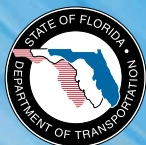


Thanks to Our Consultants:



Executive Summary Bus Toll Lane Concept Feasibility Study

May 2013



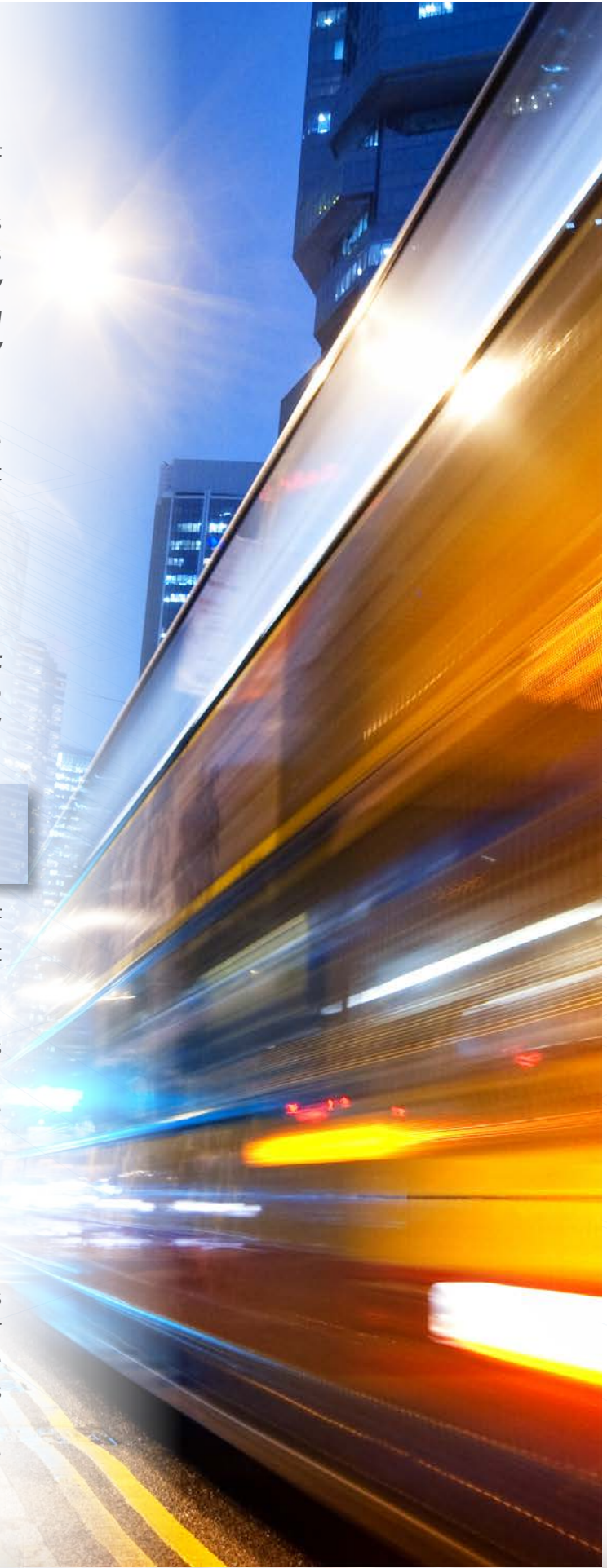
Introduction

The Bus Toll Lane (BTL) concept is a promising new idea to help solve the financial needs of public transportation and the challenges of urban traffic congestion by combining the resources of public transit and toll agencies. The BTL is a transit-based solution **creating financially sustainable transit service with increasing potential to move more people as the facility matures**. The BTL idea brings transit and tolling agencies together as equity partners to fund a multi-modal solution. It is a method to maximize person throughput by employing proven transit and tolling practices. By combining the capital funding resources of transit with the long-term revenue strength of tolls, a more effective and sustainable public transportation system can be developed sooner than either mode could produce on its own. The **Bus Toll Lane Concept Feasibility Study** (BTL Study) was undertaken to determine the operational and financial viability of this new idea.

“The BTL is a transit-based solution creating financially sustainable transit service with increasing potential to move more people as the facility matures.”

If sufficiently patronized, the efficiency of public transit service could provide significant congestion relief. However, the quality of existing public transit needs to improve to make it an attractive/competitive choice. While capital costs for new transit projects can often be funded, traditional fare box revenues from that service only cover a relatively small portion of operating costs. Thus, substantial operating funds from local, state and federal tax sources are needed to subsidize transit service.

For highway facilities, almost all new projects are being constructed with some form of user financing based on tolls. For these facilities, the long term revenue stream is robust. While costs to operate the new facilities are easily covered by the toll revenue, initial capital to build the new lanes is often an issue. This is practically a reverse image of transit funding.



The Study

The Tampa-Hillsborough County Expressway Authority (THEA) in partnership with the Hillsborough Area Regional Transit Authority (HART) conducted the Bus Toll Lanes Proof-of-Concept Study. The study was funded by a grant from the Federal Highway Administration (FHWA) Value Pricing Pilot Program (VPPP). The local match for the study was provided by the Florida Department of Transportation (FDOT) using a “soft match” of toll credits.

The BTL concept imagines a financially self-sustaining public transportation solution to help address urban congestion. The idea proposes a new premium transit service operating on newly built price-managed lanes to function as the “fixed guideway” for bus rapid transit service. Financial sustainability would be achieved through a partnership that combines funding and management practices of a public transit agency and a public toll agency. The study results conclusively confirmed this concept is viable.

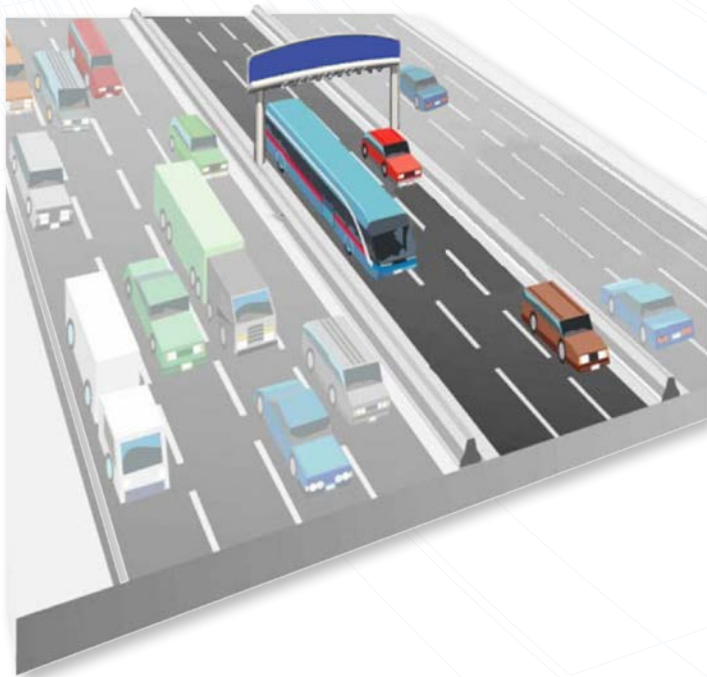


Figure 1: Example of BTL Adding New Capacity in the Median of a Limited-Access Highway with All-Electronic Tolls

BTL Elements

The BTL concept provides direct support for public transportation by inviting transit agencies to be equity investors in the construction of new **premium transit service running on new price-managed express lanes** to serve highly congested urban areas. Price-management is a toll application that varies rates by time of day to assure free-flow of traffic at all times in the lanes. This study applied toll rates that varied by time of day to assure traffic flow would be maintained at 50-miles per hour. It is a proven application of the toll industry that transit **can apply to assure sustainable service speeds**. It should be noted that the **BTL concept is not a high occupancy toll (HOT) lane**. No discounts or free passage based on vehicle type or occupancy **assures a sustainable revenue stream and eliminates occupancy enforcement costs**.

The BTL maximizes person throughput by employing proven **bus rapid transit (BRT) service on the newly constructed price-managed lanes**. Price-management of the lanes with all-electronic tolling technology ensures high speed operations at all times. The **new lane capacity is dedicated first to public transit**. All of the remaining capacity above that used by the public transit vehicles is then sold to drivers of personal vehicles who are willing to pay the variable-tolls that assure free-flow service. As shown in Table 1 on the following page, a price-managed lane moves significantly more vehicles and people (165%) than a congested highway lane. Converting auto passengers to public transit passengers substantially increases overall people moving potential. To be conservative, the study assumed bus service running on 10-minute headways. This raised the potential people moving capacity 187% higher than a congested highway lane. The BTL concept provides enhanced transit service at lower passenger costs with equal or better trip times compared to personal vehicle trips. This **provides a competitive advantage in attracting new transit ridership**. As the transit

BTL – MOVE PEOPLE!			
Condition (Vehicle Occupancy Rate = 1.1)	Buses Per Hour	Person Throughput Per Hour	Comparison to General Purpose Lane
General Purpose Lane With Severe Congested	0	1100	100%
Price-Managed Express Lane No Transit	0	1815	165%
BTL 15 Minute Headway	4	1977	180%
BTL 10 Minute Headway	6	2058	187%
BTL 5 Minute Headway	12	2302	209%
BTL 2 Minute Headway	30	3032	276%
BTL 1 Minute Headway	60	4248	386%

Table 1: BTL- Move People
Hypothetical Person Throughput on Bus Toll Lanes in a Limited-Access Free-Flow Environment
(Source: Parsons Brinckerhoff)

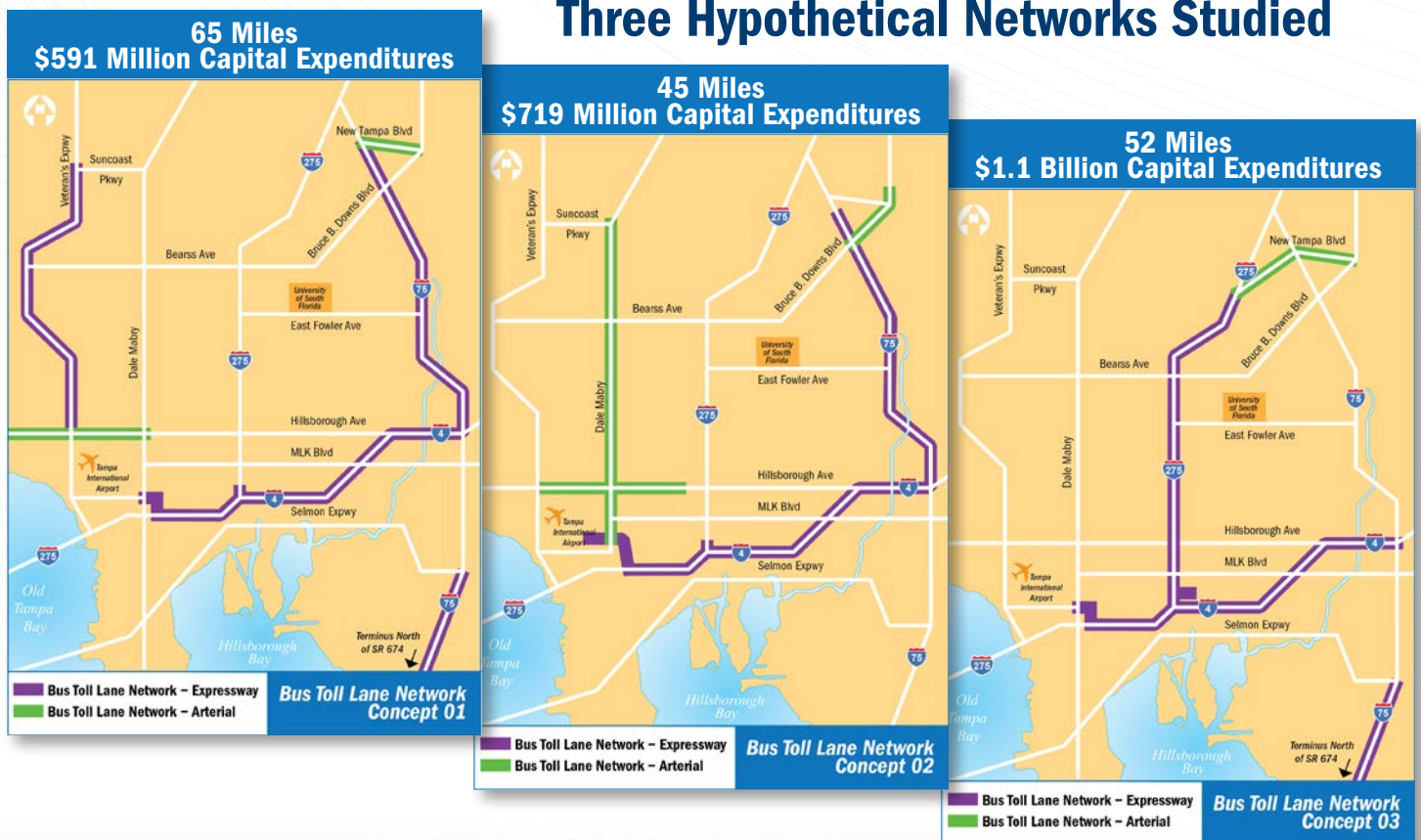
demand increases, the BTL concept provides the financial resources and lane capacity to grow the premium transit service. Even employing one-minute headways (60 buses per hour) uses less than 10% of the price-managed lane capacity

on a limited access facility. The remaining 90% is a revenue opportunity to provide funding in support the transit service. The *revenue opportunity for transit is based on the capital share invested to build the BTL system.*

BTL Networks

The BTL study used Hillsborough County as a test location. The area is representative of mid-sized urban communities within the United States. It has a total population of just over 1.2 million with Tampa being the primary central city. Hillsborough County is very much like other mid-sized American communities that exhibit heavy peak-hour traffic congestion and limited financial capability to develop and operate new premium public transit service. The purpose of this study was to test the BTL concept using real data. It was not intended to recommend a specific transit plan or project for the City of Tampa or Hillsborough County. In fact, to maintain this awareness the study team referred to the city as "Betaville" and the county as "Betaborough County" during the project.

Three Hypothetical Networks Studied





The study developed three different hypothetical BTL networks to provide depth and range to the analysis. It included bus rapid transit, express bus and managed lane design concepts on congested limited-access and high-volume arterial highways. The study horizon was projected over a 30-year period (2016-2045). It should be noted that transportation networks of this size are not usually built as one single project, but as a combination of projects over a period of time as resources become available. However, to fully assess the BTL service levels and financial components, the study assumed that all network elements would be constructed simultaneously to be in place in the opening year.

To manage speeds on the BTL and ensure a high level of service for transit using the facilities, toll prices are varied by time of day to control demand. The demand pricing (toll-rate setting) is based on levels of traffic demand in the new managed lane(s). Toll rates are higher in the morning and afternoon peak travel demand periods, and lower during off-peak travel times. The BTL Study included modeling analyses to verify that a high level of service could be maintained in the BTL lanes throughout the study horizon. The toll-rates used to maintain the high-level service (minimum 50 MPH travel speeds) were also used in the revenue analysis.

The BTL Study included traffic and transit ridership modeling along with sketch level engineering and cost estimates. The study used FDOT unit prices, prior HART studies, and actual operating costs from THEA. This information was used as the basis for independent operational performance evaluations.

Modeling

The study team chose to use the latest version (Version 19) of the Tampa Bay Regional Transit Model (TBRTM), which was developed in consultation with the FDOT, FTA, and MPO. Multiple model iterations were performed. The model incorporated projects identified in the MPO's financially feasible long range transportation plan. This base network was then modified to incorporate the BTL improvements. The three BTL networks were then modeled and tested independently.

Modeling iterations of the BTL networks were performed to develop the per mile toll-rates necessary to maintain operating speeds at 50 mph. The final model runs used a low (\$11.60/hour) and a high (\$15.00/hour) customer value of time to forecast use and revenues. The medium model results were an interpolation between those values. This resulted in per mile toll rates on

the BTL networks that ranged from a low of \$0.28 per mile in 2015 to \$1.30 per mile in 2045. These rates compare well with existing tolls needed to maintain freeflow conditions on congested corridors elsewhere in the United States.

The study developed a hypothetical set of transit stop locations for each network. In addition, the University of Florida Urban and Regional Planning GEOPLAN Center team modeled how each BTL network could influence land development patterns in Tampa and Hillsborough County for the years 2025, 2035, and 2045. These revised land-use assumptions were used in the network modeling. This allowed the study to take into account changes in land use that potentially occur with significantly improved transit service.

BTL Transit Equity Investment – The New Fare Box

The primary purpose of tolling in this application is to price-manage service levels in the new lanes. This is a change in the traditional use of tolling as a revenue source to fund construction costs. The BTL concept also proposes a repurposing of the tolls by applying transit funds to the capital financing of the new lanes as a fixed guideway for new premium transit service. The infusion of transit capital would convey ownership rights that entitle transit to an equity share of the toll revenue. A transit agency owning all or part of

the price-managed lane as a fixed guideway for premium transit service will further repurpose the tolls as a component of a new transit fare box.

Traditional transit fare box revenue is described as fares collected directly from transit passengers. In the BTL concept, the transit agency is recognized as an owner of the facility - based on the share of capital funding they provide. In this case the toll paid for the non-transit vehicle to use the transit guideway is a payment to the transit system. Thus the transit fare box would now include BTL toll revenues as well as the fares collected from bus passengers.

Assuming the BTL system was built and funded from traditional transit resources, all **new fare box revenues** would be available to cover the annual costs of operation and maintenance (O&M) for the new bus service, toll systems, and lane systems. For transit, the BTL potential to provide toll revenues as a return on the investment of transit capital funds is a significant benefit.

Table 2 demonstrates that each BTL network produced significant **new fare box revenues** for transit. Based on the results of this study, the BTL fare box provided a sustainable, inflation sensitive revenue stream that would cover 100% of all system O&M costs.

30-Year BTL Revenue and Cost Results					
Using Medium Revenue Scenario for Each BTL Network (\$Millions)					
	New Fare Box	BTL O&M¹		Net Revenue	
Network	Gross Revenue Tolls & Bus Fare	Guideway O&M	New Transit O&M	New Fare Box minus BTL O&M	Present Value @ 5%
BTL #1	3,464	545	535	2,384	807
BTL #2	1,940	371	585	984	316
BTL #3	2,274	361	567	1,346	445

¹ = Annual operations, maintenance and major maintenance

Table 2: 30-Year BTL Revenues and Costs
(Source: Parsons Brinckerhoff, Tindale Oliver, American Engineering & AECOM)



Each network produced significant revenues well above operating costs. The remaining revenues could contribute to support the BTL capital development **as a new source of local funding match to federal transit grant programs**, or it could be used to support other public transportation capital and operating needs.

The financial potential of a BTL to cover 100% of transit O&M costs from fare box revenues is unmatched by any known public transportation system within the United States. According to the American Public Transportation Association (APTA), in 2010, the average US public transit system returned slightly more than 32% of operating expenses from the passenger fare box. The rate of return is typically lower for small-to-midsized transit systems.

The BTL financial analysis offers encouraging results for a new transportation paradigm that marries traditional transit and toll financing to fund operation expenses.

Other Benefits

BTL Assists All Transit Riders Including the Transportation Disadvantaged:

Assuming a transit investment of capital to construct the BTL, the tolls generated by the network may become part of the fare box revenue. That revenue can be used to substantially reduce fares for the dedicated BTL express bus service.

The BTL study reduced the current HART rate of \$2.50 per trip for express service to \$1.00 per trip on the new rapid transit service – thus making BTL transit more attractive and affordable for all transit passengers. There is potential for further subsidies targeted to the transportation disadvantaged.

BTL is a Transit Oriented Development Solution:

In addition to the BTL being an effective and financially feasible transportation solution, land-use research by the University of Florida Urban and Regional Planning GEOPLAN Center demonstrated positive impacts on projected changes to community land-use through the BTL support of transit oriented development (TOD). **BTL networks encourage more compact, mixed-use land development which results in the reduction of trips and more efficient use of the existing transportation system.**

US Public Transportation Sources of Operating Funds									
	Agency Funds			Government Tax-Based Sources					
YEAR	Passenger Fares	Other (advertising, concessions, leases, etc.)	Total Agency Funds	Local Taxes	State Taxes	Federal Taxes	Other (public taxing organization sources)	Total Government Tax-Based Funds	TOTAL FUNDS
2010	32.1%	5.4%	37.5%	21.6%	25.0%	9.4%	6.5%	62.5%	100%

2012 Public Transportation Fact Book, Appendix A: Historical Tables - Table 63, Page 89

Table 3: Source of Public Transit Operating Funds (Source: American Public Transportation Association)

Study Findings: BTL#1 Network Overview

A BTL partnership builds on the financial and institutional strengths of transit and toll practices. Analysis indicates that BTL #1 is a strong transit project from both a ridership and financial perspective. This conclusion is based on the amount of new transit riders generated by BTL #1, the total capital cost of the project, and the resulting net cash flows.

Growth in New Transit Ridership

Premium express bus routes were developed specifically for each of the BTL networks. Existing express bus routes were also identified that would likely use the BTL network to enhance the performance of public transit systems in the vicinity of the BTL corridors. Based on the very attractive travel times created through the application of value pricing in the lanes and reduced fare costs of the BTL express bus service, a significant growth of transit ridership is forecast for all three networks as shown in table 4.

Financial Feasibility

Finding capital funds for new public transportation projects is always a challenge. Public transit

typically looks to fund major capital projects through Federal Transit Administration (FTA) New Starts and Small Starts grant programs. Matching funds for the FTA grant are usually from local and state levies of transportation fuel taxes or general tax sources. The “greater” financial challenge of transit is finding sustainable revenue sources to cover ongoing operations and maintenance costs.

As mentioned earlier, transit fare box revenues typically cover 20% to 30% of operations. Over a thirty-year period, the transit operation and maintenance costs far exceed the initial development costs. This places a financial burden on federal, state, and local governments.

The ability of toll projects to cover O&M costs is very much the opposite of transit. Toll projects have a strong potential to fully fund operations and maintenance from a very early point of being open-to-service. On the other hand, “greenfield” toll projects (new roads in new corridors) typically face a financial challenge in raising the up-front capital for construction. Such projects often need capital subsidies to supplement the revenue bonds issued for construction. Once

Transit Ridership Forecasts - Opening Year (2015)					
Network	Weekday Boardings			Annual Riders	
	Existing Express Routes	New BTL Express Routes	Total New BTL Express and BRT Routes	Ridership	Transit Use Growth within BTL Corridor
BTL 1	3,325	12,381	15,706	4,005,030	472%
BTL 2	5,176	14,238	19,414	4,950,570	375%
BTL 3	1,280	22,094	23,374	5,960,370	1826%

Table 4: BTL #1 Transit Ridership Forecasts for 2015 (Source: AECOM)

built, however, a well-planned and operated toll road has the potential to produce significant revenues in excess of O&M and debt service costs as customers are attracted to the premium service provided by the facilities.

The option to use transit capital funds provides transit a return on investment opportunity by gaining access to the toll revenue to cover transit operating costs. The infusion of transit funds for the capital development of the new lanes advances the ability to add new capacity sooner than would be possible if left to toll agency resources. The combination creates a premium transit service that moves people and provides a sustainable choice for drivers of personal vehicles. This is a strong solution to address urban transportation needs.

Utilizing data derived from the BTL #1 network, the following analysis results demonstrate:

- Stand-alone challenges for transit to develop BRT service
- Stand alone challenges for a toll agency to develop price-managed express lanes – with and without issuing construction bonds.
- Combined funding efforts to show the strength and benefits of the BTL concept.

Price-Managed Fixed Guideway Facility

Figure 4 provides cost and revenue data for the new price-managed lanes that would be built for premium bus service on BTL #1. The capital cost to build 65-centerline miles of new fixed guideway, and the tolling elements essential to price-manage the lane operation of BTL #1 is \$560 million (grey bars). This element of the

BTL 1 – Fixed Guideway Price Managed Lane

Dollars in Millions	Fixed Guideway
Guideway Capital Cost	\$560
Toll Revenue	\$3,406
Guideway O&M Cost	\$545
Net Revenue	\$2,861

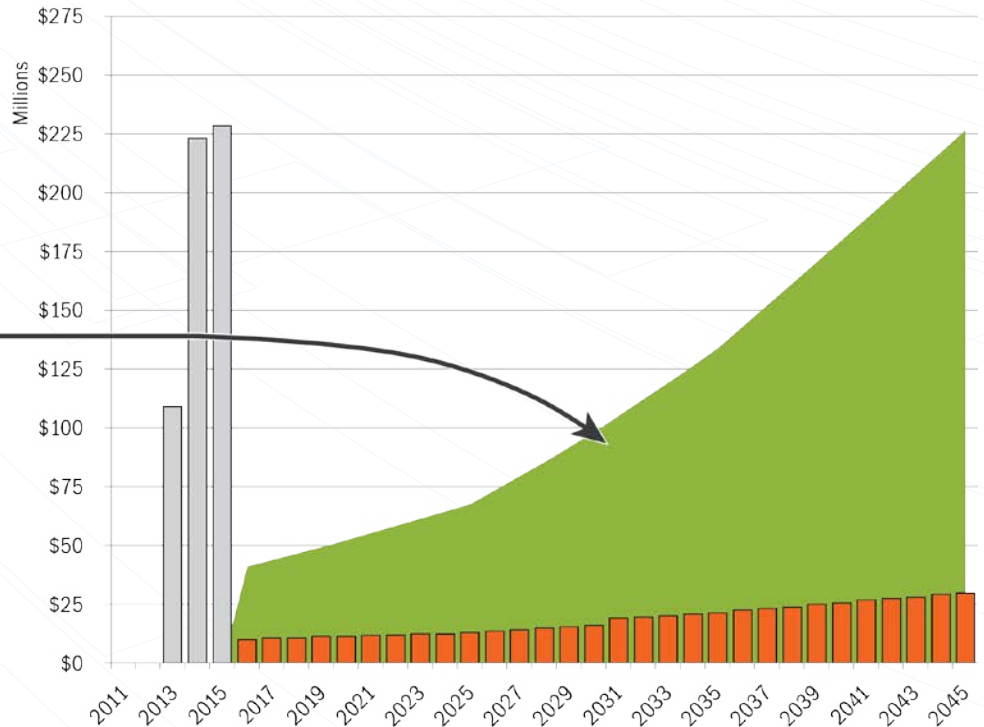


Figure 4: Fixed Guideway Facility
 (Source: Parsons Brinckerhoff, American Engineering, AECOM & HNTB)

BTL system would generate about \$3.4 billion in toll revenue over 30-years (green area of the chart from opening year 2015 through 2045). Those funds would be sufficient to cover 100% of the \$545 million cost for the fixed guideway operations, and maintenance over that 30-year period (shown as the orange bars). This leaves about \$2.9 billion in net revenue.

While this net revenue is significant, the relatively small amount of revenue available in the first 10-years of operation constrains the ability to finance the capital costs from tolls alone. This is demonstrated on Figure 5.

Figure 5 adds a relatively basic bond (construction costs) issue to the prior chart. The revenue in excess of the toll O&M for the BTL could provide \$268 million, or 48% of the \$560 million capital funds

needed for construction of the fixed guideway network. The 30-year principle and interest for that financing is \$875 million. The dark-blue and light-blue bars show interest and principal payments respectively. The debt service of this bond issue was structured to reflect the stronger revenue potential in the later-half of the 30-year period. It assumed a 30-year bond interest rate of 5.46% with an annual debt service coverage ratio of 1.5 times the annual debt service cost.

This financing approach leaves \$292 million as the unfunded capital cost to build and implement managed lanes. That would be the un-funded capital cost if the lanes were built as a stand-alone toll facility. It would require additional funds from some other source to fund construction. The source of that match determines ownership of the revenue stream.

BTL 1 – Fixed Guideway Price Managed Lane

Dollars in Millions	Fixed Guideway
Guideway Capital Cost	\$560
Toll Revenue	\$3,406
Guideway O&M Cost	\$545
Net Revenue	\$2,861
Toll Bond Financing	\$268
Cost of Finance	\$268
Net All Costs	\$2,003
Unfunded Capital	(\$292)

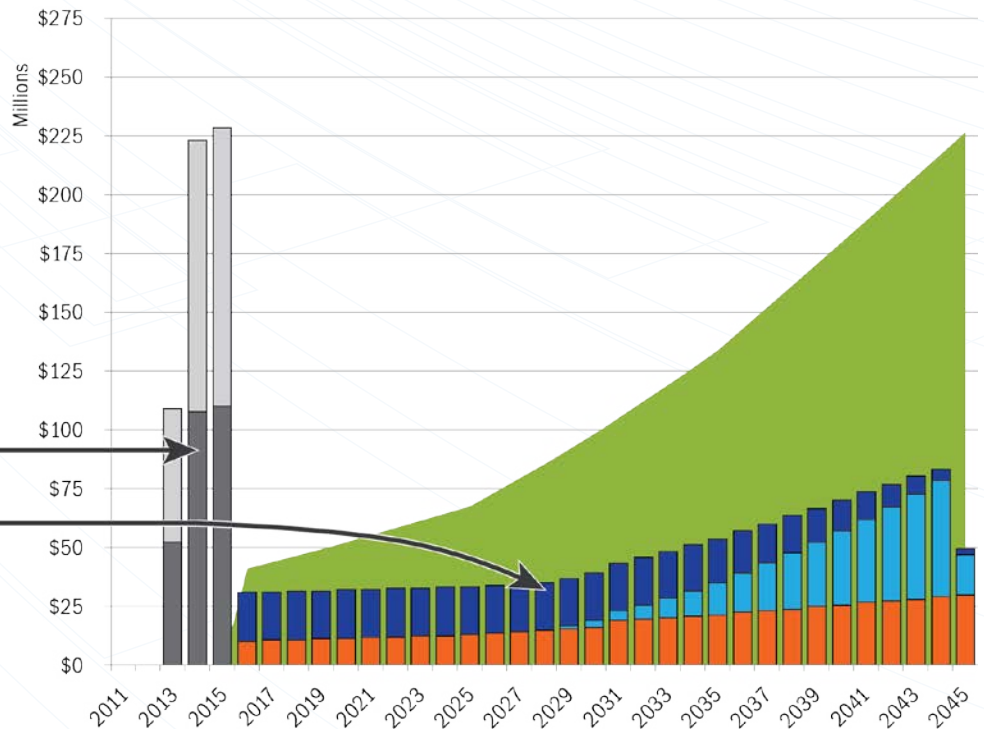


Figure 5: Fixed Guideway Facility
 (Source: Parsons Brinckerhoff, American Engineering, AECOM & HNTB)

An optimized financing structured could utilize additional debt products such as Capital Appreciation Bonds (CABs) or a federal TIFIA loan to aggressively tailor project financing and produce additional upfront proceeds. Public-Private Partnerships could also explore the use of additional debt products. In each case, there will be trade-offs of increased upfront capital proceeds for construction in exchange for less, perhaps significantly less, net revenue over the life of the project.

Premium Bus Service

Figure 6 demonstrates the new premium bus service on BTL #1 running on 10-minute headways. Purchase of the rolling stock and infrastructure to support operations would cost

\$31 million (grey bar on the chart). Operations, routine maintenance and major-maintenance over 30-years would cost about \$559 million (yellow bars on the chart). The sharp changes in operating costs are from 12-year sinking funds that support the purchase of new/replacement buses in 2027 and 2039. Revenue from bus-fares would generate \$58 million over that period (green area on chart). The chart clearly demonstrates the inability of the traditional transit fare box to cover operating costs. Net revenue after operations is a negative \$501 million. This relationship of relatively low capital costs to large operation and maintenance costs over time demonstrates the ongoing financial challenge for transit.

BTL 1 – Premium Bus Service

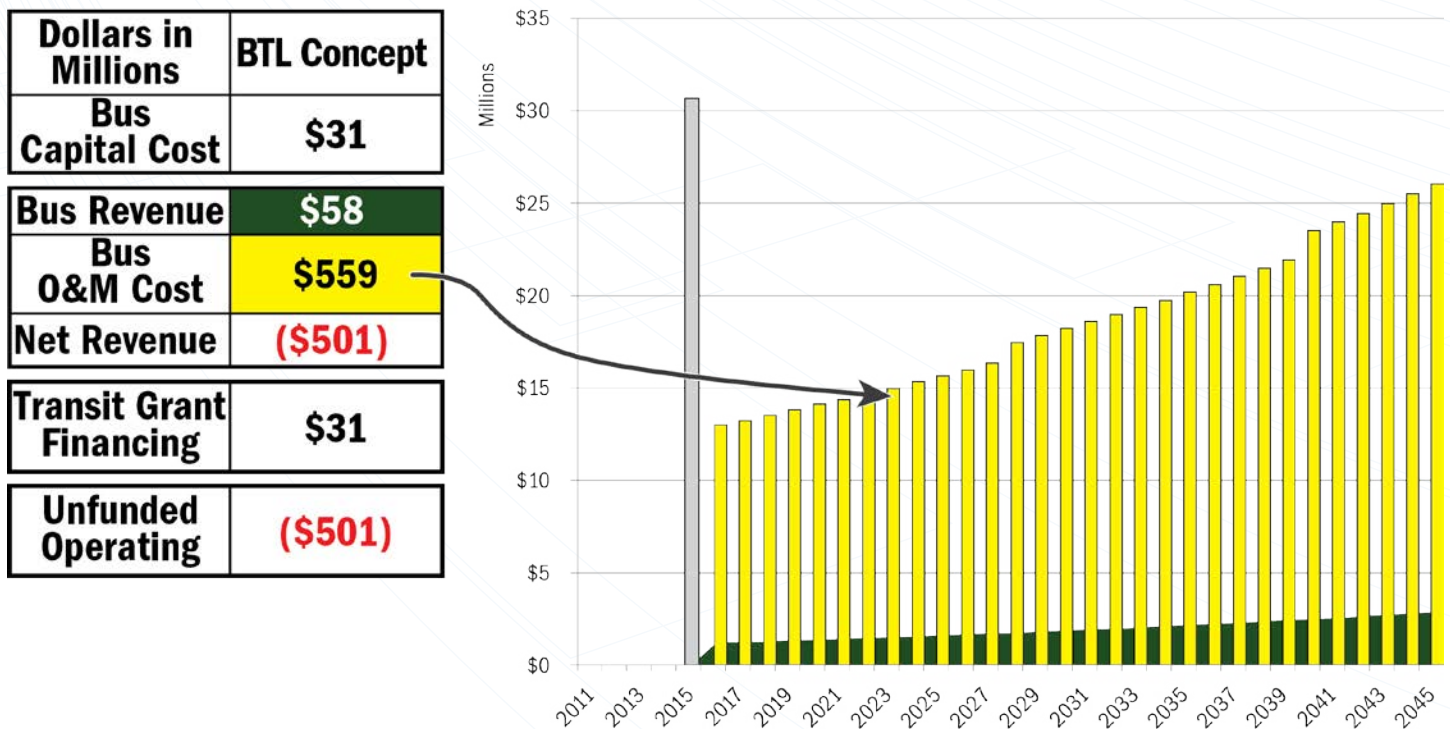


Figure 6: Premium Bus Service
 (Source: Parsons Brinckerhoff, Tindale Oliver, AECOM & HNTB)

The BTL Concept

Figure 7 presents the previous elements as the unified financial concept for a BTL. By optimizing the strengths of toll financing and transit financing, the project is much more likely to be financially feasible. While toll bond financing can cover a significant portion of the overall capital costs, funding from traditional transit capital grant sources is applied to cover the combined \$591 million in capital costs. Rather than relying only on traditional sources to provide the required local matching funds for a federal transit grant, this toll bond financing is used as a new source of local matching funds.

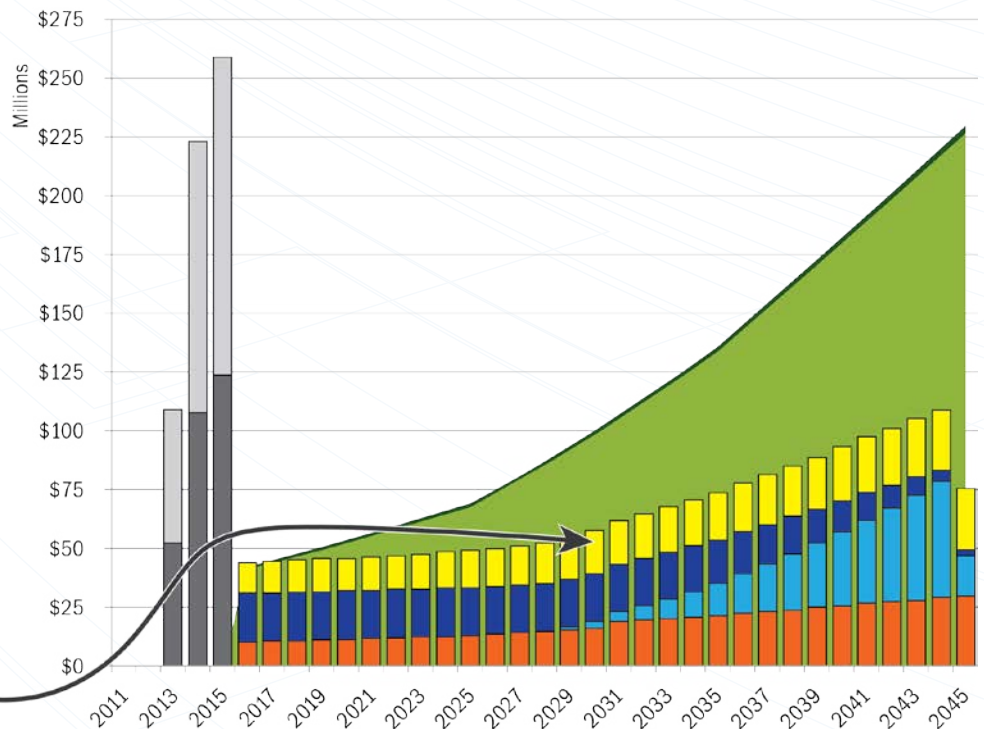
Using the bond structure discussed earlier, the revenue in excess of the toll O&M for the BTL could provide \$268 million, or 45% of the capital

funds for construction of the fixed guideway network. This would serve as an element of the required local match. The total 30-year principle repayment and interest cost for that financing is \$875 million, as represented the dark and light blue portion of the bars in the graph.

This financing approach leaves \$323 million as the unfunded capital cost to build and implement the BTL as a premium transit service. The analysis assumed that remaining capital cost would come from traditional transit grant financing sources (federal, state and local). That \$323 million capital cost is an equity investment that would make the transit agency the owner of the revenue stream – creating the new transit fare box.

BTL 1 Concept

Dollars in Millions	BTL Concept
Total Capital Cost	\$591
Revenue	\$3,464
Guideway O&M Cost	\$545
Net Revenue	\$2,919
Transit Grant Financing	\$323
Toll Bond Financing	\$268
Cost of Finance	\$875
Bus O&M Cost	\$559
Net All Costs	\$1,485



Assumes a 30-year bond at 5.46% interest rate with a debt service coverage ratio of 1.5X. The debt service was structured to reflect the stronger revenue potential in the later-half of the 30-year period.

Figure 7: Bus Toll Lane #1 – Combining the Strengths of Transit and Tolls
 (Source: Parsons Brinckerhoff, Tindale Oliver, American Engineering, AECOM & HNTB)

The yellow bars on top of the blue debt service bars show the annual O&M cost for transit. As can be seen on the graph, the majority of bus service and maintenance costs are covered in the first year and fully funded thereafter. As previously described in Figure 6, there was an anticipated \$501 million operating deficit to provide the transit service over the 30-year period. The \$323 million transit capital investment gained access to the toll revenue stream that now covers 100% of that cost.

Finally, there is the net revenue of \$1,485 million. Again, because the \$323 million transit capital investment gained access to the toll revenue

stream, this revenue would also be available to the transit agency to supplement existing service or add new transit service.

Table 5 illustrates that a transit capital investment in the construction of the BTL guideway provides a significant revenue stream during the life of the project. For BTL 1, the revenue stream produces more than 600% of the original investment. While BTL 1 produces the most return, BTL 2 and BTL 3 also return significantly more revenue than the original capital investment. In short, **all networks cover the transit operating shortfall while producing significant amounts of additional revenue for the transit agency.**

BTL 1 – Return on Transit Grant Investment			
Transit Grant (Local, State, Federal)		\$323	
Bus Operating Subsidy	\$501		
+ Net System Revenue	\$1,485		
	$\$1,986 / \$323 =$		617%

BTL 2 – Return on Transit Grant Investment			
Transit Grant (Local, State, Federal)		\$568	
Bus Operating Subsidy	\$545		
+ Net System Revenue	\$467		
	$\$1,012 / \$568 =$		178%

BTL 3 – Return on Transit Grant Investment			
Transit Grant (Local, State, Federal)		\$838	
Bus Operating Subsidy	\$510		
+ Net System Revenue	\$759		
	$\$1,269 / \$838 =$		151%

Table 5 - Return on Original Transit Investment

Moving Forward

While the BTL concept is different than what is normally thought of as a transit facility, it nonetheless provides the operational benefits of an exclusive fixed guideway transit system. In addition, it provides a self-generating revenue source for transit O&M that is lacking in traditional transit funding.

While it can be reasonably interpreted that BTLs qualify under Small Starts, under New Starts it is less clear. That eligibility could be confirmed on premise that BTLs are a Transit Fixed Guideway Asset.

The reasoning for this is straightforward. BTLs dedicate available guideway capacity first to transit vehicles. BTLs maintain a high level of service on the guideway through value pricing. All vehicles using the BTL guideway specifically benefit public transportation by moving people and providing the necessary revenue stream for transit operations.

Recommendations

The acceptance of the BTL toll revenue as a contribution to the “local financial commitment” is an important element of the acceptability of the BTL concept. This provision, along with the favorable treatment of bond proceeds as local match and debt service reserve reimbursement potential, all seem favorable to a BTL or BTL network as envisioned within the Proof-of-Concept Study. The following recommendations are presented to assist in BTL implementation within urban areas:

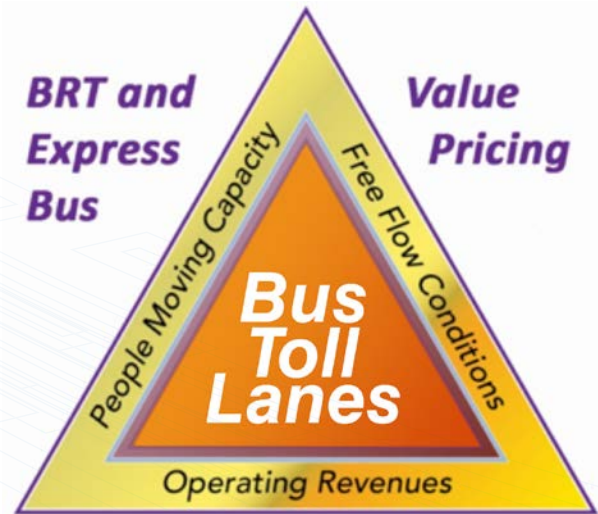
- To ensure that BTL projects are eligible for FTA capital, the next surface transportation authorization should specifically clarify that the definition of “fixed guideway” allows Federal funding for transit agencies who wish to be equity partners in the construction and operation of BTL projects and networks.
- The establishment of a pilot program would support the development and operation of BTL networks within urbanized communities.



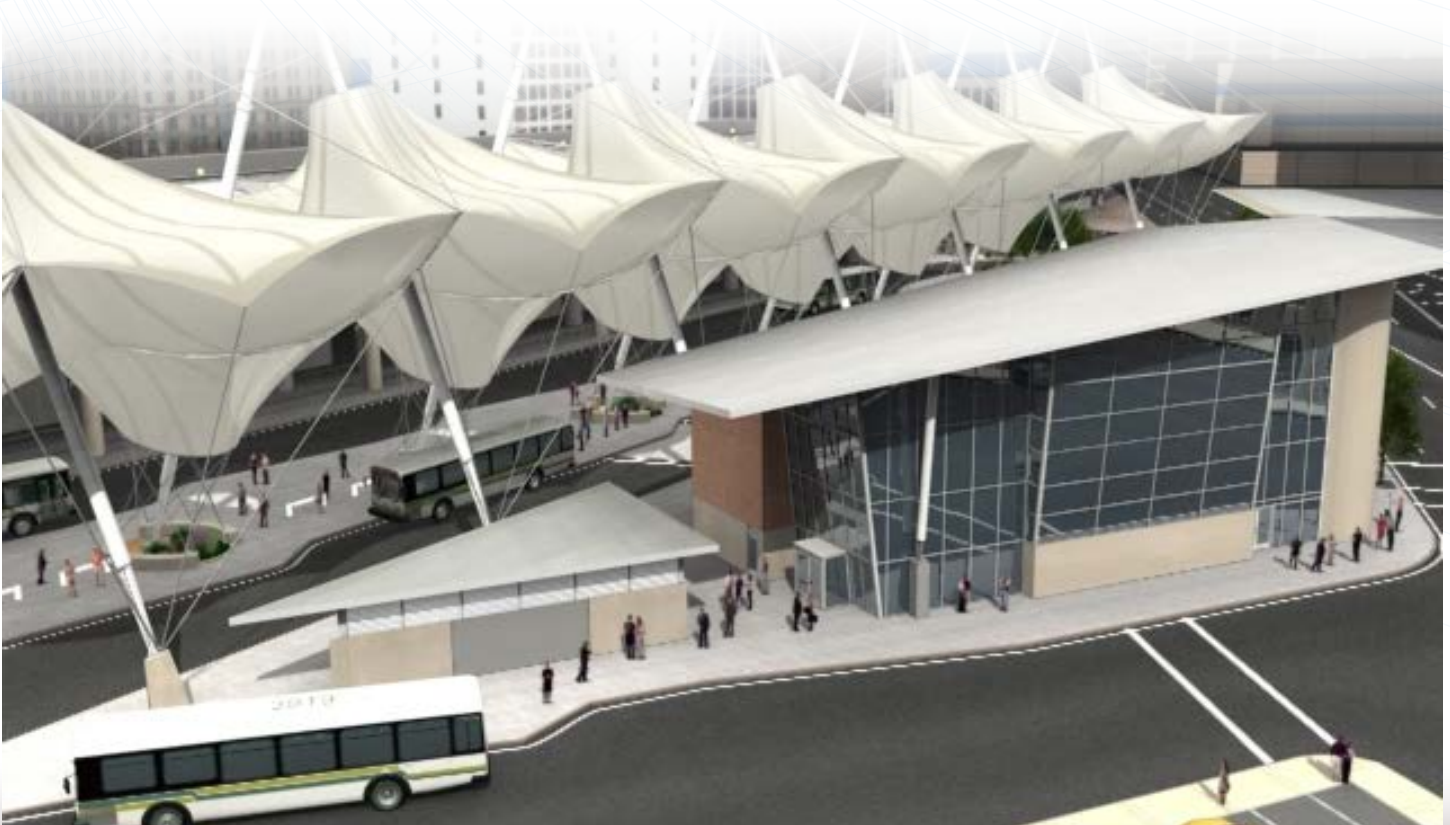
Summary– The Bus Toll Lanes Transit-Tolls Partnership Delivers Excellent Financial, Transportation and Community Benefits

- The BTL transit-tolls partnership is a financially feasible and sustainable public transportation solution to fund the construction and operation of a robust, competitive public transit system.
- Value Pricing on the BTL is an effective tool to add significant and sustainable new capacity to existing travel routes and substantially reduce urban traffic congestion.
- The BTL uses Premium BRT and Express Bus service to substantially increase the “people-moving” capacity within high-demand urban corridors.
- Application of proven toll practices on the BTL will create a new transit fare box as a revenue source to support expansion of public transportation systems and reduce requirements for local transit tax subsidies.
- BTL “transit first” practices address the needs of the transportation disadvantaged by funding more frequent transit service and reducing public transit fares.

- BTL networks support transit oriented development resulting in more compact, efficient urban land-use.
- Policy guidance from FTA can optimize Federal funding for transit agencies who wish to be equity partners in the construction and operation of BTL networks.



Toll Paying Drivers and Fare Paying Pasengers





Thanks to Our Consultants:



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Section A

Bus Toll Lane Concept and Study Description

1. The Bus Toll Lane Concept

A New Transit-Tolls Partnership to Create Financial Sustainability for Public Transportation and Reduce Urban Traffic Congestion

A Bus Toll Lane (BTL) is a promising new idea to solve the financial needs of public transportation and the challenges of urban traffic congestion by combining the funding resources and operational capabilities of public transit and toll agencies. The BTL is a transit-based solution for creating financially sustainable new transportation capacity by making transit a partner in the toll road business. A BTL would maximize passenger throughput by employing proven bus technologies, electronic open road tolling (ORT), and dynamic, congestion-based pricing techniques on new, multi-modal, high-speed transit-owned guideways. With BTLs, capacity would be dedicated first to public transit. The remaining guideway capacity would be sold to all other vehicles, using dynamically priced tolls, to ensure that the BTL level of service would always be high enough to maintain the competitive quality of the transit service. Revenues generated from tolls would be used first to cover any debt service related to the construction of the guideway lanes and the cost of the infrastructure's operations and maintenance. Revenues in excess of these costs would be shared between the transit and toll agencies (and any other partners such as DOTs, MPOs, COGs, etc.) involved in funding the construction of the new lanes based on the percentage of their respective capital contributions.

During the past 50 years, the United States has experienced a steady increase in annual vehicle miles traveled (VMT). The concurrent decline in the financial resources available for new transportation facilities and the resulting failure to keep pace with these growing traffic volumes is a significant cause of the severe traffic congestion now found on almost all highways within the country's major urban areas. For the most part, the financial deficit is a result of the primary reliance on the per-gallon fuel tax to fund transportation and the reluctance to increase the tax or support other meaningful transportation funding to keep up with a half century of inflation and traffic growth.

The combination of increasing VMT, more efficient vehicles that result in substantial reductions in gallons of fuel purchased per miles driven, inflation that has increased the cost of operating and maintaining our national infrastructure as well as building new facilities, and the lack of funding increases to offset rising costs have contributed to the financial crisis in transportation now facing the country. Today, many state governments spend all of their gas tax revenues to simply maintain, rebuild, renew, and occasionally expand existing transportation facilities. In some of these states, tolls are the only source of financing for new major "greenfield" highway construction. Coupled with weak economic conditions, the U.S. is in the midst of a "perfect storm" of transportation finance that makes the construction of new capacity even more difficult; hence, the need for new financing and operating ideas.

HOT Lanes, Managed Lanes and Variable Pricing Solutions

One set of solutions has focused on techniques to make our existing infra-structure more efficient. The conversion of existing high-occupancy vehicle (HOV) lanes into high-occupancy toll (HOT) lanes using variable-pricing scenarios (often referred to as managed lanes) has proven to be an effective strategy. The managed-lane approach increases or decreases the toll rate based on variables such as time of day or levels of existing congestion. The purpose of the variable toll rate is to use pricing to guarantee service quality (traffic speed and volume), thereby maximizing throughput and making the lanes attractive to toll payers.

Unfortunately, many HOT lane projects have not involved building the additional capacity needed to substantially reduce the traffic congestion choking America's urban streets and highways. And, by providing free capacity to those who meet occupancy thresholds (usually two or three occupants per vehicle), these projects forgo large amounts of potential revenue that could support the financial sustainability of urban transportation systems.

HOT lanes also involve vehicle occupancy enforcement that can be very costly and difficult to implement in a uniform manner. Verifying the number of occupants in moving vehicles as part of the toll violation enforcement process is currently a manual undertaking and, as such, is labor intensive and open to considerable human error. Automated approaches using fairly expensive forms of video technology to define vehicle occupancy have been developed but not yet thoroughly tested.

Early evaluations of these technologies indicate that enough errors occur to still require human intervention. Therefore, in addition to the high initial capital expense of the video equipment, there will likely be additional operating and maintenance costs to verify and enforce vehicle occupancy. These automated approaches to determining vehicle occupancy also present significant public concerns about the protection of personal privacy in the toll violation process – concerns that will have to be addressed and resolved before automated enforcement can become an acceptable reality.

Bus Rapid Transit and Premium Express Bus Solutions

Bus rapid transit (BRT) and express bus are other techniques that offer great promise for improving transportation efficiencies. By combining carrying capacities that can approach those of rail with the route flexibility of rubber-tired vehicles, BRT and express buses theoretically produce the type of passenger throughput that could result in meaningful reductions in traffic congestion while offering the rider a premium style of service. However, to provide effective, reliable, and competitive service, these bus premium level systems must have access to free-flowing travel lanes, which often come at a very high cost, if they are available at all.

2. Bus Toll Lanes – A New Multi-Modal Solution

Bus Toll Lanes are envisioned as an effective multi-modal solution for moving people by combining the efficiencies of high-capacity high-speed bus systems with the dependable level of service and the revenue streams provided by price-managing the lanes all within one guideway. As shown in the following table, a single limited-access BTL, using articulated buses, could carry a tremendous number of passengers depending on the number of buses running in the guideway and the level of service.

What should make the BTL concept even more attractive to local officials is the possibility of creating a sustainable source of revenue sufficient to reliably support public transportation operations. Even at extremely high levels of bus service, (60 buses per lane per hour - one minute between buses) more than 90% of lane capacity still remains for sale. Using all-electronic free-flow toll collection with dynamic pricing to ensure LOS C or better, a BTL would move a large amount of people while still providing the opportunity to generate a significant amount of toll revenue.

Bus Toll Lanes - MOVE PEOPLE

Level of Service	Vehicles Per Hour	Vehicle Speed (MPH)	Vehicle Occupancy ³	Passenger Trips per Hour	Equivalent Lanes
LOS C	1,600	50-60	1.2 (assumed)	1,920	1
Bus Toll Lane with 25 Buses ¹ (1.6%) ²	1,587 ³	50-60	2.7	4,296	2.2
Bus Toll Lane with 50 Buses ¹ (3.2%) ²	1,575 ³	50-60	4.0	6,242	3.3
Bus Toll Lane with 100 Buses ¹ (6.4%) ²	1,551 ³	50-60	6.5	10,134	5.3

¹ Assumes an 80-passenger bus

² Percentage of lane capacity used by transit

³ Assumes 15% of autos have 3 occupants

Joe Waggoner
Executive Director
Tampa Hillsborough Expressway Authority

**Table A - 1: BTL Potential Passenger Carry Capacity
(Source: Joe Waggoner, Tampa Hillsborough Expressway Authority)**

And, while achieving these extremely high carrying capacities, the BTL guideway can be constructed and operated at a fraction of the cost of a rail guideway and the flexibility of buses requires no complementary infrastructure to feed passengers into the system. BTL projects should also allow communities to better utilize existing transportation resources. Medians and shoulder areas on current limited-access and major arterial highways could be used to locate the BTL guideway and existing rolling stock could be used by transit systems to begin the BTL network, upgrading to BRT or articulated express-bus as ridership grows.

3. BTL Transit and Toll Partnership

Combining the Operational and Financial Strengths of Transit and Tolls

A BTL partnership within an urban area would combine the transportation efficiencies of high-capacity high-speed bus systems and the effectiveness of managed lanes with the revenue returns of high-demand toll facilities. This combination would merge the advantages of the unique operating and financial strengths of public transit and toll agencies.

In the BTL partnership, the transit agency would be responsible for all bus operations, schedules, bus maintenance, etc. – knowledge, experience, and capabilities that already exist within public transit agencies. In the same manner, the partnering toll agencies would be responsible for the electronic toll collection, toll violation enforcement and roadway operations related to the non-transit users; maintenance and renewal activities related to the highway infrastructure; and payment of the debt service for the toll agency contribution to the capital cost of the facilities – activities that toll agencies already undertake.

The financial dynamics of transit and toll projects are almost mirror images of each other. In the BTL partnership, each of their strengths can be used to overcome their partner’s challenges.

The financial strength of public transit is access to capital funding while the financial challenges is the lack of resources to support system operations. At the Federal level, the desire to create true multi-modal systems that provide a range of public transportation choices results in significant capital being made available to construct transit facilities. Unfortunately, this funding does not significantly carry over into the operating side of public transit. According to the American Public Transportation Association (APTA), fare box revenues do not cover the cost of transit operations anywhere within the US, thus placing a tremendous financial burden on state and local governments to subsidize the annual operation of their public transportation systems.

US Public Transportation Sources of Operating Funds									
YEAR	Agency Funds			Government Tax-Based Sources				TOTAL FUNDS	
	Passenger Fares	Other (advertising, concessions, leases, etc.)	Total Agency Funds	Local Taxes	State Taxes	Federal Taxes	Other (public taxing organization sources)		Total Government Tax-Based Funds
2010	32.1%	5.4%	37.5%	21.6%	25.0%	9.4%	6.5%	62.5%	100%

2012 Public Transportation Fact Book, Appendix A: Historical Tables - Table 63, Page 89

Table A – 2: Sources of Operating Funds for US Public Transportation (Source: 2012 American Public Transportation Association Public Transportation Fact Book)

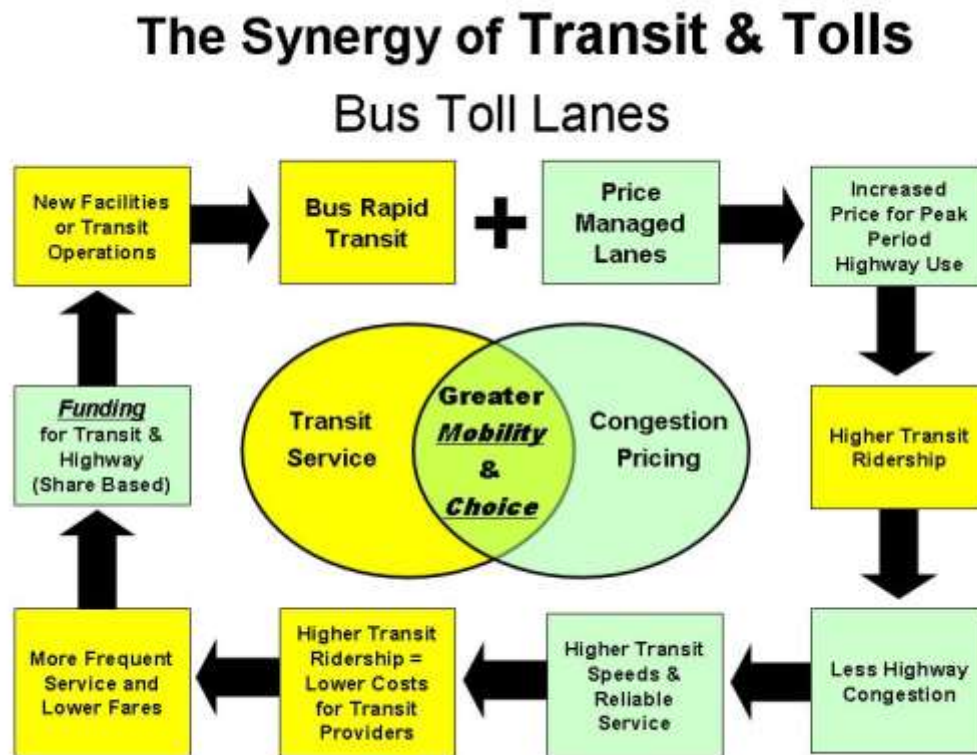
The inability of local communities to meet the financial requirements needed to sustain their local transit programs often translates into reductions in the number of routes and frequencies of public transportation service.

The financial strengths and challenges of the toll industry are very much the opposite of transit. The strength of the toll industry is in long-term operations and revenue generation while the financial challenge is generally located in the raising of the up-front capital needed to finance new toll facilities. Toll agencies often struggle to acquire all of the funding needed for the construction of new facilities. However, once built, a well-planned and operated toll road usually produces significantly increasing revenues as customers are attracted to the premium service provided by the facilities.

BTL Revenue Sharing Model = Sustainable Public Transportation

The BTL equity-based revenue-sharing model matches the strength of the transit agency’s ability to acquire capital funding with the strength of the toll agency’s long-term growing revenue stream. As pointed out below, the resulting synergy of this combination of transit and tolls should produce a financially and operationally sustainable transportation system by providing dedicated capacity for public transit and enough excess capacity to deliver a substantial stream of revenue and meaningful congestion relief for non-transit toll-paying customers.

Figure A - 1: The Synergy of Transit & Tolls
 (Source: Joe Waggoner, Tampa Hillsborough Expressway Authority)



The high level-of-service produced by managed-lane pricing should make the bus a very competitive transportation choice, thus increasing ridership. The sharing of toll revenue combined with revenue from higher bus ridership should also contribute to a reliable income stream that transit agencies could then use to support operations or system expansion.

The New Transit Fare Box: Equity In = Revenue Out

The BTL partnership creates a new vision of the transit fare box – combining revenues from the transit passenger and toll payer into one revenue stream for the benefit of public transportation. In simple terms, the equity investment by transit in the construction of the guideway would result in ownership of all or a portion of the total BTL revenue stream (transit fares and tolls) depending on the amount of the investment.

4. Potential Benefits of the BTL

Benefits to Transit Riders and Transit Agencies

The benefits of a BTL to the transit side of the partnership should be numerous. Transit riders would achieve time savings that are equivalent to those of toll-paying auto drivers with the same schedule reliability; however they would also save the expense of the tolls, fuel and parking. Because buses can travel anywhere an auto can, the number of transfers would be minimized, thus saving riders even more time over traditional combination transit service. In addition, BTL revenues could also be used to reduce the cost of transit fares.

Time savings, reliable trip times and lower trip costs should produce higher bus ridership and more overall revenue for the transit system which should then translate into more frequent transit service (improved headways) and expansion of bus routes. And, for transit agencies, these improvements should mean more efficient, cost-effective system operations and the development of a sustaining inflation-sensitive method for funding transit operations.

All of these benefits should make public transit very competitive with single occupancy vehicles within BTL network corridors.

Benefits to Automobile Drivers and the Community

The dynamically priced tolls, set to ensure a free-flowing level of service on the guideway, would make the safety, convenience, trip reliability and time savings of the BTL available to all drivers whenever they need it and are willing to pay the toll. In addition, every toll-paying trip and bus rider on the BTL removes that trip from non-tolled lanes and other routes, thus providing congestion relief for other competing roadways as well.

Because a BTL represents the construction of new capacity, this means real reductions in traffic congestion on the entire highway network. The improved travel speeds should also mean improvements in local air quality. The BTL should have a positive impact on the local economy because the lanes can also be used by private transit providers (shuttle buses, taxis, jitneys, etc. who are willing to pay the toll) and for the movement of goods and services.

On the financial side, the combination of transit and toll resources should reduce the reliance on local taxes for construction, operations and maintenance. Additionally, the opportunity to plow excess revenues back into local transportation operations and improvements should benefit all who live and work in the community.

5. Proof-of-Concept Study Approach

The Tampa-Hillsborough County Expressway Authority (THEA) in partnership with the Hillsborough Area Regional Transit Authority (HART) conducted a Proof-of-Concept Feasibility Study of alternative BTL networks within Hillsborough County, Florida. The study was funded by a grant from the Federal Highway Administration (FHWA) Variable Pricing Pilot Program (VPPP).

This research study used Hillsborough County and the city of Tampa as a test location because the area is representative of similar sized urban communities within the United States. Located on the west coast of central Florida with a total population of just over 1.2 million, Hillsborough County and Tampa are very much like many mid-sized American communities that exhibit heavy peak period traffic congestion and transit demand while not having the financially capability to develop and operate a sufficiently robust public transit system.

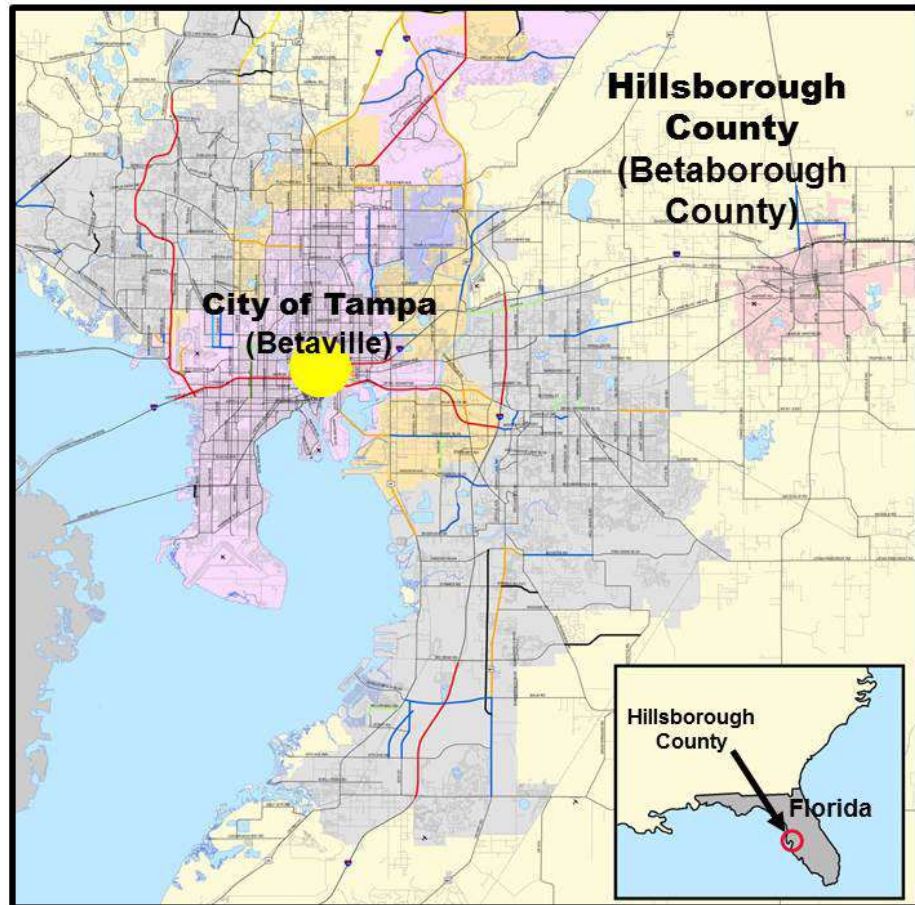


Figure A - 2: Location Map - Hillsborough County and the City of Tampa (Source: Hillsborough County MPO)

BTL Proof-of-Concept Study Process

The study team used the City of Tampa and Hillsborough County essentially as a test bed – referring to the County as “Betaborough County” and the City of Tampa as “Betaville” to ensure the study team maintained focus on the Proof-of-Concept research theme for the study. To better fulfill the research goal of testing the concept for the application to similar urban areas, the team developed three different BTL networks to test a wide range of BRT, express bus and managed lane configurations on both limited-access and high-volume arterial highways over a 30-year period (2016-2045). The study team then analyzed the three BTL networks for transportation effectiveness and financial feasibility.

As shown below, these “mythical” networks were different enough in terms of length, construction requirements, operating characteristics and costs necessary to provide the range and depth for a fair evaluation of the BTL concept. The three network concepts provide a variety of test circumstances while allowing the study to employ “real-world” traffic, engineering, social and economic data as the basis for the analysis (as described in detail within the following sections of this report). The following figure depicts the final three networks tested for the study. The network graphics identify the limited-access guideway and arterial components and the enclosed chart describes the overall makeup, length and construction cost of the BTL infrastructure elements.

Figure A – 3: Final BTL Test Networks
 (Source: PB America and American Consulting Engineers)



Guideway Construction & Right-of-Way Costs

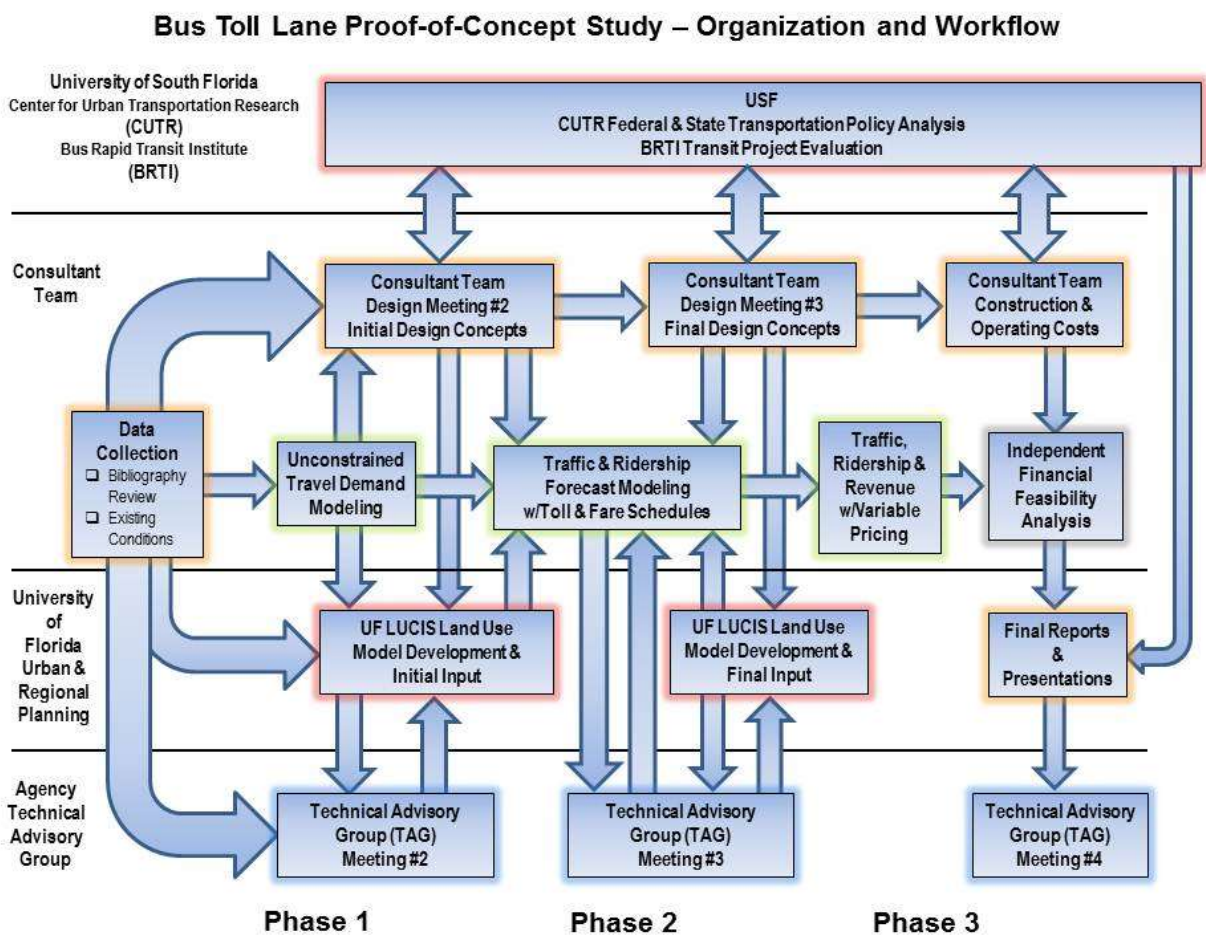
BTL Network	Capital Cost Estimate (in 2011 \$)	Network Length (Miles)	Network Description
1	\$530,382,314	64.55	Primarily Special-Use Lanes within the Medians of Existing Limited-Access Highways with Urban Arterial Connectors
2	\$621,959,238	45.05	A Mix of Special-Use Lanes within Medians of Limited- Access Highways + Arterial Highways with Grade Separated Queue Jumps with Access Management Techniques
3	\$915,368,626	52.37	Primarily Special-Use Lanes within the Medians of Existing Limited-Access Highways (mostly on structure) with Urban Arterial Connectors

START HERE BTL Study Elements and Process Flow

The study primarily involved the development of travel and transit demand projections, toll revenue and fare box forecasts, conceptual engineering, and capital and operational cost estimates for each of the networks. The BTL networks were then evaluated operationally and financially to determine feasibility based upon the traffic and ridership projections, revenue forecasts and cost estimates.

The study process flows and interactions of the various study components were divided into three general phases which aligned the three primary modeling components with land-use input and the development and refinement of the BTL design concepts.

Figure A - 4: BTL Proof-of-Concept Study Process (Source: PB America)



The analysis used traditional travel demand forecasting tools and conceptual engineering methodologies coupled with a new land-use development impact model developed by the University of Florida GEOPLAN Center, a policy analysis by the University of South Florida Center for Urban Transportation Research (CUTR) and a unique model for analyzing the financial feasibility of a major transportation project.

Phase 1 represented the development and testing of the BTL concept applied to three initial networks. The subsequent phases then involved the refinement of the design of each network and the modeling leading to projections of traffic, ridership and revenue that were balanced against construction, operating and maintenance cost estimates to determine financial feasibility.

The three phases included the following activities:

Phase 1

Phase 1 included the following primary study activities:

- Selection of the Tampa Bay Regional Transit Model (TBRTM) model based on FTA approval for recent Tampa Bay regional transit studies
- Identification of travel forecast strategy using the TBRTM
- Production of unconstrained travel demand to better understand the origins and destinations of travel within the various BTL network corridors
- Modifications to initial BTL network components
- Identification of preliminary BTL lane requirements
- Identification of preliminary BTL access points

In Phase 1, unconstrained travel demand estimates were developed and used by the study team to answer a number of questions:

- Was there enough demand within each BTL corridor to warrant each part of a BTL test network?
- Were modifications to any of the corridors suggested by the initial modeling results?
- Was the information from this modeling enough to form the basis for determining initial BTL lane requirements within each study corridor?

The output of this process became an input to the study team Work Session #1 where the initial conceptual engineering analysis of the BTL improvements took place. Throughout the study, the team employed multi-day workshops at key stages to bring all of the study disciplines together to review and vet the methodologies and findings.

At Work Session #1, the background travel demand in the initial corridors for 2035 was used by the study team to create the initial sizing of the BTL improvements for future testing within the full range of the 10-year increments of the study: 2016-2025, 2026-2035 and 2036-2045.

The study team then developed a Build Alternative for each of the three BTL transportation networks during Work Session #2. The second Work Session was conducted as a conceptual engineering brainstorming session involving highway engineers, transit engineers, and managed lanes experts. A sketch or thumbnail of various BTL transportation improvements was developed as an outcome of this second Work Session. The work session discussions included reviews of

the anticipated demand, access points, transit routes and stations, types of civil improvements, possible cost data sources, and potential BTL typical sections.

Phase 2

The key elements of Phase 2 included:

- Development of initial conceptual Build Alternatives for each BTL network
- Identification of initial new BTL transit routes, park & ride locations, station locations and interactions with existing and planned transit resources
- UF produced initial land development scenarios with population and employment projections for 2025, 2035 and 2045 for input to travel demand modeling
- Production of initial traffic and ridership forecasts with base tolls and transit fares

After Work Session #2, a technical memorandum and sketches were circulated for approval by the study partners. After comments were incorporated, the BTL improvements were then coded by the study team and converted to ArcGIS format for use by UF to create the 2025, 2035, and 2045 land use impact scenarios using the LUCIS model. The second round of travel demand modeling to generate the first set of transit ridership and toll highway projections used the output of the UF LUCIS model the input for the future year development, population and employment.

Phase 3

Phase 3 produced the final study outputs to include:

- Development of variable toll rate schedule and fare box pricing
- Refinement of BTL associated transit routes and locations for BTL related park & ride lots and transit stations
- Production of annual projections of transit ridership and fare box return
- Production of annual forecasts for toll traffic and revenue
- Final refinement of conceptual engineering for BTL networks
- Cost estimating for acquisition of dedicated BTL transit rolling stock and maintenance for BTL dedicated transit routes and off-system routes that would use the BTL networks
- Cost estimating for the construction, routine maintenance and major maintenance of the BTL network roadway components
- Development of the final financial feasibility model and determination of feasibility for the three BTL networks based on high, medium and low estimates of travel demand, revenue and associated costs

Forecasts of annual transit ridership and fare box return and toll traffic and revenue were produced in the third model effort which incorporated the results of additional transit runs at differential fare box rates and toll elasticity evaluations to determine the appropriate toll rates for the variable pricing element of the managed lanes component.

Concurrent with the forecasting activities, the study team refined the conceptual engineering leading to formula-based cost estimates for construction, right-of-way, operations and maintenance of the lanes and the transit rolling stock. These outputs then became inputs to the

financial model to determine the feasibility of each BTL network to produce a sustainable source of revenue for public transit.

The inputs to the financial feasibility model included: (1) high and low forecasts of toll traffic and transit ridership and the resulting estimates of gross revenue (toll and transit fare box revenue) for each network; (2) estimates of the CapEx for the roadway construction and right-of-way based on the conceptual design of each network and cost data provided by the Florida Department of Transportation (FDOT) and the CapEx for the dedicated BTL transit based on estimates from HART; and (3) estimates of the OpEx for both the toll and transit components based on actual cost data supplied by THEA and HART.

A complete, detailed explanation of the study process, activities, methodologies, assumptions and results of the BTL Proof-of-Concept Study is presented in Sections B through E.

BTL Technical Study Team

The BTL Proof-of-Concept Study Team was comprised of a wide range of professionals with both transit and toll experience from the public and private sectors. The organizations and roles of the participants included:

Public Sector Team

- **Tampa Hillsborough Expressway Authority (THEA)**
Senior Management Oversight, Project Management, Planning and Coordination
- **Hillsborough Area Regional Transit Authority (HART)**
Planning and Project Coordination
- **Federal Highway Administration (FHWA) Variable Pricing Pilot Program (VPPP) -**
Project Oversight
- **Florida Department of Transportation District VII -** Project Oversight

The study also had participation from two university research centers.

- **University of Florida's Department of Urban and Regional Planning GeoPlan Center (UF)** - supported the travel demand forecasting effort with the new Land Use Conflict Identification Strategy (LUCIS) Model, a land use analysis and allocation tool to better identify the potential land use impacts to the community from the transportation investment associated with implementation of the potential BTL networks.
- **University of South Florida (USF) Center for Urban Transportation Research (CUTR)** – undertook the policy analysis to identify changes to any federal laws, rules or policies that would be necessary for the BTL to take advantage of federal funding. The CUTR Bus Rapid Transit Institute (BRTI) also conducted an evaluation of the BTL characteristics to identify how well the BTL would match up with FTA project selection criteria and requirements.

Consulting Team

- **Parsons Brinckerhoff (PB)** - Project Management, Conceptual Roadway Engineering, Roadway Operations Cost Estimating, Transit System Review, Documentation
- **AECOM** – Travel Demand, Ridership and Revenue Forecasts
- **American Consulting Engineers (ACE)** - Conceptual Roadway Engineering and Cost Estimating
- **Tindale Oliver and Associates (TOA)** - Transit Concept Development and Cost Estimating
- **Quest Corporation of America (QCA)** – Communications Production
- **Independence Acquisition and Appraisal, LLC (IAA)** -Sketch Level Analysis of Right of Way Costs.
- **HNTB** – Financial feasibility Analysis
- **Reason Foundation** – Review of Concept and Conclusions

BTL Technical Advisory Group (TAG)

Additional policy and technical input came from a Technical Advisory Group (TAG). The TAG provided input on the development of the initial study corridors and the land-use strategies for future development within Hillsborough County to support the transportation forecasting.

Representation on the TAG came from:

- Florida Department of Transportation, District VII
- Hillsborough County Metropolitan Planning Organization
- Hillsborough County Public Works
- City of Tampa Transportation
- Tampa Hillsborough City/County Planning Commission
- Tampa Bay Area Regional Transportation Authority (TBARTA)
- Hillsborough County Aviation Authority
- Hillsborough Area Regional Transit Authority
- Tampa Hillsborough Expressway Authority

Section B

Phase 1 Study Methodology and Results

Initial BTL Network Development and Testing

1. Phase 1 Initial BTL Networks

The three initial BTL networks used at the beginning of the study were comprised of limited-access and arterial corridors and are shown in on Figures B-1 through B-3. Network #1 included I-75 to the north and south of Interstate 4, the Veterans Expressway, and I-275 between downtown Tampa and the airport interchange with the Veterans Expressway. The Selmon Expressway is highlighted on the network maps because it connects to I-75 but is not part of any of the BTL network. The network includes direct arterial connections of New Tampa Boulevard to the I-75 BTL and Hillsborough Avenue west of the Veterans Expressway.



Figure B - 1: Initial Bus Toll Lane Network #1 (Source: THEA)

Network #2 included the same I-75 north corridor and I-275 between downtown Tampa and the airport interchange as in Network #1. The network included an arterial connection of Bruce B. Downs Boulevard to I-75 instead of the New Tampa Boulevard/East-West Road connection.



Figure B - 2: Initial Bus Toll Lane Network #2 (Source: THEA)

Network #3 included I-275 north of I-4 and I-275 between downtown Tampa and the airport interchange with the Veterans Expressway. The network included an arterial connection of New Tampa Boulevard to I-275 using the alignment of the EW Road project.



Figure B - 3: Initial Bus Toll Lane Network #3 (Source: THEA)

2. Phase 1 Unconstrained Travel Demand Testing

The methodology for forecasting and analyzing the land use and transportation data to test the three BTL networks in Hillsborough County was developed by the study team partners with input from the study TAG based upon study team technical coordination meetings that took place in September and October, 2011. Analytical partners included THEA and HART staff and General Engineering Consultants, the BTL Study Consultant Team, the University of Florida and the University of South Florida Center for Urban Transportation Research.

The study team chose to use the latest version (Version 19) of the Tampa Bay Regional Transit Model (TBRTM) developed for the Hillsborough Area Regional Transit Authority (HART) Alternatives Analysis as the modeling tool for developing traffic and transit usage projections for the various Bus Toll Lane (BTL) scenarios. The TBRTM provides several advantages over its regional planning counterpart – the Tampa Bay Regional Planning Model (TBRPM Version 7.0) which has been adopted for long-range transportation planning efforts, as mentioned below:

- The TBRTM is a time-of-day version of the TBRPM. It models four time-periods (AM, Mid-day, PM and Evening) for Highway assignments and two periods (peak and off-peak) for Transit.
- The TBRTM was refined as part of the Pinellas Alternatives Analysis and other corridor studies performed by the Tampa Bay Area Regional Transportation Authority (TBARTA) to address the New Starts analysis requirements of the Federal Transit Administration (FTA).
- TBRTM has significantly upgraded components to assist with the representation of transit patterns and has undergone a strong transit calibration and validation process using the most recent HART and Pinellas Suncoast Transit Authority (PSTA) on-board surveys.
- Use of the TBRTM provides conformity with regional planning efforts and acceptance by the Federal Transit Administration (FTA) for New Starts applications. This regional and federal conformity is vital if funding at the federal and state level will be considered as part of the financial package to implement future BTL transportation improvements.

Due to the strong transit component in the TBRTM, the TBRTM 2035 Transportation Systems Management (TSM) scenario was selected as the base transit system for the BTL analysis. The first round of highway forecasts included two sets of runs; constrained and unconstrained, as listed below:

- Base year: 2015 demand on 2015 networks (regular and unconstrained)
- Forecast year: 2035 demand on 2035 networks (regular and unconstrained)

The constrained (“regular” or “background”) runs were compared with the unconstrained runs to help estimate the number of lanes on the various new BTL facility segments. The unconstrained

runs were performed as highway-only assignments with virtually un-limited capacity on the new BTL facilities. The new BTL facilities included links and access ramps with 10 times the normal capacity of their adjacent freeway links to prevent the volume-delay functions from reducing the BTL speeds. In addition, the unconstrained scenario combined the three preliminary BTL scenarios (BTL #1, BTL #2 and BTL #3) into a single regional network. The combined network runs were used to verify the candidate corridors as appropriate for study as part of the three BTL networks and to determine if any changes were needed within each of the BTL networks. The combination of the networks is shown in Figure B-4.



Figure B - 4: Combined Network for BTL Unconstrained Projections (Source: AECOM)
620 links were identified from all three networks in order to track the changes in traffic flow and four time-of-day assignments were used:

- AMPK: Morning peak-hours from 6:30-9:00 am (2.5 hours)
- MDOP: Mid-day operations from 9:00 am – 3:30 pm (6.5 hours)
- PMPK: Afternoon peak-hours from 3:30 – 6:30 pm (3 hours)
- EVOP: Evening operations from 6:30 pm – 6:30 am (12 hours)

As part of the network preparation, the 2014 Existing plus Committed (E+C) highway and transit networks from TBRPM were coded as the 2015 E+C scenario in the TBRTM model. The existing 2035 TSM scenario in TBRTM was used for the forecast year since it was pre-configured in the TBRTM model.

Land use data (ZDATA 1 and 2) corresponding to years 2015, 2025, 2035 and 2045 was provided as generated by the Renaissance Planning Group (RPG) in support of the model update by CDM Smith for the THEA investment grade traffic and revenue studies conducted in 2010. The 2015 ZDATA was formatted for use in the 2015 base year model run. The 2035 ZDATA from RPG was not used, but was compared against the existing 2035 TSM scenario in the TBRTM. The ZDATA1 comparisons reveal that Renaissance's projections for 2035 are lower for both households and population by about 150,000 and 300,000, respectively. The more conservative (lower growth) land use data was retained for the initial BTL study model runs.

Four model assignments corresponding to two years (2015 and 2035) and two scenarios (regular and unconstrained) were performed and the initial results were shared with the study team. These results included two variations of the unconstrained scenarios – one with two times the regular capacity for BTL links and another with 10 times the regular capacity for BTL links. Maps showing the hourly assignment volumes, volume differences and V/C ratios by four time periods (AM, MD, PM and EV) in ESRI shape-file format were prepared for review by the study team.

In addition, daily summaries of volumes, volume differences, V/C ratios, transit networks, park-and-ride connectors, roadway lane comparisons and highway OD trip-table summaries by districts were also prepared for review by the study team.

The results from these runs showed significant demand on all facilities in the unconstrained runs, especially the I-275 section between Veterans Expressway and downtown Tampa. Logical shifts were also seen from facilities that were un-tolled and constrained to the facilities that were tolled and un-constrained. These results were presented to the study team and formed the basis for recommendations to revise the routing and configuration of the BTL alternatives as they were originally identified in the scope for the study as represented in Figures B-1 through B-3.

The output of the initial model runs are depicted on Figures B-9 through B-14 and Tables B-1 and B-2 on the following pages.

However, prior to reviewing the results of the modeling, it is important to understand the context of the general land-use make-up of Betaborough (Hillsborough) County and the region of Florida in which the community is located as well as the historical travel patterns within the region and what drives those patterns.

Figure B-5 on the following page presents the population distribution within which the BTL networks would operate.

Hillsborough County has approximately 1.2 million people with Tampa as the one large, incorporated city within the County. The County is located on the west coast of central Florida, virtually in the center of six other urbanized counties which total just under four million in population – very similar to many mid-sized urban areas within the United States.

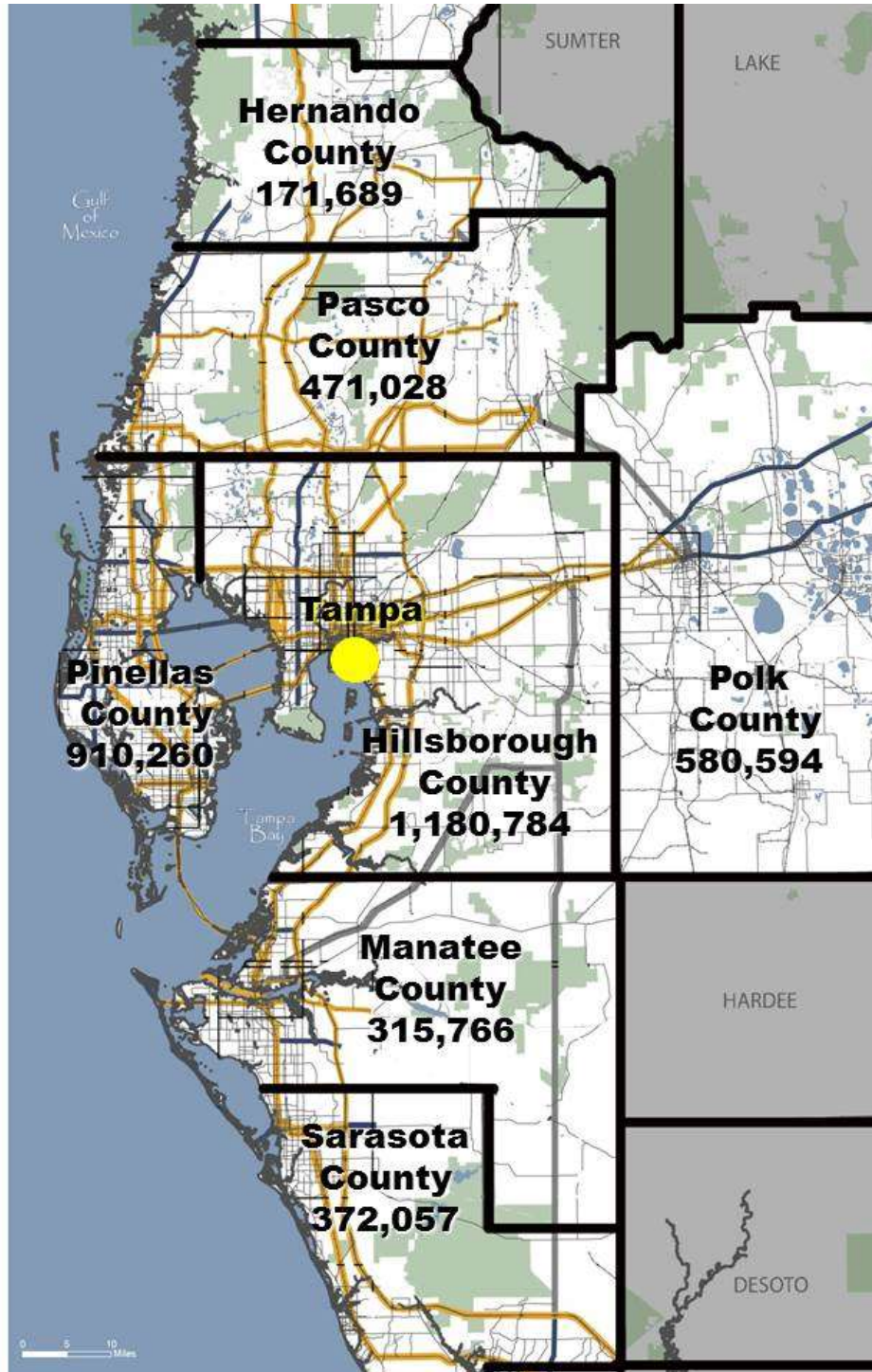


Figure B - 5: Regional Population for West Central Florida
(Source: TBARTA Map and 2010 US Census)

The output of the initial model runs are depicted on Figures B-9 through B-14 and Tables B-1 and B-2 on the following pages.



Figure B - 6: Hillsborough County Major Employment Centers (Source: THEA)

The other two incorporated cities within Hillsborough County, Temple Terrace and Plant City, are not large enough in terms of population or employment to have a significant effect on the travel demand or travel patterns within the region.

However, as depicted on Figure B-6, Hillsborough County has three large centers of employment that drive journey-to-work traffic - downtown Tampa, the Westshore area and MacDill Air Force Base. A fourth large area of employment known as the Gateway area, is located in Pinellas County directly west of the two main bridges connecting Hillsborough County to Pinellas

County directly west of the two main bridges connecting Hillsborough County to Pinellas County across Tampa Bay. The City of Tampa is located approximately in the center of Hillsborough County and the surrounding urbanized counties. The other three primary employment centers are also within the same general location within the region.

While there are many other dispersed employment centers within the region, as shown in Figures B-7 (below) and B-8 (on the following page), the journey-to-work travel pattern to these centers dominates the operation of the major highway system and is very directional in nature.

Both the AM and PM peak-hour travel patterns are highly directional from and to the north, south and east and bi-directional between the City of Tampa and Pinellas County (nominally, almost an even directional split between Tampa, Westshore and the Pinellas Gateway).

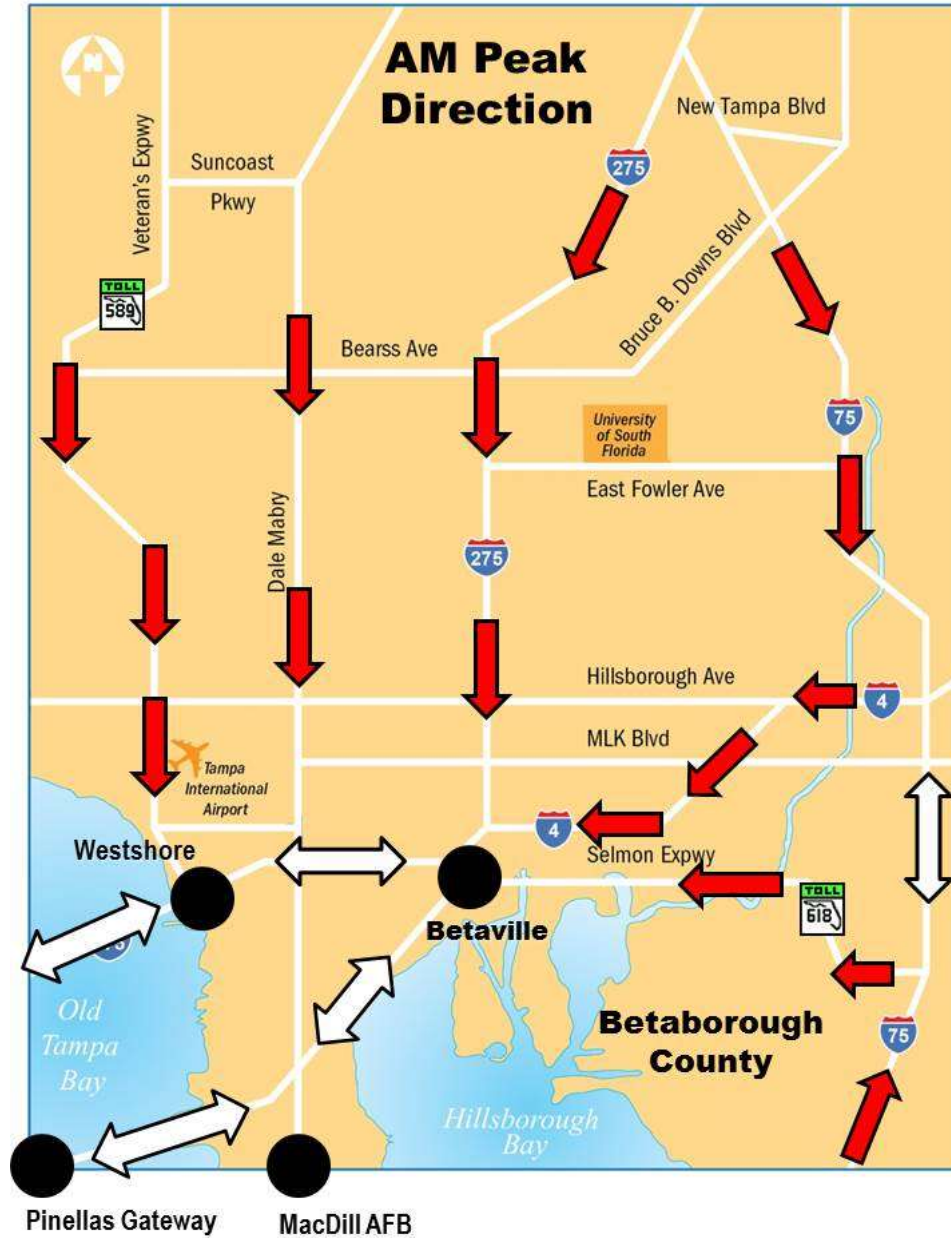


Figure B - 7: Hillsborough County AM Peak Direction Travel Pattern (Source: THEA)

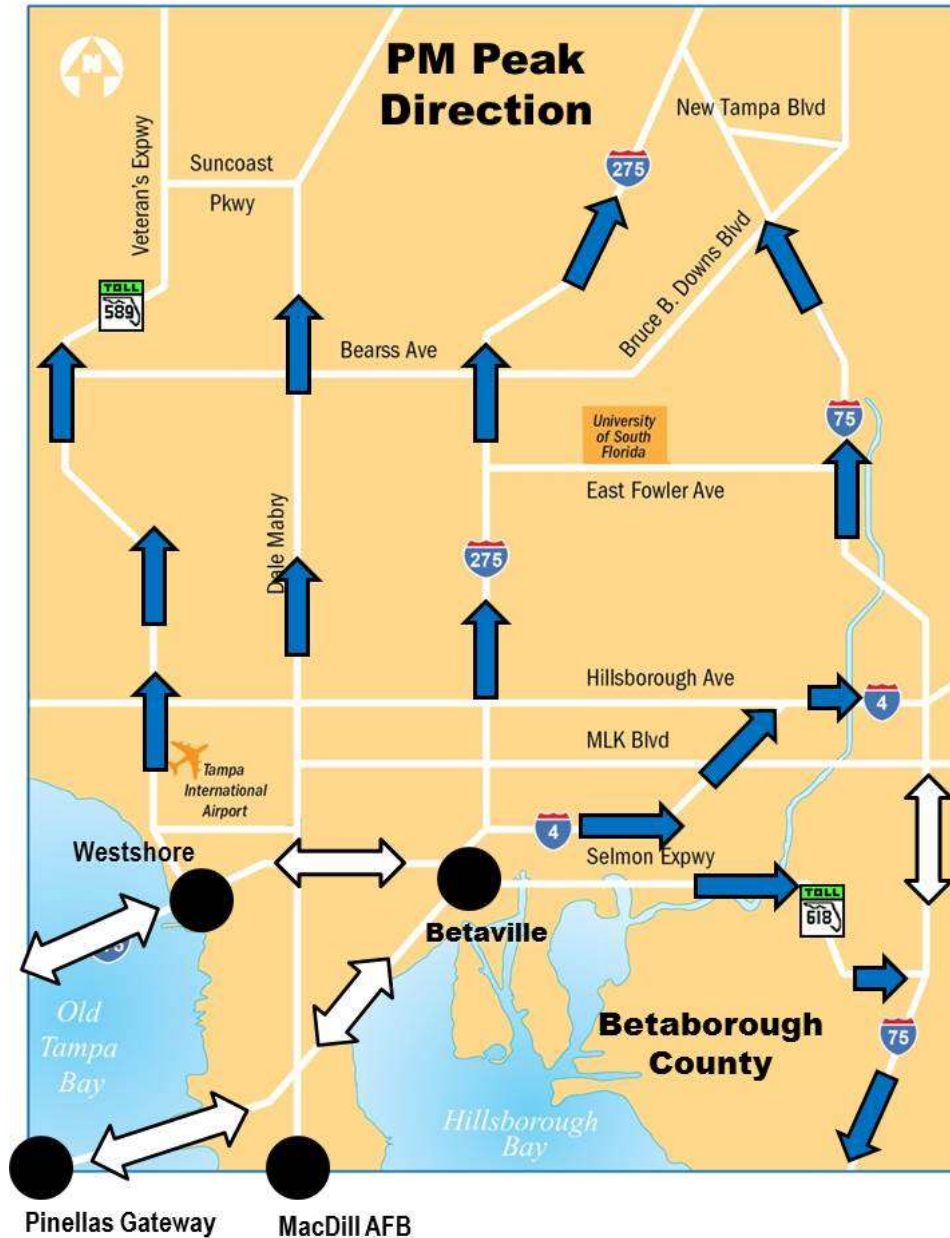


Figure B - 8: Hillsborough County PM Peak Hour Travel Pattern (Source: THEA)

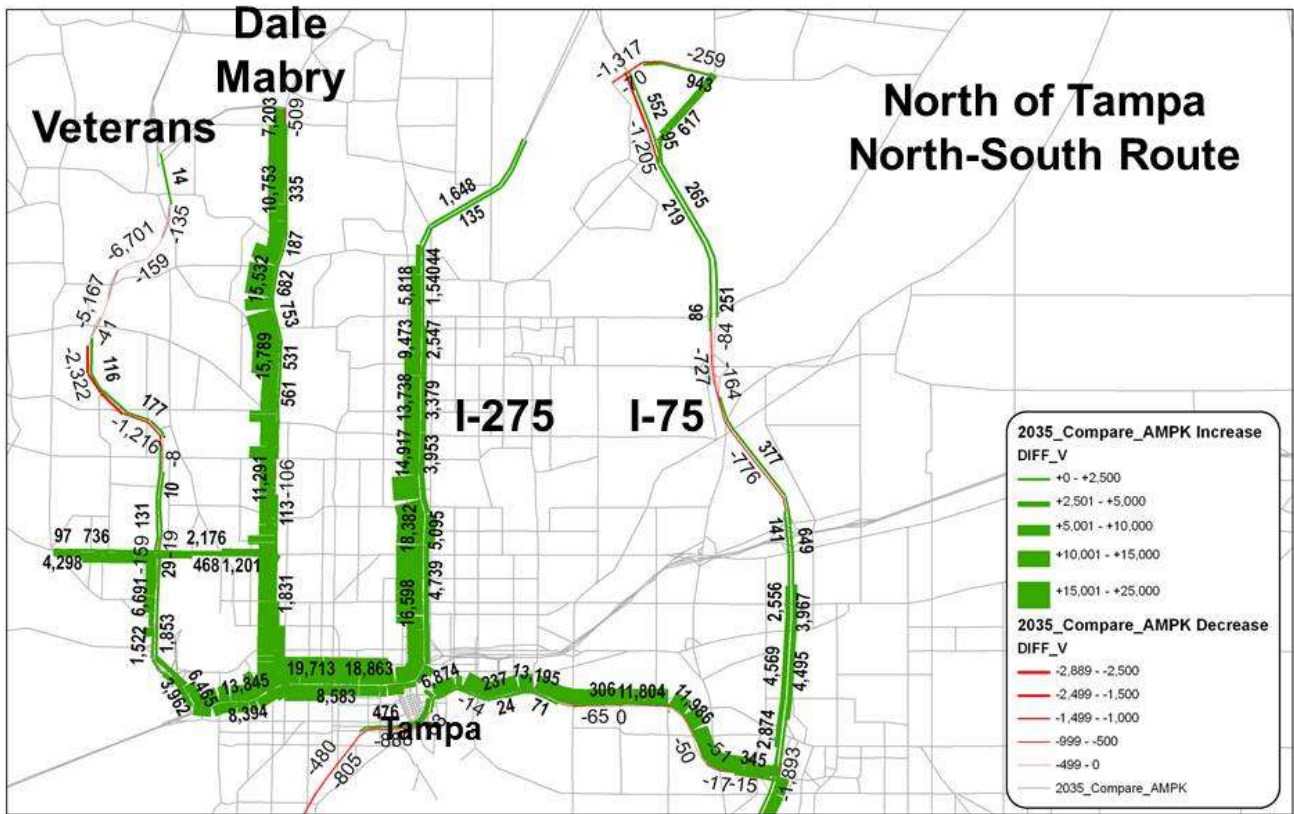
These well-known travel characteristics were confirmed by the initial modeling efforts for the unconstrained BTL networks. With this background it was no surprise to see highly directional traffic in the peak hours that mirrored the directions identified on Figures B-9 through B-14.

However, it was interesting to see a large gravitation of the peak demand toward the two central corridors within the three BTL networks as shown on the Figures B-9 through B-14. These figures use volume difference maps to graphically present the volume changes that occurred as traffic was diverted from the constrained network of existing roadways to the un-constrained new BTL networks, thus providing an indication of the corridors with the highest travel preferences.

Reviewing the changes in volumes in the AM and PM peak hours, the general demand for capacity within the BTL corridors appeared to be very strong.

As shown in Figures B-9 and B-10, two of the north-south corridors to the north of the City of Tampa and the other employment centers (I-275 and Dale Mabry Highway) attracted far more traffic than the Veterans Expressway and I-75, the most eastern and western of the north-south corridors when all four of the routes were placed in an unconstrained condition.

Unconstrained Demand – Volume Differences - 2035

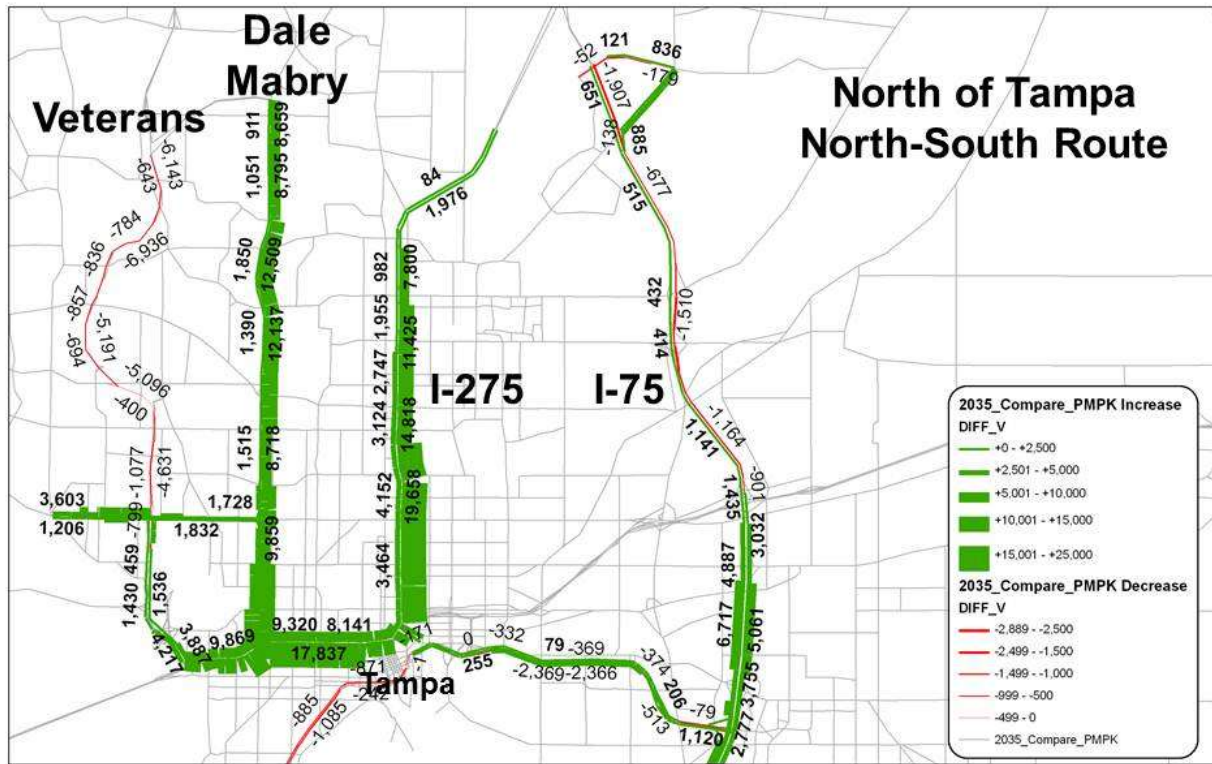


AM Peak Change

Figure B - 9: Unconstrained Demand/AM Peak Volumes – North of Tampa (Source: AECOM)

The volumes identified for both Am and PM are representative of the significant imbalance in directional distribution that exists within the routes north of the major employment centers. In addition, traffic from the east also exhibits the same characteristics as depicted on the representation of the alignment for the Selmon Expressway that exhibits the same type of directional imbalance. The spread of volumes between the AM and PM peak hours is also similar to the differences noted in the current TBRTM results for the constrained network.

Unconstrained Demand – Volume Differences - 2035



PM Peak Change

Figure B - 10: Unconstrained Demand/ PM Peak Volumes – North of Tampa (Source: AECOM)

The substantial volume differences between the “inside” corridors (I-275 and Dale Mabry Highway) and the “outside” corridors can be explained when looking at the land-use configurations north of downtown Tampa.

As depicted on the land use maps within the section related to the Phase 2 modeling efforts, large blocks of residential development occur between the Veterans Expressway to the west and I-75 to the east within Hillsborough County. Because of the proximity of these traffic producers to the center two corridors (Dale Mabry and I-275) and the employment destinations created by downtown Tampa, Westshore and MacDill AFB, all of which are directly south of the center two corridors, the pronounced loading of traffic onto the two center corridors was not a major surprise given the removal of travel constraints for this effort.

The results for I-75 BTL south of Tampa and the I-2715 BTL between downtown Tampa and Westshore were consistent with directional information in Figures B-7 and B-8.

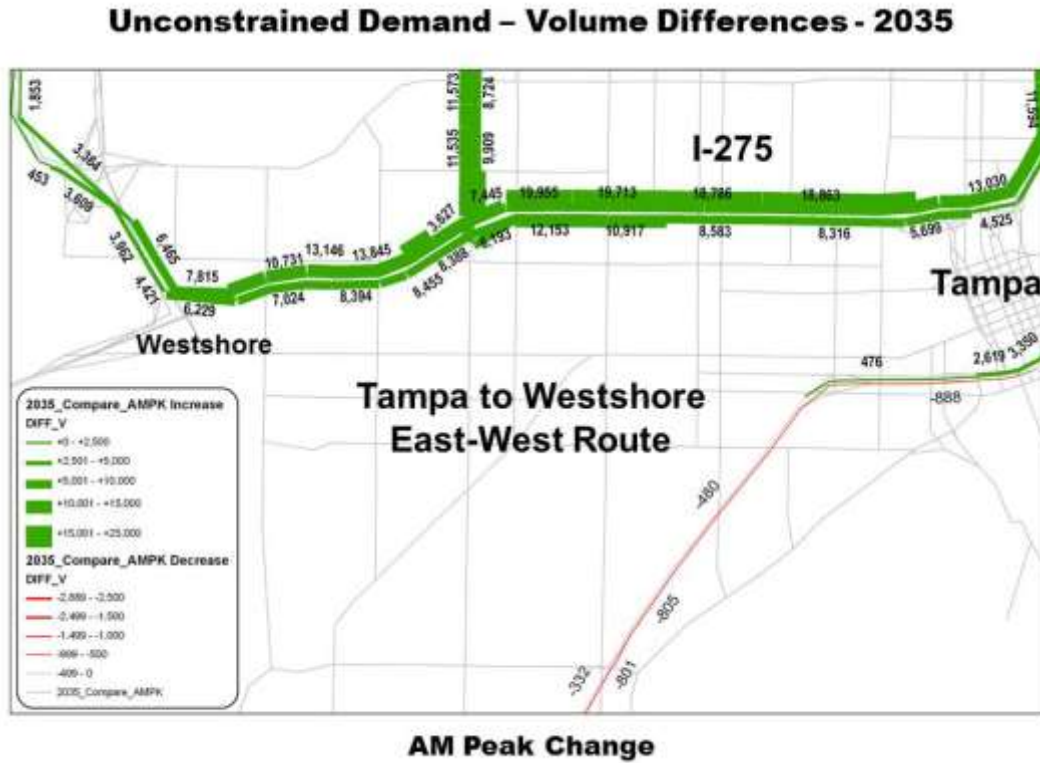


Figure B - 13: Unconstrained Demand/AM Peak Volumes – West of Tampa (Source: AECOM)

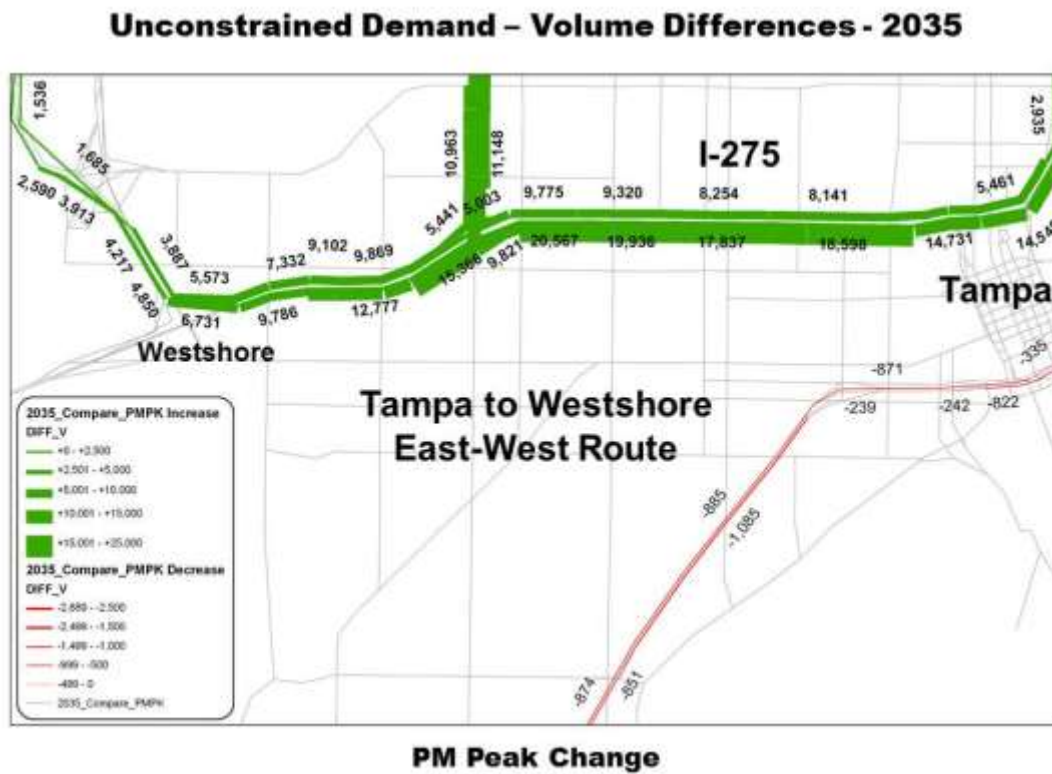


Figure B - 14: Unconstrained Demand/PM Peak Volumes – West of Tampa (Source: AECOM)

Tables B-1 and B-2 show the volume/capacity (V/C) ratios for the AM and PM peak hours for the tolled and non-tolled links within the model. The value of the additional BTL capacity and the location of the corridors was confirmed by the V/C ratios that shows the ability of the links within the BTL networks to accommodate the “spillover” that occurs from constraining the demand on the other links within the TBRTM network.

V/C Ratios (AM Peak)

V/C			AMPeak					
Low	High		All Links		Diff	BTL Links		Diff
			REG_V/C	BTL_V/C		REG_V/C	BTL_V/C	
0.0	0.2		12,980	13,213	233	35	220	185
0.2	0.4		1,431	1,669	238	55	211	156
0.4	0.6		1,348	1,527	179	9	113	104
0.6	0.8		1,515	1,617	102	13	47	34
0.8	1.0		1,555	1,691	136	4	22	18
1.0	1.2		1,670	1,748	78	17	7	(10)
1.2	1.4		1,670	1,731	61	16	-	(16)
1.4	1.6		1,701	1,729	28	37	-	(37)
1.6	1.8		1,577	1,625	48	35	-	(35)
1.8	2.0		1,494	1,479	(15)	29	-	(29)
2.0	2.2		1,343	1,246	(97)	22	-	(22)
2.2	2.4		1,131	1,108	(23)	24	-	(24)
2.4	2.6		991	942	(49)	34	-	(34)
2.6	2.8		840	719	(121)	44	-	(44)
2.8	3.0		728	584	(144)	53	-	(53)
3.0	5.0		2,075	1,426	(649)	192	-	(192)
5.0	10.0		31	26	(5)	1	-	(1)
10.0	99.0		1	1	-	-	-	-
SUM			34,081	34,081	-	620	620	-
SUM if	1.2	99	13,582	12,616	(966)	487	-	(487)

Table B - 1: V/C Ratios - AM Peak Hours (Source: AECOM)

V/C Ratios (PM Peak)

V/C			PMPeak					
Low	High		All Links		Diff	BTL Links		Diff
			REG_V/C	BTL_V/C		REG_V/C	BTL_V/C	
0.0	0.2		12,535	12,737	202	3	194	191
0.2	0.4		1,174	1,489	315	4	247	243
0.4	0.6		1,048	1,180	132	9	105	96
0.6	0.8		1,145	1,282	137	37	49	12
0.8	1.0		1,348	1,392	44	34	22	(12)
1.0	1.2		1,415	1,479	64	19	3	(16)
1.2	1.4		1,544	1,634	90	25	-	(25)
1.4	1.6		1,525	1,566	41	16	-	(16)
1.6	1.8		1,588	1,654	66	18	-	(18)
1.8	2.0		1,697	1,607	(90)	32	-	(32)
2.0	2.2		1,645	1,591	(54)	26	-	(26)
2.2	2.4		1,501	1,439	(62)	42	-	(42)
2.4	2.6		1,374	1,261	(113)	47	-	(47)
2.6	2.8		1,122	966	(156)	54	-	(54)
2.8	3.0		885	779	(106)	55	-	(55)
3.0	5.0		2,500	1,985	(515)	196	-	(196)
5.0	10.0		33	38	5	3	-	(3)
10.0	99.0		2	2	-	-	-	-
SUM			34,081	34,081	-	620	620	-
SUM if	1.2	99	15,416	14,522	(894)	514	-	(514)

Table B - 2: V/C Ratios - PM Peak Hours (Source: AECOM)

Section C

Phase 2 Study Methodology and Results

Revised Networks and Initial Travel Demand

1. Revised BTL Study Alternatives

Based on the results of the Phase 1 modeling and input from the TAG, the study corridors were revised to produce final planning configurations for each network.

It was apparent from the initial demand modeling that all three of the primary north-south BTL routes in Network #1 should be operated as reversible guideways – BTLs that would operate only in the peak direction for the AM peak hours and then would change direction to accommodate the travel demand for the peak direction of the PM peak hours. Therefore, the BTL study concepts developed for the Veterans Expressway and for both components of I-75 (north and south) were identified for reversible operations. I-4 was added to the I-75 North BTL and was carried as a reversible operation all the way to downtown Tampa and to a connection with the I-275 BTL which remained a two-way operating element. The I-75 South BTL was terminated at the Selmon Expressway Reversible Express Lane toll facility which is already in operation.



Figure C - 1: BTL Network #1 Final Planning Configuration (Source: Parsons Brinckerhoff)

Revisions to Network #2 included the same addition of I-4 to the I-75 north corridor and the operation of the entire corridor to downtown Tampa as reversible guideways. In place of the Veterans Expressway on the west side of the County, Dale Mabry highway functions as an arterial BTL using a combination of grade-separated queue jumps at major intersections, applications of access management techniques that would close the corridor to crossing traffic at minor intersections along with the employment of channelized left-turns and u-turns, and priority signalization at the remaining minor intersections. I-275 remains as a two-way facility because of the cost of construction and difficulties with one-way operations.

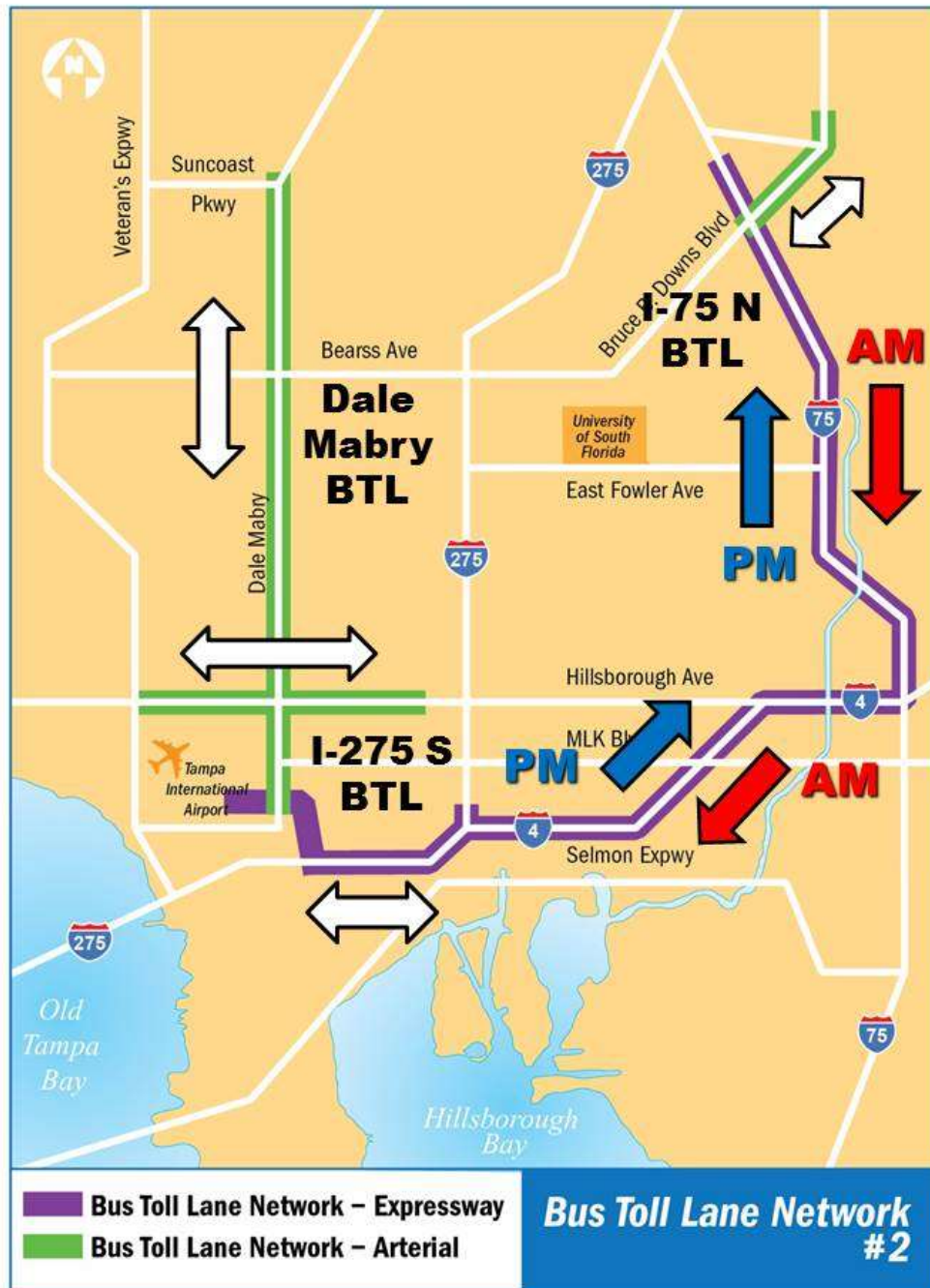


Figure C - 2: BTL Network #2 – Final Planning Configuration
(Source: Parsons Brinckerhoff)

Revisions to Network #3 included the operation of the I-275 North BTL corridor as a reversible guideway. As in Networks #1 and #2, I-275 remains as a two-way operation. The I-75 South BTL was identified for reversible operation and terminated at the Selmon Expressway Reversible Express Lane toll facility which is already in operation.

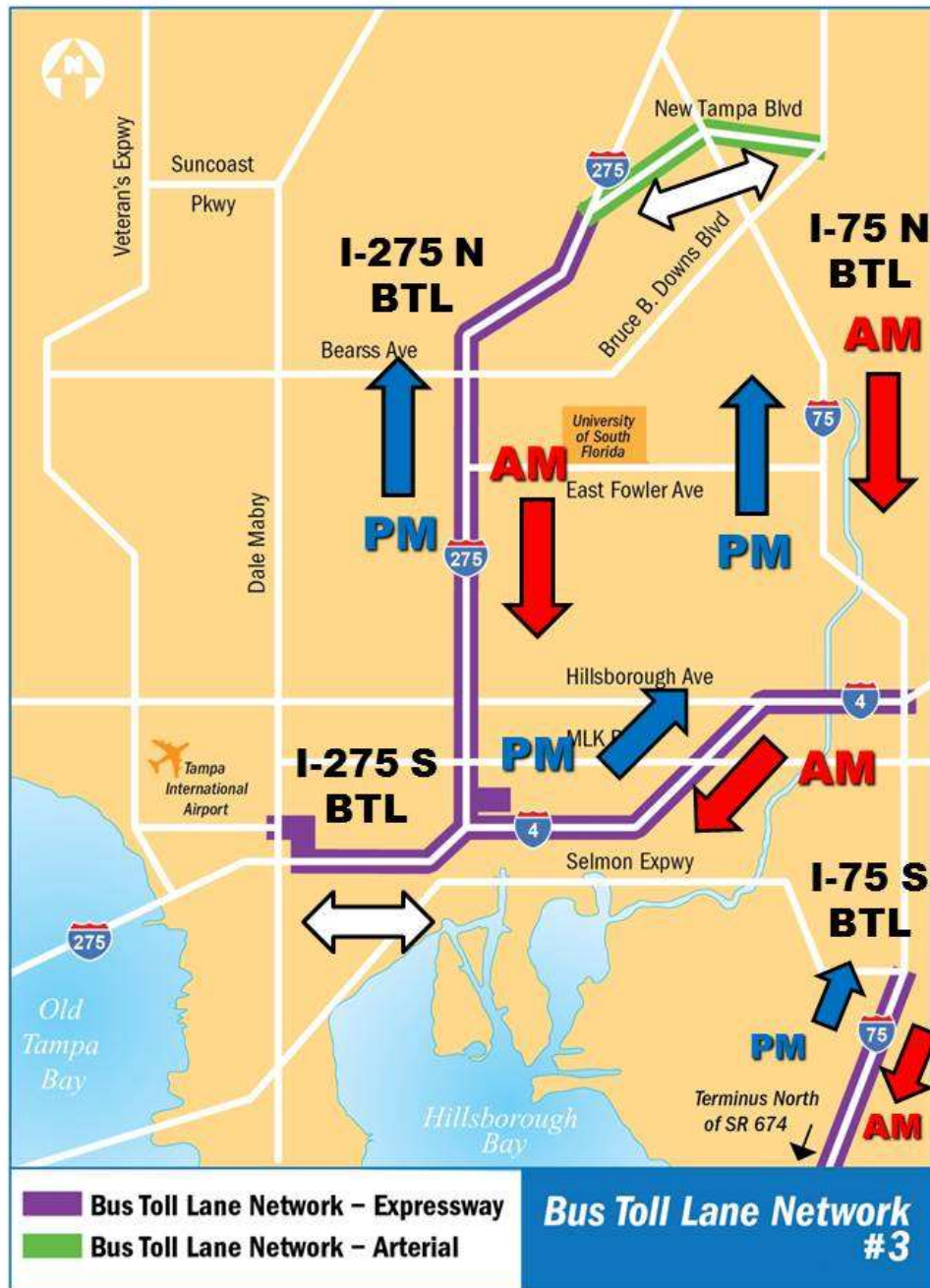


Figure C - 3: BTL Network #3 – Final Planning Configuration
(Source: Parsons Brinckerhoff)

These revisions formed the basis for development of more the more detailed transportation concepts for each of the BTL network corridors during Phase 2 of the study.

2. Transportation Concepts

BTL Highway Concepts

After revisions to the overall BTL study networks, each of the network concepts was developed to enough detail to support the second round of transportation demand modeling. This included the more specific identification of test alignments and the initial lane configurations which were based on the results of the first model runs.

BTL Concept for All Networks

I-275

The following revised alignment for I-275 between the Airport Interchange near Westshore and downtown Tampa as shown on Figure C-4 is the same for all three Phase 2 BTL Networks. The BTL uses the FDOT plan for special use lanes on I-275 – three lanes in each direction with barrier separation. A separate elevated guideway connection to Tampa International Airport is provided on new alignment.



Figure C - 4: I-275 Limited-Access BTL Between Tampa Airport and Downtown Tampa
 (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

BTL Concepts for Networks #1 and #2

Hillsborough Avenue

Figure C-5 represents the revised alignments for the Phase 2 BTL segments for Hillsborough Avenue that appears in in both Networks #1 and #2. Hillsborough Avenue is an arterial that is converted into a BTL corridor by using a series of queue jumps and traffic signal prioritization.



Figure C - 5: Hillsborough Avenue Arterial BTL Queue Jump Location (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

I-4

Figure C-6 represents the revised alignments for the Phase 2 BTL segments for I-4 that appears in both Networks #1 and #2. I-4 employs barrier-separated reversible guideways in the median with shoulders and slip ramps between the BTL and the general purpose lanes to handle the heavy peak direction traffic.



Figure C - 6: I-4 Limited Access BTL from I-275 in Downtown Tampa to I-75 (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

BTL Concepts for Network #1 and #3

I-75 South

As shown in C-7, the I-75 South revised corridor appears in BTL Networks #1 and #3 with the same general alignment and access points. The BTL would be constructed as a reversible guideway that would include full barrier separation and shoulders on both sides of the BTL. I-75 currently has enough room in the existing median and right-of-way to accommodate such a design with any additional acquisition of property. Access to and from the general purpose lanes would be provided by a series of slip ramps.



Figure C - 7: I-75 South Limited-Access BTL from SR 674 to the Selmon Expressway (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

BTL Concepts Exclusively for Network #1 Only

I-75 North

The I-75 North revised concept included in BTL Network #1 employs reversible operations and uses the same general alignment as the I-75 North concept in BTL Network #2 except for the northern terminus and access to Bruce B. Downs Boulevard. The alignment identified in Figure C-8 is exclusive to BTL Network #1 because of the use of New Tampa Boulevard to connect between Bruce B. Downs Boulevard and the BTL located within I-75. The connection is a 2-way operation.

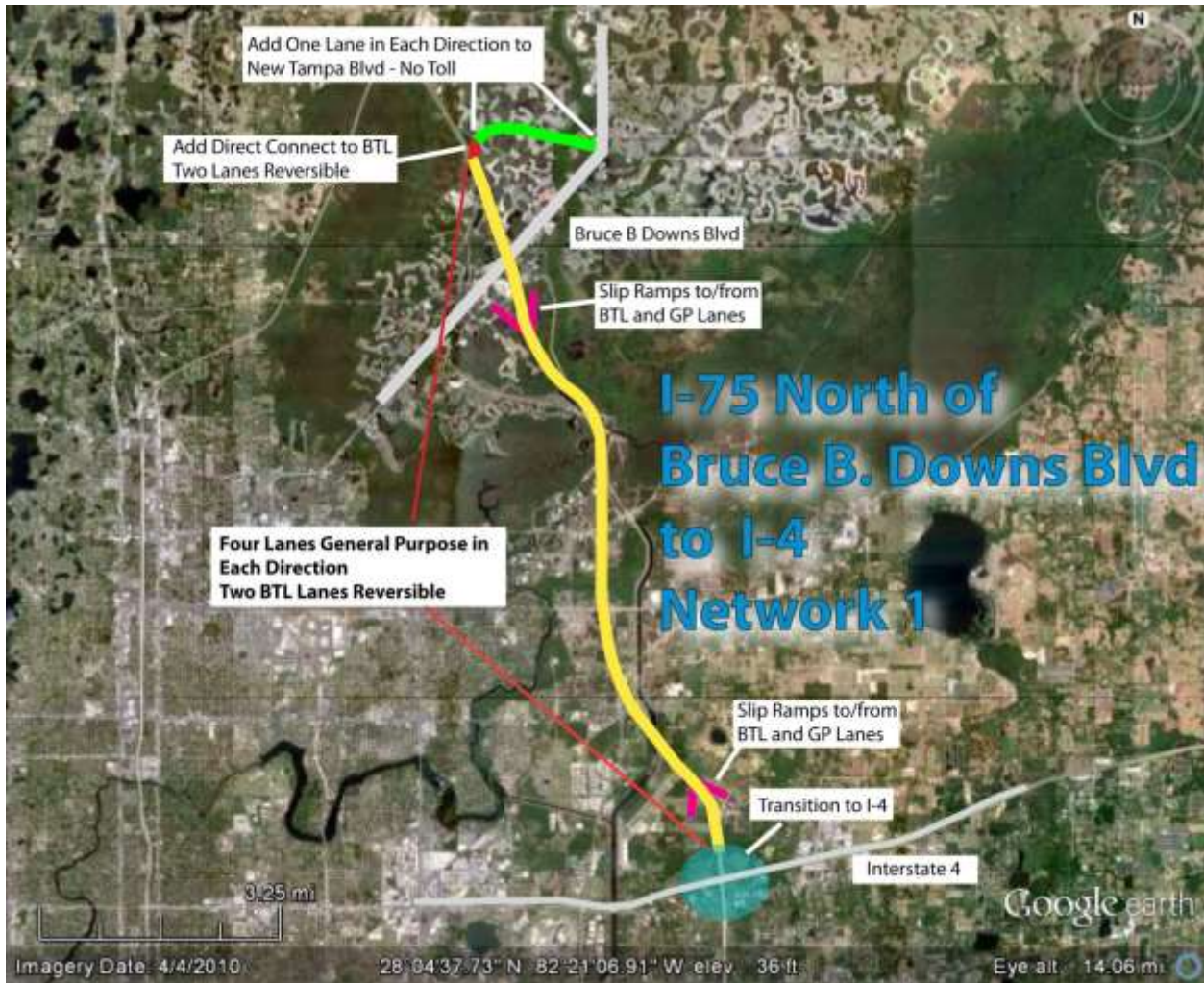


Figure C - 8: I-75 North Limited-Access BTL from New Tampa Boulevard to I-4 (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

Veterans Expressway

The following four figures (C-9 to C-12) depict the revised concepts for the Veterans expressway as part of BTL Network #1.



Figure C - 9: Veterans Expressway Limited-Access BTL from I-275 to North of Hillsborough Avenue (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

Veterans Expressway

The initial concept for the Veterans BTL is a two-lane reversible guideway to take advantage of the strong peak-hour peak-direction of traffic flow. The guideway would include traditional barrier separation and inside shoulders for safe operation.

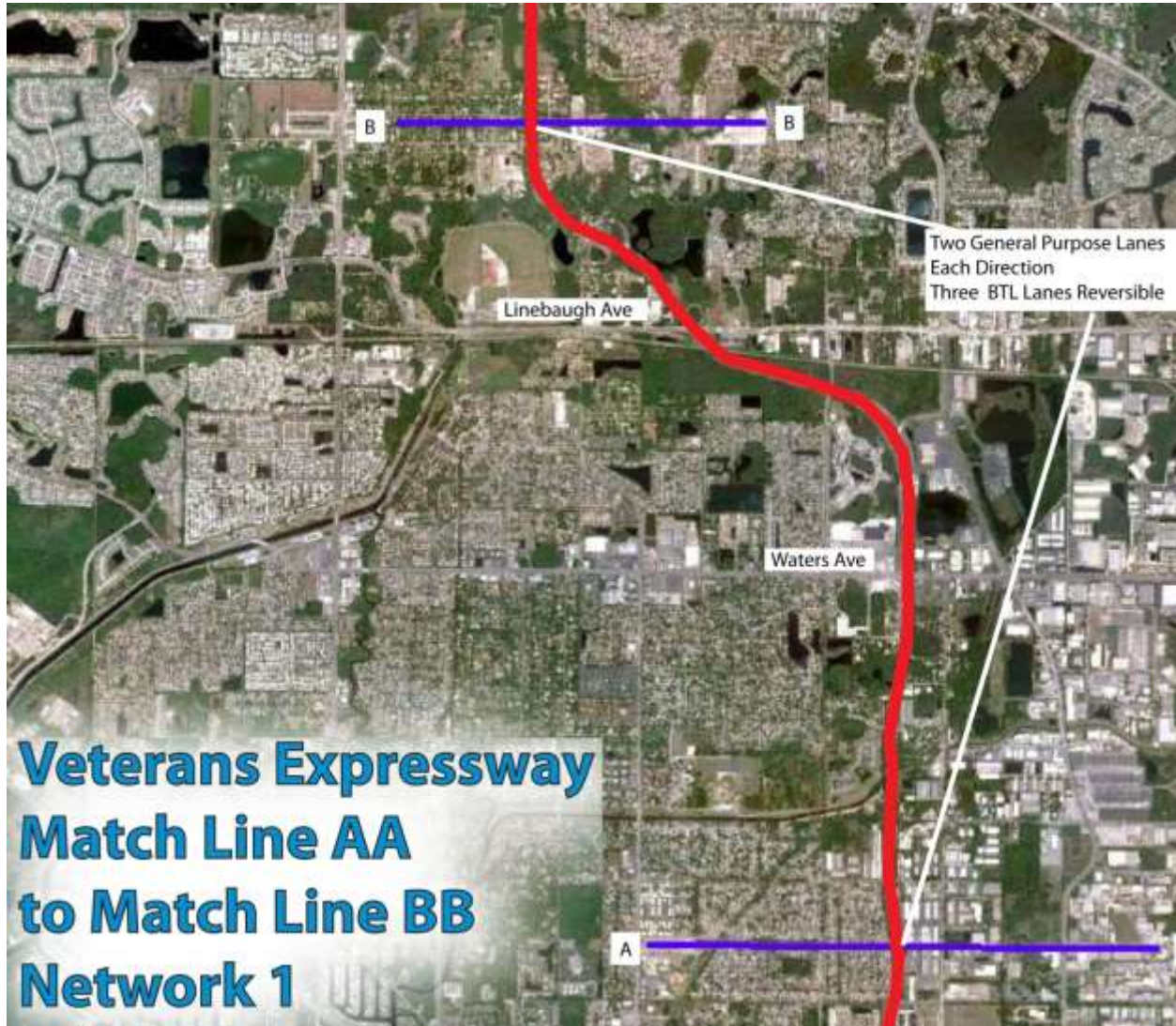


Figure C - 10: Veterans Expressway Limited-Access BTL from North of Hillsborough Avenue to North of Linebaugh Avenue (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

Veterans Expressway

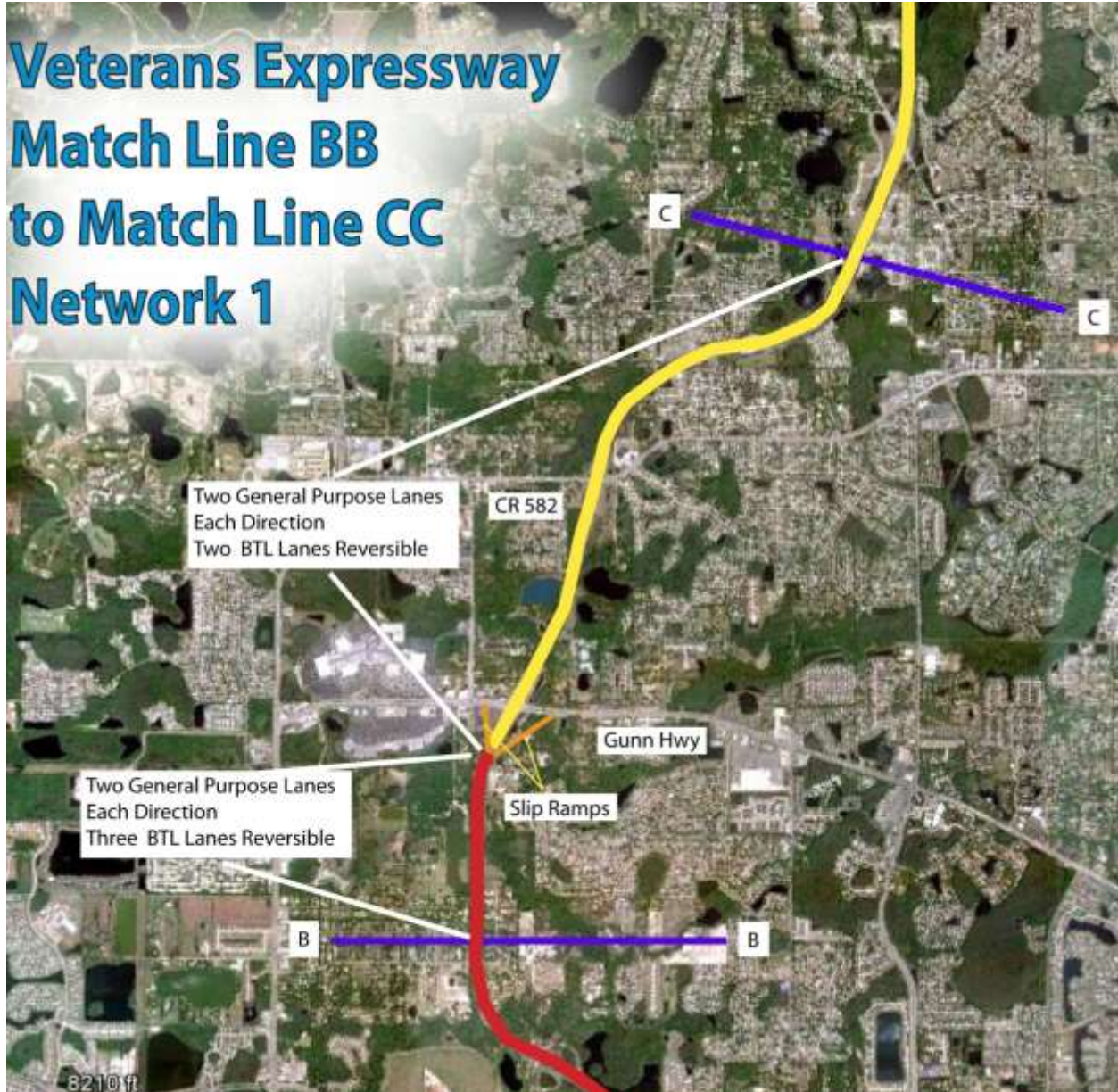


Figure C - 11: Veterans Expressway Limited-Access BTL from North of Linebaugh Avenue to North of CR 582 (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

Veterans Expressway



Figure C - 12: Veterans Expressway Limited-Access BTL from North of CR 582 to SR 568
 (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

BTL Concepts Exclusively for Network #2 Only

Dale Mabry Highway

The Dale Mabry Highway revised arterial BTL concept identifies the location of the queue jumps and signal priority locations initially recommended to create a virtual busway and tollway while maintaining the general land service character of this arterial highway.

Queue jumps could be constructed as either overpasses or underpasses depending on the specific circumstances of each queue jump location. Due to the design uncertainties of underpasses, primarily related to underground utilities, costs developed in the study assumed overpasses. In the right circumstances, however, underpasses are financially competitive.

At Northdale Boulevard, the queue jump would be designed as an elevated flyover to accommodate extremely heavy PM peak-hour turning movements.

The Bearss Avenue queue jump could potentially be built as an underpass able to accommodate multi-modal transfers from local bus, express bus and BRT routes.

The Fletcher Avenue queue jump would be a three-block long elevated section overpassing three traffic signals.

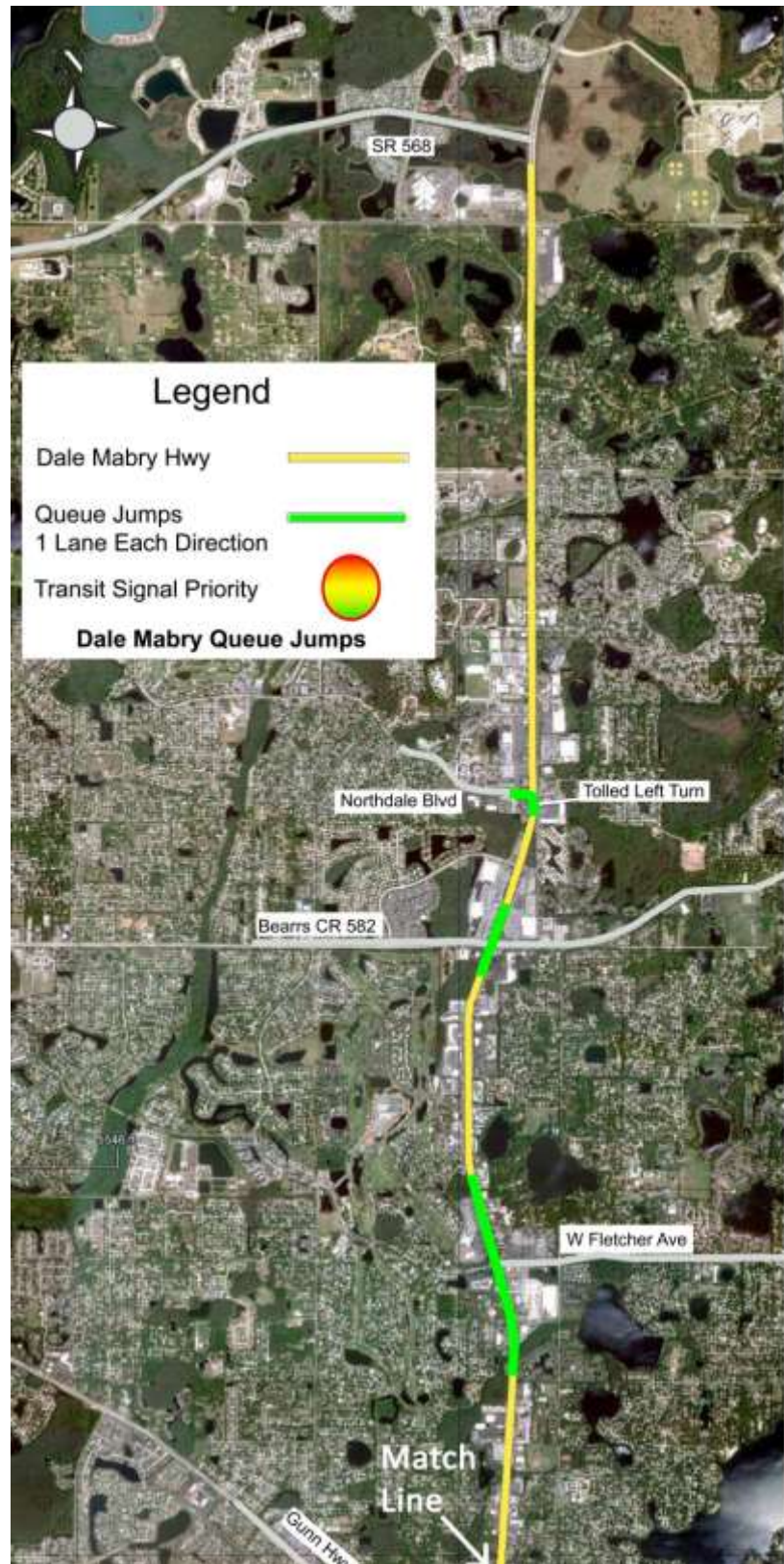


Figure C - 13: Dale Mabry Highway Queue Jump and Signal Priority Locations from north of Linebaugh Avenue to Northdale Blvd (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

The Busch Boulevard area would also be constructed as a long elevated section overpassing the Linebaugh traffic signals.

The Waters and Sligh Avenue queue jumps would be built as underpasses.

Dale Mabry would continue to provide access to properties along the route in much the same manner as it does today, however, access management techniques applied between the queue jumps would change the operation characteristics for vehicular traffic.

Most of the intersections for minor crossing streets between queue jumps would be closed by constructing raised medians. Left-turn and cross-corridor movements would then be accommodated by channelized u-turns built into the medians downstream from the closed intersections.

The high number of peak-hour peak-direction turning movements at Martin Luther King Boulevard would be handled with priority signalization.



Figure C - 14: Dale Mabry Highway Arterial BTL Queue Jump and Signal Priority Locations from I-275 to North of Linebaugh Ave (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

I-75 North

From its connection to I-4, the revised I-75 North BTL includes two reversible lanes, barrier-separated in the I-75 median, with two sets of slip ramps providing access between the guideway and the outside general purpose lanes. Enough room exists within the existing I-75 to include full shoulders on both sides of the reversible guideway and on the I-75 general use lanes and to construct the system without the need for additional right-of-way.



Figure C - 15: I-75 North with Direct connection to Bruce B. Downs Boulevard with Queue Jumps (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

BTL Concepts Exclusively for Network #3 Only

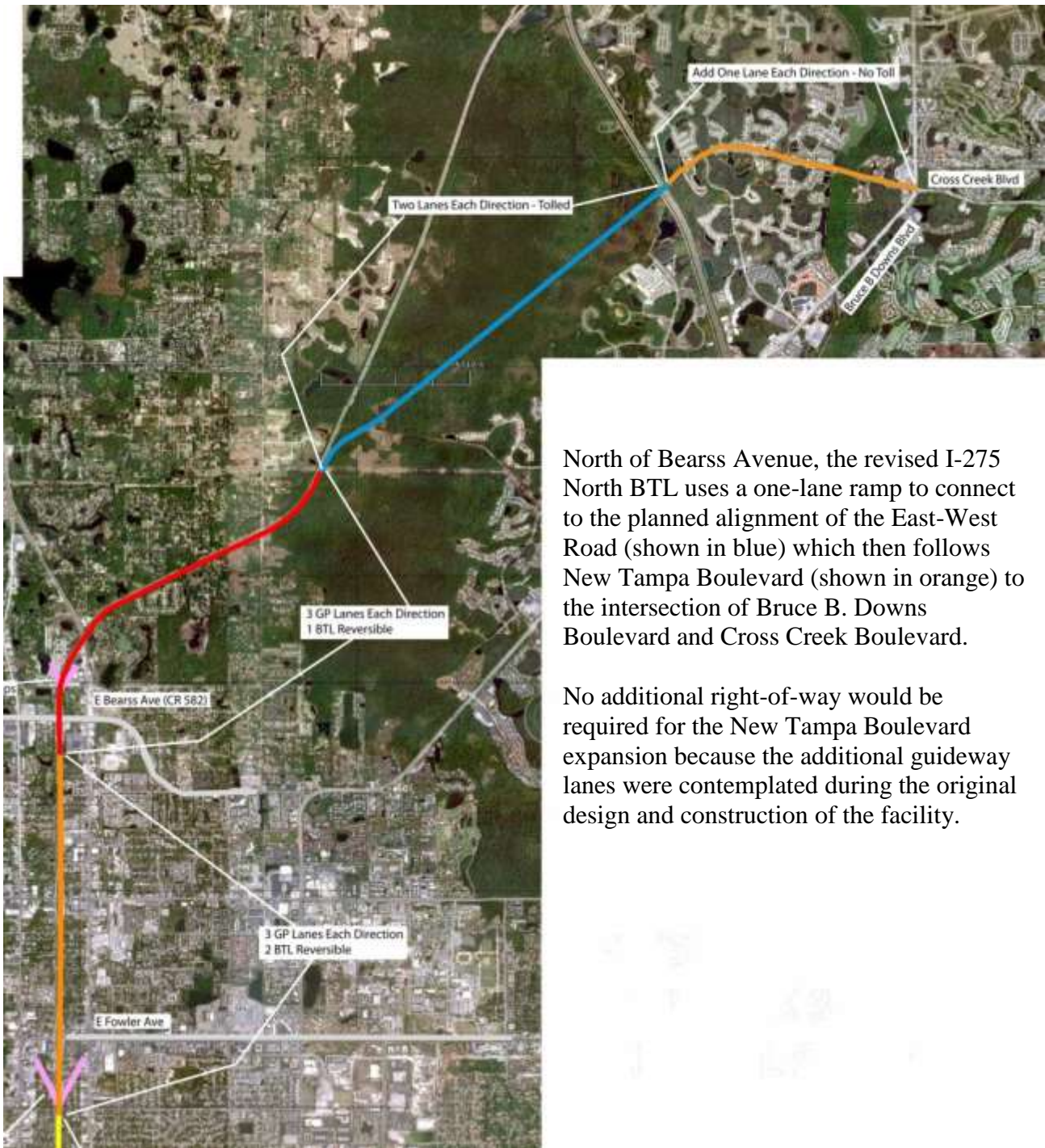
I-275 North

The revised I-275 North BTL guideway features a three-lane reversible concept that connects to the downtown via the Florida Avenue/Tampa Street one-way pair near Floribraska Avenue. Virtually all of the BTL would be built on structure within the existing I-275 right-of-way.



Figure C - 16: I-275 North Limited-Access BTL from Downtown Tampa to Fowler Avenue (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

I-275 North



North of Bearss Avenue, the revised I-275 North BTL uses a one-lane ramp to connect to the planned alignment of the East-West Road (shown in blue) which then follows New Tampa Boulevard (shown in orange) to the intersection of Bruce B. Downs Boulevard and Cross Creek Boulevard.

No additional right-of-way would be required for the New Tampa Boulevard expansion because the additional guideway lanes were contemplated during the original design and construction of the facility.

Figure C - 17: I-275 North Limited-Access BTL from Fowler Avenue to Bruce B. Downs Boulevard (Source: Parsons Brinckerhoff – Base Map Imagery © 2013 DigitalGlobe, The Florida Department of Environmental Protection, U.S. Geological Survey, Map Data © 2013 Google)

Arterial BTL Queue Jump and Access Management Concepts

Arterial highways can be effective BTL corridors with the application of a combination of design concepts to include: (1) grade-separated queue jumps, (2) access management techniques that close the corridor to crossing traffic and (3) priority signalization. The techniques can be employed to create a “virtual busway” as defined by the Reason Foundation – which allows the existing arterial lanes to be used by BRT and express bus operations in a manner that simulates the operation of an exclusive guideway yet still permits the use of the lanes by other traffic.



Figure C - 18: Underpass Queue Jump Concept (Courtesy of Reason foundation)

Queue Jumps (grade separations) at intersections or at other bottleneck locations can be a key component of an arterial BTL. The queue jumps may be constructed as either overpasses or underpasses and can incorporate BRT or express bus stops and/or stations in the same fashion as elevated or depressed rail stations.



Figure C - 19: Underpass Queue Jump Concept (Courtesy of Reason foundation)



Figure C - 20: Overpass Queue Jump Concept (Courtesy of Reason foundation)

As shown in Figures C-18 through C-20, the queue jump can be tolled and can be used with other access management techniques and all-electronic open-road tolling to create free-flowing traffic conditions that can facilitate competitive public transit service.

Other access management techniques can also be employed to enhance the bus level-of-service within a corridor. Channelized medians that prohibit cross-corridor movements and left-turns can be very effective tools for increasing free-flow traffic movement. Special signal timing employed during peak-hours can also be used to increase the flow of peak-direction traffic, and signal prioritization systems that change traffic signals to accommodate approaching buses are other effective ways to provide more efficient transit operations. When combined with the exclusive lanes provided by queue jumps, these additional access management techniques can make public transportation operate at service levels that approach those of automobiles.

BTL Transit Concepts

Managed toll lanes and their application and use for reducing congestion and improving travel times can be effectively used by public transportation services for the same purposes. Specifically, there are a number of advantages afforded to bus transit services through the implementation and shared use of a tolled guideway.

Typically, the speed of bus transit services and, in turn, travel times on those buses are a function of the level of congestion and the type of roadway facility (e.g., limited-access, arterial, collector, etc.) on which the bus is traveling.

When separated from existing traffic, transit becomes more competitive with the automobile as a transportation option by:

- Improving travel time
- Improving schedule adherence and reliability
- Reducing bus passenger anxiety
- Enhancing the perception of the bus service (premium and priority service)

For the BTL study, two types of premium rubber-tired transit services were proposed to be examined within the test community on the three different BTL networks. Those premium services include bus rapid transit (BRT) and premium express bus services. A transit service network consisting of the proposed premium transit services was created for each BTL network, and corresponding operating, maintenance, and capital costs associated with the implementation of each of those premium bus service networks were developed.

Transit Technologies



Rubber-tired transit service modes come in a variety of shapes and sizes. The dynamic nature of bus scheduling, service planning, and transit infrastructure interact to create a variety of factors that influence the operation of any service. For example, minor changes to the number of stops or service frequencies may qualify a route as a premium service over the existing operation, which may be an all-stop, less frequent service. Additionally, technology and infrastructure improvements, such as queue jumps and even passenger information systems, also contribute to the perception of bus service as “premium” in nature.

Consequently, incremental benefits in the real and/or perceived notions of premium service can be achieved through the implementation of a variety of service and infrastructure enhancements. Furthermore, as enhancements are added, the cumulative benefit gained over time through the combination of two, three, and four or more service enhancements creates an indefinite transition between traditional fixed-route bus service and the highest level of service for bus services that may vary by definition and purpose.

BTL Service Modes

To simplify the list of possible bus transit services for this study, two premium bus service modes were selected, and specific operating characteristics for each were defined. The application of the type of service is predicated on the type of highway facility on which it will operate.



- **Highway – Premium Express Bus**
- **Arterial Roadways – Bus Rapid Transit (BRT)**

Type of Express		Operating Characteristics
Traditional Express Bus	 <p>Pinellas Suncoast Transit Authority (PSTA) Ulmerton Road Park-and-Ride</p>	<ul style="list-style-type: none"> • Coach-style vehicles • Medium-to-high capacity vehicles • Operate in mixed traffic (arterial and highway facilities) • Fewer stops than local bus service • Medium frequency (30-minute headways) • More frequent service in the peak hours • Share/use transit stops with local service • Commuter-focused
BTL Premium Express Bus	 <p>Virginia Department of Transportation Rendering</p>	<ul style="list-style-type: none"> • Coach-style vehicles • Medium-to-high capacity vehicles • <i>Operate on bus priority toll lanes*</i> • Limited stops concentrated at ends of route • Park-and-ride • <i>High frequency (10- to 15-minute headways)*</i> • Commuter-focused

**Bold, italic text highlights distinguishing characteristics offered by BTL.*

Table C - 1: Premium Express Service Characteristics
(Source: Tindale Oliver and Associates)

The two bus services are different from traditional express and traditional BRT as they will employ BTL infrastructure and technology not typically associated with those services, particularly the premium express bus services. Tables C-1 and C-2 document the typical characteristics of express bus and BRT compared to the premium express bus and BRT envisioned for operation on the BTL networks. Illustrations are also included to further distinguish the various services.

Type of BRT	Operational Characteristics	
Bus Rapid Transit  Las Vegas Max	<ul style="list-style-type: none"> • Stylized vehicle design • High-capacity vehicles • Segregated from traffic • Traffic signal priority • High frequency (10- to 15-minute headways) • Specially branded • Larger, more substantial stations than typically used for local bus service • Commuters and local trips 	
BTL Bus Rapid Transit  Miami-Dade Busway	<ul style="list-style-type: none"> • Stylized vehicle design • High-capacity vehicles • Segregated from traffic • <i>Operate on bus priority toll lanes*</i> • <i>Experience additional speed and travel time gains due to:*</i> <ul style="list-style-type: none"> – <i>minimized side street friction</i> – <i>underpass/overpass intersection treatments</i> – <i>queue jump lanes</i> • Traffic signal priority • High frequency (10- to 15-minute headways) • Specially branded • Larger, more substantial stations than typically used for local bus service • Commuters and local trips 	

**Bold, italic text highlights distinguishing characteristics offered by the BTL.*

Table C - 2: Bus Rapid Transit Characteristics (Source: Tindale Oliver and Associates)

Other Technologies

It is envisioned that the BTL network of services will reflect the “gold standard” of bus transit service and, consequently, will make use of a host of transit technologies that will not only increase the speed and reliability of the service, but will also enhance the experience and comfort of BTL bus service customers. Technologies to be implemented as part of the BTL would likely include the following.

- **Off-Board Fare Collection** – There are generally two major fare collection methods, on-board fare collection and off-board fare collection, of which off-board fare collection is most commonly associated with express, BRT, and other commuter transit services. Off-board fare collection minimizes any delay related to on-board fare payment and, in turn, reduces station dwell times and overall bus travel times.
- **Passenger Information** – Intelligent transportation systems (ITS) provide dynamic (real-time) information to passengers at stations, stops, and terminals, or on a vehicle. Generally, dynamic passenger information may come from video monitors or variable message signs, depending on the application. On vehicles, a traditional information system consists of printed timetables and driver announcements. Technology enhancements for BTL services will allow stop announcements to be delivered by automated voice recordings and/or some type of message display.
- **Enhanced Station Areas and Infrastructure** – BTL premium express and BRT bus stations will include features beyond those typically found at traditional bus stops. BTL stations will be designed to meet operational needs and enhance the passenger experience. High-quality passenger amenities, off-board fare collection, and real-time passenger information systems are some of the amenities to be included at BTL stations.
- **Bus Preferential/Priority Treatments** – Bus preferential treatments give buses priority over other vehicles when they arrive at an intersection. Treatments include queue bypass lanes, queue jump operations, and transit signal priority (TSP). The intent of bus preferential treatments at intersections is to reduce bus travel time and improve schedule adherence by reducing bus delay at congested intersections.

BTL Transit Network Development

A separate BTL transit services network was developed for each BTL alternative. A number of resources were used to develop those networks. The resources used and the network plans and associated costs are described below. The BTL networks of BRT and premium services were a product of a concerted and cooperative effort among BTL project team members. Two major sources of information were used to develop the three bus service networks, project team technical expertise, and local agency planning documents.

Many of the BTL baseline services can be referenced back to agency planning documents. Those document resources were made available to the project team and were used to develop the initial network of services and the capital facilities that would support those services. Although many agency planning documents were referenced for this exercise, only the most pertinent are described in the following.

- **HART Transit Development Plan (2012–2021) – Vision Plan:** The State of Florida Public Transit Block Grant Program was enacted by the Florida Legislature to provide a stable source of State funding for public transportation. The Block Grant Program requires public transit service providers to develop and adopt a 10-year Transit Development Plan (TDP). Hillsborough Area Regional Transit (HART) completed an update of its 10-year TDP to include the planning period of FYs 2012–2021. That plan also includes a Vision Plan for enhanced transit services in the future.

Essentially, the TDP is the strategic guide for public transportation, and strategic elements pertinent to the BTL study from the TDP include a review of demographic and travel behavior characteristics of the service area, the development of proposed transit enhancements, and the proposed Vision Plan, which includes express and BRT services.

- **HART MetroRapid:** MetroRapid is a new premium bus service planned to be provided by HART in mixed traffic along selected corridors in Hillsborough County. The goal of MetroRapid is to reduce travel time for commuters and users through a variety of enhancements including limited stops, higher frequency service, and signal prioritization. The proposed MetroRapid service network was used as the basis for initial BTL service development.
- **HART Park-and-Ride Study:** An evaluation of HART’s Park-and-Ride program was undertaken to determine the feasibility of converting the existing decentralized park-and-ride system to a more centralized, regional system. Using a centralized park-and-ride system concept, a regional plan is delineated based on the current park-and-ride lot inventory and conditions, planned improvements, land use analysis, accessibility issues, express bus services plans, and projected capital and operating costs. As part of the long-term regional park-and-ride network, 15 regional park-and-ride locations are included in the Park-and-Ride Study. Those regional park-and-ride lots served as the basis for the network of park-and-ride facilities that will support the premium express and BRT services operating on the BTL facilities.
- **Hillsborough County MPO Long Range Transportation Plan:** The Hillsborough County MPO’s 2035 Long Range Transportation Plan (LRTP) is one of the fundamental planning documents for transportation in Hillsborough County and identifies the specific needs for reaching transportation-related goals. The LRTP focuses on all aspects of mobility and the most recent update was adopted by the Hillsborough County MPO in December 2009. Consequently, transit service improvements included in the HART plan superseded proposed LRTP transit service improvements unless already included in the agency’s existing plus committed network of services.

Transit Services Networks, Stations and Park & Ride Lots

The BTL network of transit services is primarily based on transit services described in the HART Vision and MetroRapid Plans. It is important to note that, to maximize the use of the proposed BTL facilities, many existing and proposed express and BRT services from the noted plans had to be realigned and/or restructured. The revision of bus services to the BTL facilities is an integral part of the concept plan in that the use of the tolled guideway by the bus services ensures and strengthens the “premium” nature of the BTL bus services above what is typically considered BRT and/or express service.

Operating levels for bus services can be described using three major components: service frequency, span of service (hours of service), and days of service. Levels of service were defined for each of the three operating components for each network. In addition, a service frequency was developed for peak and off-peak periods. As a result of the varying service frequencies that would occur throughout the course of a day, daily hours of service for each of those periods were also defined. To convey and reinforce the impression of “premium” bus service, service spans and service frequencies reflect high, but realistic, levels of service for the operating environment exhibited by the test community. Table C-3 summarizes the major operating characteristics for the BTL BRT and premium express bus services.

Operating Characteristic	Premium Express	Bus Rapid Transit
Facility Type	Highway	Arterial
Service Frequency (peak/off-peak)	10/15	10/15
Span of Service (total hours)	14	16
Peak (hours)	6	6
Off-Peak (hours)	8	10
Days of Service	5	5

Table C - 3: Operating Characteristics of BTL Transit Technologies
(Source: Tindale Oliver and Associates)

Transit capital components for the BTL networks consist of two primary elements: vehicles and transit stations. Vehicles typically comprise a major part of transit agency capital expenses, and the number of vehicles necessary for any service is directly tied to the frequency of service. More frequent service requires that vehicles be added if the same service routing is to be continued. Other factors that influence the vehicle requirement include route length and average speed. More information on the vehicle requirements for all three BTL network alternatives is documented in the Costs section of this report.

Important to the development of the transit component for the BTL study was the land-use scenario information supplied by the University of Florida (see following section on Land Use). This information was used to guide the placement of stations and park-and-ride facilities. An effort was made to balance travel time and speed gains from operation on limited access facilities and accessibility to the various services by potential riders. Consequently, special attention was paid to accessibility, and significant efforts were undertaken to strategically place BRT stations and park-and-ride facilities to maximize access to the system without impacting the desired speed and reliability outcomes envisioned for the bus services.

Park-and-ride facilities are drawn primarily from the HART Park-and-Ride Study. That study emphasizes a centralized, regional network of park-and-ride facilities that consolidates many of the service area’s existing park-and-ride lots. The existing decentralized park-and-ride system comprises smaller-size lots scattered throughout the service area, and many are often shared with existing community facilities.



Figure C - 21: Metro Rapid type C Station (Source: HART)

Consequently, the goal of the BTL park-and-ride network mirrors HART’s regional approach to provide larger, more centralized locations that can offer a more ample supply of parking that will meet the expected demand for BTL bus services.

To complement the BTL networks and their corresponding premium bus services, park-and-ride facilities from the regional plan were added to the BTL bus capital infrastructure plan. In addition, several smaller, existing HART express bus stations and a few additional park-and-ride facilities not included in HART’s park-and-ride plan were added to the regional park-and-ride network to better support premium express bus routing and to improve the connectivity and proximity of park-and-ride facilities to BTL highway facility access ramps.

To organize the station types developed for the BTL study, BTL network stations were split into two categories: BRT stations and premium express bus stations.

Station Type	Description	Source
BRT Station	Substantial stations that include a range of passenger amenities, including real-time bus information, ticket vending machines, and other technologies.	HART MetroRapid Type C Station
Premium Express Stations		
Express Stops	Express bus stops with limited parking availability designed for drop-off and pick-up of express bus riders.	HART MetroRapid Type A Station
Park-and-Ride	Large stand-alone facilities with an ample parking supply designed to meet the demand for BTL express bus services.	HART Park-and-Ride Study

Table C - 4: Type and Description of BTL Stations (Source: Tindale Oliver and Associates)

It is important to note that, wherever applicable, premium express bus stations were considered to be shared facilities that allowed for connectivity between local, express, and BRT bus services. BRT stations for the BTL networks are modeled after HART’s MetroRapid Type C stations. Additional premium express bus stops were modeled after HART’s MetroRapid Type A stations.

Other capital facilities that will support BTL bus services include major transfer centers. Major transfer centers serve as the nexus of all bus services operating in a given area and facilitate transfers between different bus routes and modes. An example of such a facility is the main HART bus terminal in Downtown Tampa. All existing HART transfer centers were kept in the BTL network, and several new transfer centers were added in order to facilitate transfers and connectivity between BTL premium bus services and other local bus services that would operate within the service area.

Map illustrations of the robust nature of the BTL transit services and capital facilities were developed for each BTL network alternative and are shown in Figures C-22 through C-25 below and on the following pages. Two maps were created for BTL Network #2 to distinguish premium express bus and BRT services proposed to operate in that alternative.

Tables C-5 through C-7 on the following pages summarize the characteristics of all premium express bus and BRT services for the three BTL networks.

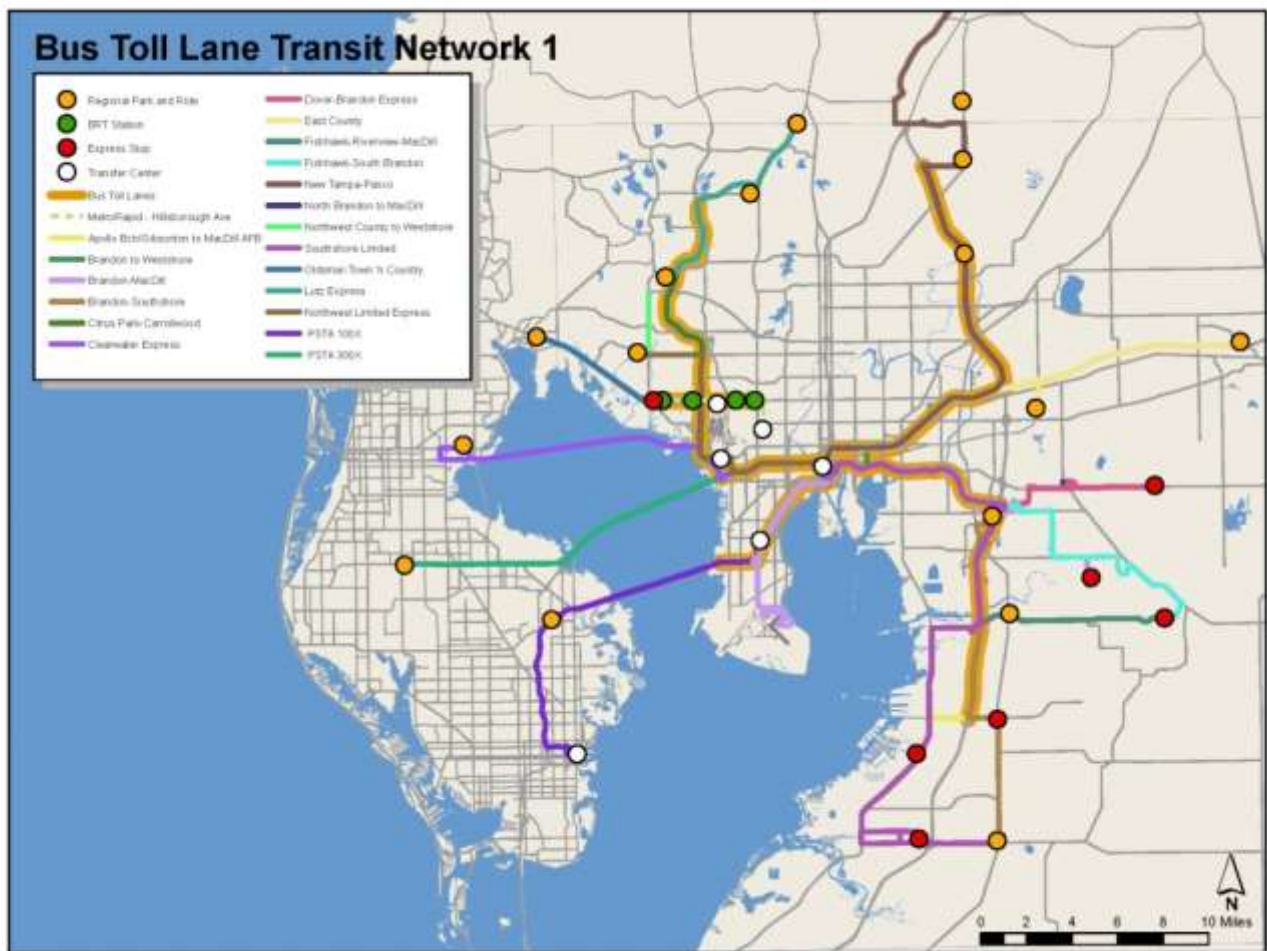


Figure C - 22: BTL #1 Transit Network (Source: Tindale Oliver and Associates)

Route Name	Route Length (mi)	Service Type	Corresponding HART/PSTA Route #	From	To
Apollo Beach/Gibson to MacDill	36.6	Express	N/A	Apollo Beach/Gibson	MacDill Air Force Base
Brandon to Westshore	15.6	Express	N/A	Westfield Brandon Mall	TPA Transfer Center
Northwest County to Westshore	10.4	Express	N/A	Northwest County	TPA Transfer Center
Northwest Limited Express	14.2	Express	N/A	Northwest Transfer Center	Marion Transit Center
North Brandon to MacDill	23.9	Express	N/A	Dover Park-and-Ride	MacDill Air Force Base
Lutz Express ¹	9.8	Express	20	Citrus Park Park-and-Ride	Pasco County Rd @ Dale Mabry Hwy
Dover - Brandon Express	18.2	Express	22	Marion Transit Center	Dover Park-and-Ride
Fishhawk-Riverview-MacDill	35.6	Express	24	Fishhawk Sports Complex Park-and-Ride	MacDill Air Force Base
Brandon-MacDill	30.7	Express	25	Bell Shoals Rd @ Glenhaven Dr	MacDill Air Force Base
Fishhawk-South Brandon	23.5	Express	27	Fishhawk Sports Complex Park-and-Ride	Marion Transit Center
East County ¹	21.6	Express	28	Mt. Zion Assembly of God Church Park-and-Ride	Marion Transit Center
Brandon-Southshore ^{1,2}	25.4	Express	35	South 301 Park-Ride	Marion Transit Center
Southshore Limited	38.1	Express	47	South 301 Park-Ride	Marion Transit Center
Citrus Park-Carrollwood ¹	16.5	Express	50	Citrus Park Park-and-Ride	Marion Transit Center
New Tampa-Pasco ¹	34.6	Express	51	Victorious Life Church Park-Ride	Marion Transit Center
Oldsmar-Town 'n' Country ^{1,2}	17.5	Express	59	Oldsmar	Marion Transit Center
Clearwater Express	20.6	Express	200	Eddie C. Moore Park-and-Ride	Marion Transit Center
PSTA 100X ¹	23.7	Express	100X	Williams Park	Marion Transit Center
PSTA 300X	19.8	Express	300X	Ulmerton Rd. @ Starkey Rd	Marion Transit Center
MetroRapid - Hillsborough Ave	5.7	BRT	N/A	West Tampa Transfer Center	Memorial Hwy @ Hillsborough Ave

¹Existing service realigned to operate on BTL facilities.

²Terminated by HART on July 10, 2011.

Table C - 5: Characteristics of BTL Network # 1 (Source: Tindale Oliver and Associates)

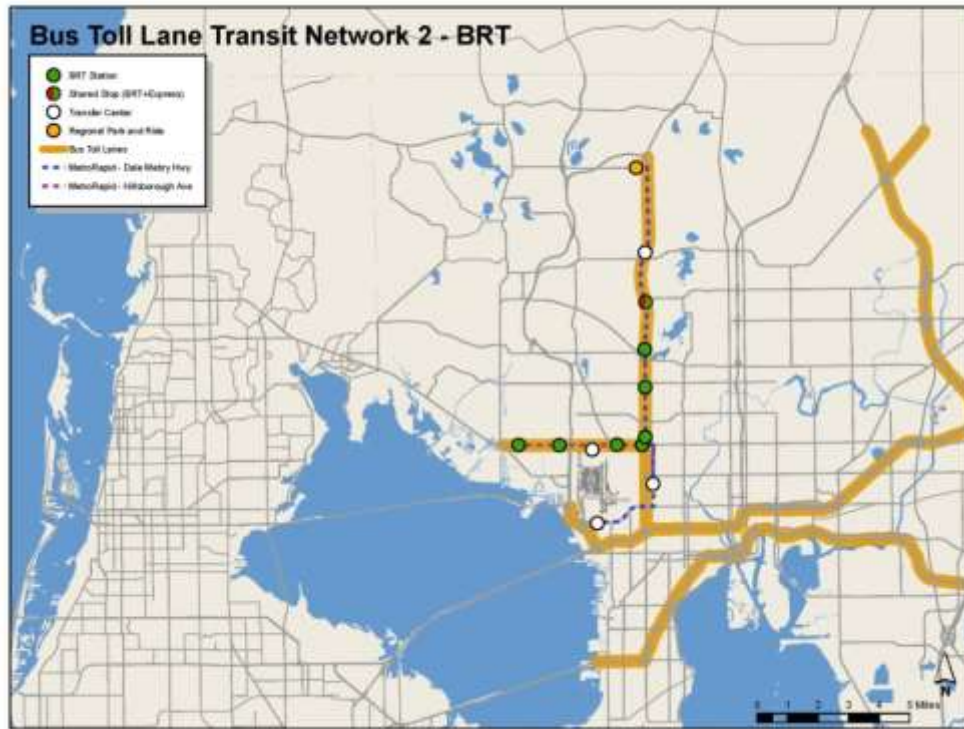


Figure C - 23: B TL #2 Bus Rapid Transit Network (Source: Tindale Oliver and Associates)

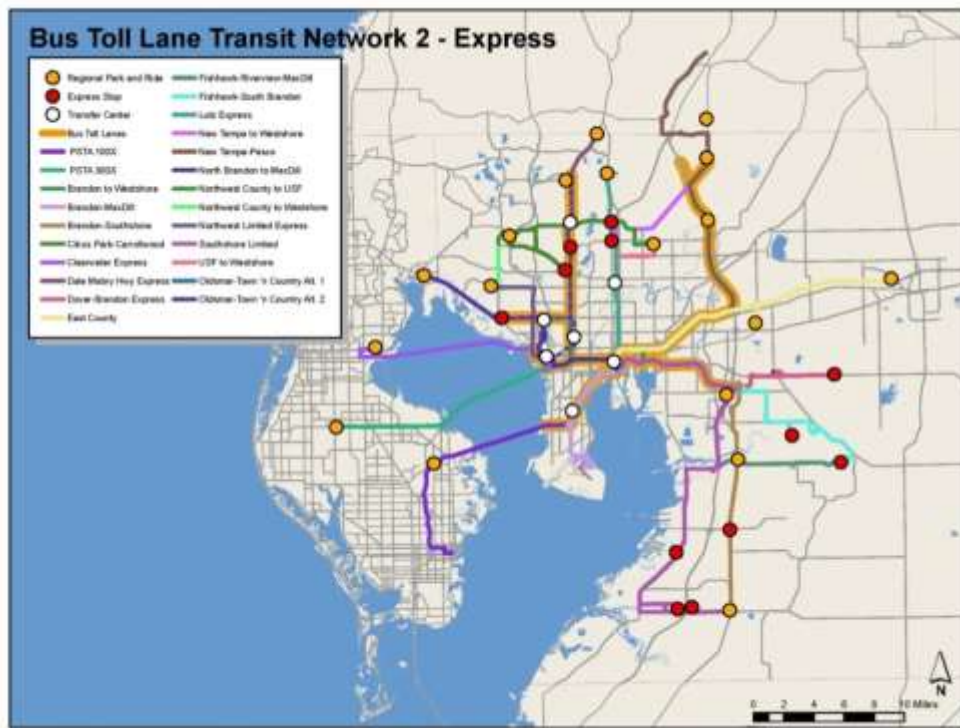


Figure C - 24: BTL #2 Express Bus Network (Source: Tindale Oliver and Associates)

Route Name	Route Length (mi)	Service Type	Corresponding HART/PSTA Route #	From	To
New Tampa-Westshore	24.8	Express	N/A	CR 56 @ Bruce B. Downs Blvd	TPA Transfer Center
Brandon to Westshore	15.6	Express	N/A	Westfield Brandon Mall	TPA Transfer Center
Northwest County to USF	12.3	Express	N/A	Citrus Park Park-and-Ride	University Area Transit Center
Northwest County to Westshore	10.4	Express	N/A	Northwest County	TPA Transfer Center
USF to Westshore	15.2	Express	N/A	University Area Transit Center	TPA Transfer Center
N Brandon to MacDill	23.9	Express	N/A	Dover Park-and-Ride	MacDill AFB
Lutz Express	13.9	Express	20	First Baptist Church of Lutz Park-and-Ride	Marion Transit Center
Dover-Brandon Express	18.2	Express	22	Dover Park-and-Ride	Marion Transit Center
Fishhawk-Riverview-MacDill	35.6	Express	24	Fishhawk Sports Complex Park-and-Ride	MacDill Air Force Base
Bradon-MacDill	30.7	Express	25	Bell Shoals Rd @ Glenhaven Dr	MacDill Air Force Base
Fishhawk-South Brandon	23.5	Express	27	Fishhawk Sports Complex Park-and-Ride	Marion Transit Center
East County ¹	21.6	Express	28	Mt. Zion Assembly of God Church Park-Ride	Marion Transit Center
Brandon-Southshore ^{1,2}	15.5	Express	35	Westfield Brandon Mall	South 301 Park-and-Ride
Southshore Limited	38.1	Express	47	South 301 Park-Ride	Marion Transit Center
Citrus Park-Carrollwood ¹	21.4	Express	50	Citrus Park Park-and-Ride	Marion Transit Center
New Tampa-Pasco ¹	37.8	Express	51	Victorious Life Church Park-and-Ride	Marion Transit Center
Oldsmar-Town 'n' Country ^{1,2}	16.8	Express	59	Oldsmar	Marion Transit Center
Northwest Limited Express	14.2	Express	61	Northwest Transfer Center	Marion Transit Center
Clearwater Express	20.6	Express	200	EC Moore Park-Ride	Marion Transit Center
PSTA 100X ¹	23.7	Express	100X	Williams Park	Marion Transit Center
PSTA 300X	19.8	Express	300X	Ulmerton Rd @ Starkey Rd	Marion Transit Center
MetroRapid - Hillsborough Ave	5.9	BRT	N/A	West Tampa Transfer Center	Memorial Hwy @ Hillsborough Ave
MetroRapid - Dale Mabry Hwy	13.7	BRT	N/A	Tampa International Plaza	Yan Dyke Rd @ Dale Mabry Hwy

Table C - 6: Characteristics of BTL Network #2 (Source: Tindale Oliver and Associates)

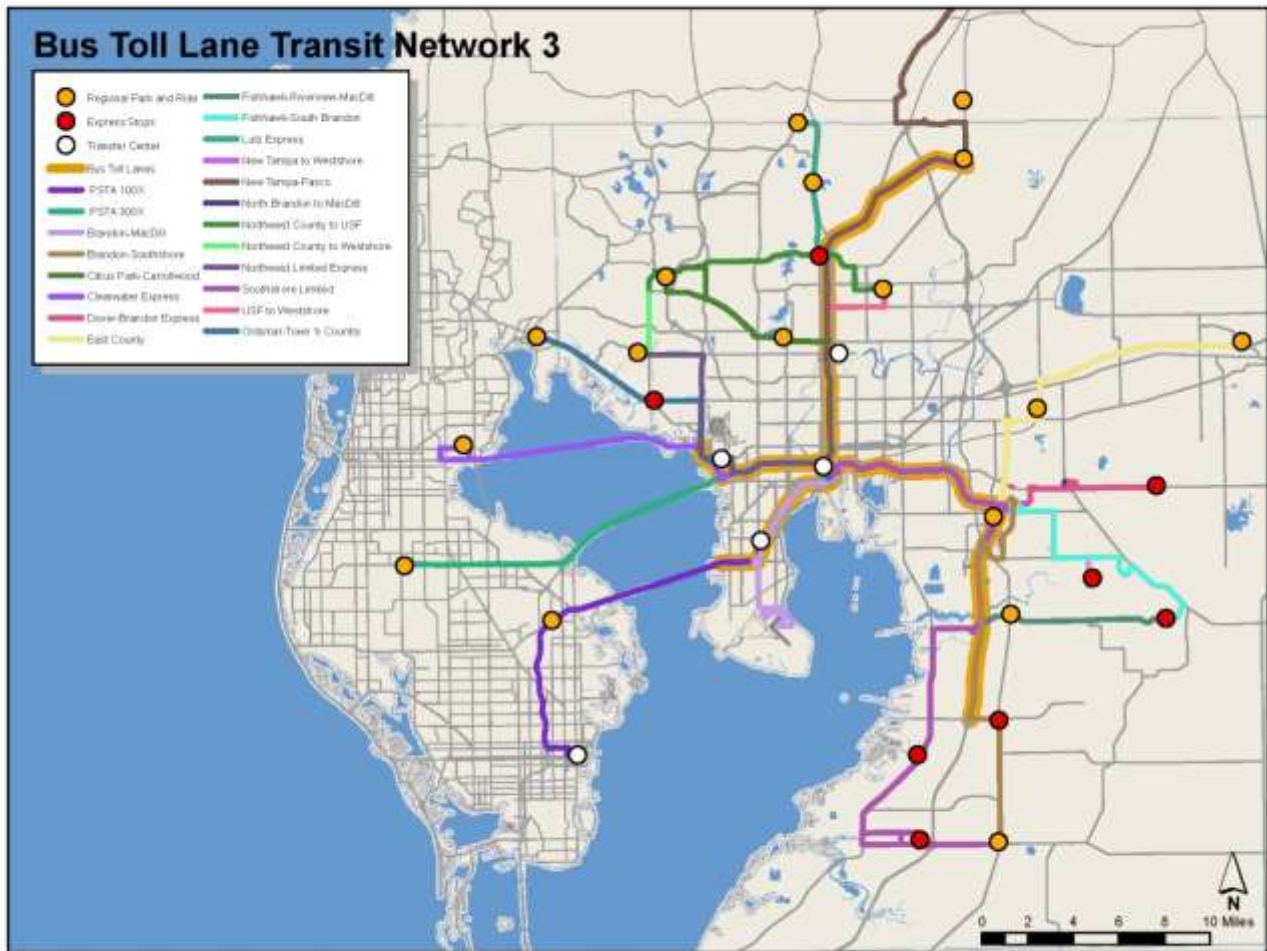


Figure C - 25: BTL #3 Transit Network (Source: Tindale Oliver and Associates)

Route Name	Route Length	Service Type	Corresponding HART/PSTA Route #	From	To
New Tampa-Westshore	24.5	Express	N/A	CR 56 @ Bruce B. Downs Blvd	TPA Transfer Center
Brandon to Westshore	15.6	Express	N/A	Westfield Brandon Mall	TPA Transfer Center
Northwest County to USF	12.3	Express	N/A	Citrus Park Park-and-Ride	University Area Transit Center
Northwest County to Westshore	10.4	Express	N/A	Northwest County	TPA Transfer Center
USF to Westshore	15.2	Express	N/A	University Area Transit Center	TPA Transfer Center
North Brandon to MacDill	23.9	Express	N/A	Dover Park-and-Ride	MacDill Air Force Base
Lutz Express	16.0	Express	20	Pasco County Rd @ Dale Mabry Hwy	Marion Transit Center
Dover-Brandon Express	18.2	Express	22	Marion Transit Center	Dover Park-and-Ride
Fishhawk-Riverview-MacDill	35.6	Express	24	Fishhawk Sports Complex Park-and-Ride	MacDill Air Force Base
Brandon-MacDill	30.7	Express	25	Bell Shoals Rd @ Glenhaven Dr	MacDill Air Force Base
Fishhawk-South Brandon	23.5	Express	27	Fishhawk Sports Complex Park-and-Ride	Marion Transit Center
East County ¹	26.8	Express	28	Mt. Zion Assembly of God Church Park-and-Ride	Marion Transit Center
Brandon-Southshore ^{1,2}	20.7	Express	35	Westfield Brandon Mall	South 301 Park-and-Ride
Southshore Limited	38.1	Express	47	South 301 Park-and-Ride	Marion Transit Center
Citrus Park-Carrollwood ¹	15.2	Express	50	Citrus Park Park-and-Ride	Marion Transit Center
New Tampa-Pasco ¹	33.3	Express	51	Victorious Life Church Park-and-Ride	Marion Transit Center
Oldsmar-Town 'n' Country ²	17.5	Express	59	Oldsmar	Marion Transit Center
Northwest Limited Express	14.2	Express	61	Northwest Transfer Center	Marion Transit Center
Clearwater Express	20.6	Express	200	Eddie C. Moore Park-and-Ride	Marion Transit Center
PSTA 100X ¹	23.7	Express	100X	Williams Park	Marion Transit Center
PSTA 300X	19.8	Express	300X	Ulmerton Rd @ Starkey Rd	Marion Transit Center

Table C - 7: Characteristics of BTL Network #3 (Source: Tindale Oliver and Associates)

3. Land Use Projections

UF GeoPlan Center employed a “Community Assessment Computer Model” known as LUCIS for analyzing the three alternative BTL corridors through Hillsborough County using 10, 20, and 30-year horizons beginning with the year 2015 (2025, 2035 and 2045).

Using the LUCIS Model’s “Smart Land Use Analysis” system with data from Hillsborough County, and the Florida Geographic Data Library (FGDL), land use scenarios were modeled for three BTL networks to identify land use changes within the county that would be associated with the investment in the transportation system from implementation of the BTL guideway concept.

The results of the analysis indicated that, when combined with the proper land-user development policies, the BTL concept demonstrated positive impacts on projected changes to community land-use through the support of transit oriented development (TOD) within each of the tested networks. A complete, detailed description of the study methodologies and results for the transportation and land-use projections are included in this section.

Research was supported by THEA and results of the study were presented to the THEA and HART Boards of Directors, the Florida Department of Transportation (FDOT), the Federal Highway Administration (FHWA), the Hillsborough County Metropolitan Planning Organization (MPO) and the Tampa Bay Area Regional Transportation Authority (TBARTA).

Description of Hillsborough County

Hillsborough County is located on the west coast of the state of Florida, in the Tampa Bay Area. Part of the Tampa-St. Petersburg-Clearwater Metropolitan Statistical Area, Hillsborough County comprises approximately 685,352 acres or 1,070 square miles. According to the U.S. Census Bureau, the total population of Hillsborough County in 2010 was 1,229,226 and the total population of the Tampa Census County Division (CCD) was 625,570.

Tampa is the largest city in Hillsborough County. The racial make-up of the county according to 2010 U.S. Census Data was 71.27% White, 16.68% African American, 3.4% Asian, .38% American Indian and Alaska Native, .07% Native Hawaiian and Pacific Islander, 5% Other, and 3.1% are identified by two or more racial categories. Approximately 76% of the population of the County is over the age of 18 and 11.8% of the population is over the age of 65. There are 536,092 total housing units in Hillsborough County, of which 289,098 (53.9%) of these units are in Tampa CCD. The mean household income for Hillsborough County is \$64,380.

FDOT released their 2011 City County Mileage data (data as of September 30, 2010). According to FDOT, there are 3,319.5 total miles of County Roads (not including City Roads) in Hillsborough County. In Tampa, there are 1213.3 total miles of City Roads. There are approximately 5,214.597 miles of public roads and 34,745,256 daily vehicle miles traveled. The following major roads and other highways are in Hillsborough County: U.S. Route 41, U.S. Route 92, U.S. Route 301, Interstate 4, Interstate 75, and Interstate 275. Of the employed workers in Hillsborough County, only 1.8% use public transportation to commute to work, as opposed to 79.3% of the workforce that drives alone in a car, truck, or van.

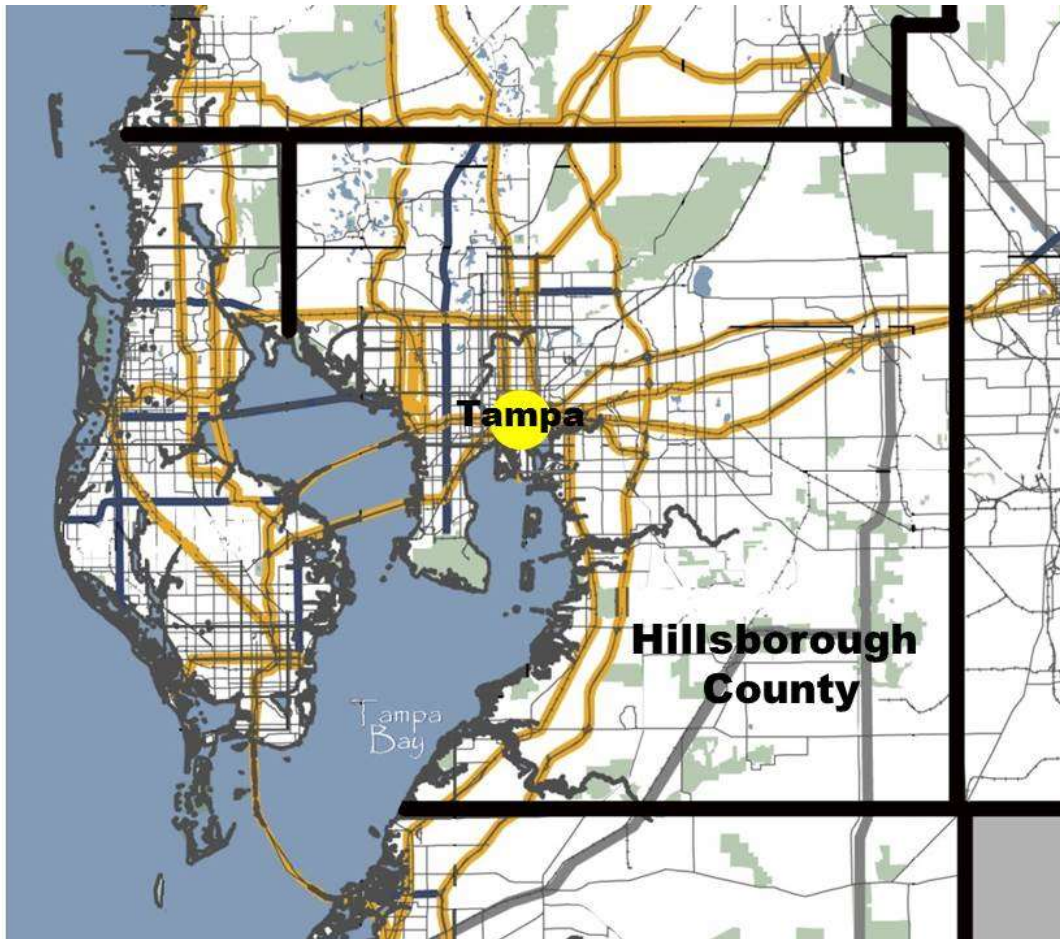


Figure C - 26: Hillsborough County Location Map (Source: TBARTA)

Methods and Process

The analysis process modeled land use suitability based on current policies with increased unit density changes for the transit opportunities. This input helped identify potential conflicts among three major land use categories, agricultural, ecologically significant areas, and urban/suburban uses throughout the county.

Additionally, urban opportunities for land use change within the proposed BTL corridors, existing vacant lands and other urban/suburban locations were also modeled. The expectation was that this process would assist the study team in visualizing potential future land use changes along three identified corridor routes and within the county as a whole, thereby indicating impacts, including changes in county population allocations and its future land use.

Figure C-27 shows the general urban suitability modeling process employed for the BTL Proof-of-Concept Study using Hillsborough County, Florida as the testing location.

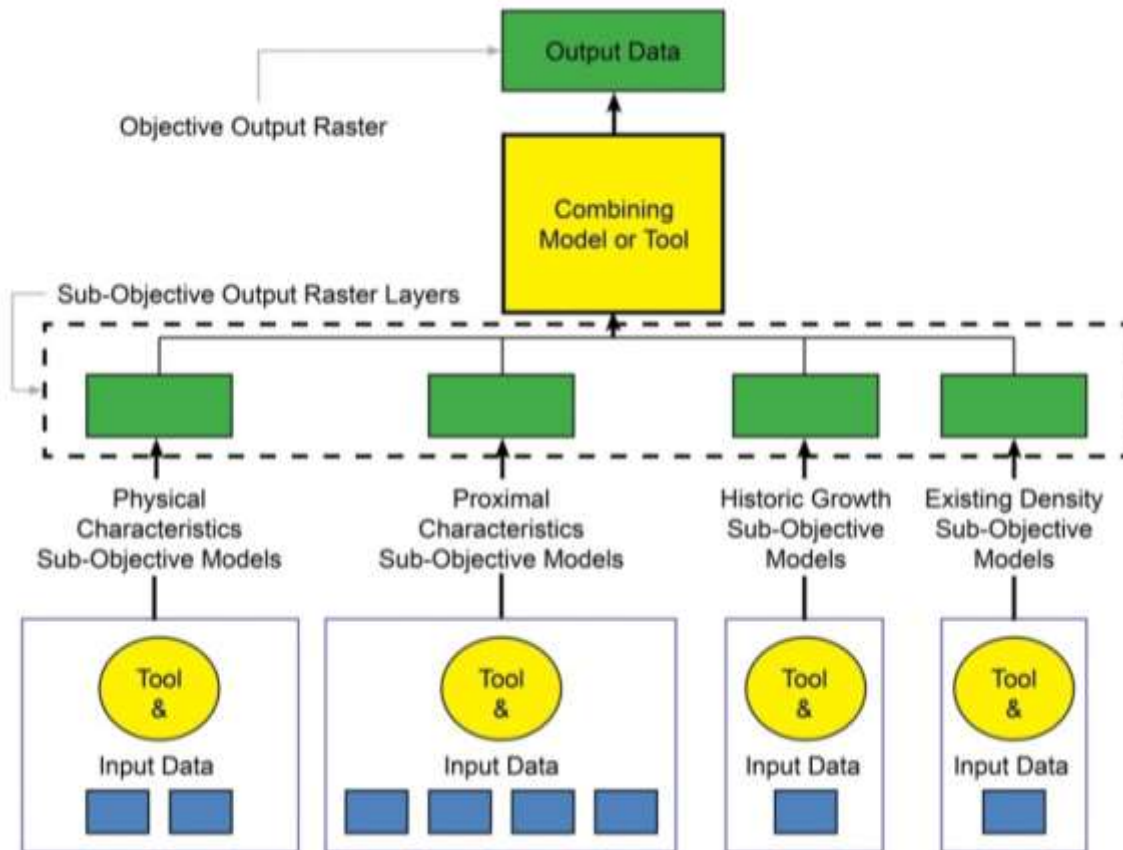


Figure C - 27: General Urban Suitability Model Process (Source: UF GeoPlan Center)

The model utilizes suitability for physical characteristics, proximal or access characteristics, historic growth patterns, and land use densities. An example of physical suitability would be soil drainage. Some examples for proximal suitability would be the proximity to schools, hospitals, or employment centers. One example for historic growth is a three decade spatial pattern of single family residential development; and an example of density is the density of commercial buildings per square mile. Models for agricultural and ecological significance were also employed.

The UF team modeled potential land use impacts of the three route alternatives for the BTL networks. The work flow was distributed within eight major tasks that were accomplished within a sequential process. Presentations were made to the project TAG and individually to the Hillsborough County MPO and to Hillsborough county Public Works to obtain feedback on the land use and population allocations for the various BTL network segments.

The LUCIS Model: General Description

This study employed the Land-Use Conflict Identification Strategy, also known as the LUCIS model as published in “Smart Land-Use Analysis: The LUCIS Model” (M. Carr and P. Zwick, Esri Press, 2007). LUCIS provides a foundation for visualizing future land use and the consequences of land-use decisions over time by using traditional land-use suitability analysis as the basis for producing spatial representations of future land-use patterns.

LUCIS was developed in a University of Florida graduate design studio for students from the departments of landscape architecture and urban and regional planning. The early concept for the LUCIS model is based on the work of the prominent ecologist, Eugene P. Odum. From his work came the LUCIS land classification scheme which provides optimal suitability based on three broad land-use categories: agriculture, ecological significance, and urban.

Specifically, UF used the BTL transportation networks as the basis for estimating a range of land use (population and employment) impacts for the interim and future years. UF then developed land use, population, employment, and income data for the Hillsborough County study area. The socio-economic data from the LUCIS model was provided at the parcel and traffic analysis zone (TAZ) level and the TAZ data was formatted using the ZDATA fields required by the TBRTM.

The LUCIS model identifies suitability in subcategories within the following three major uses (LUCIS Model Definitions):

- **Agriculture:** The agriculture land-use category includes the full range of agricultural uses and can be customized depending upon one’s region and the character of agriculture to be found there. For our purposes it includes croplands; low-intensity livestock that occurs mostly on pasture and shrub and brushland; intensively managed livestock, including feedlots, swine operations, and dairies; commercial timberlands or silvicultural (forestry) operations; and specialty agriculture that includes fruit orchards, nurseries, and aquaculture.
- **Ecological Significance:** The ecological significance land-use category includes lands with some degree of permanent protection with at least a partial conservation mission. These may be publicly owned like national and state parks or forests, Bureau of Land Management lands, or national and state wildlife refuges and management areas. They may also be privately owned like agricultural lands protected through conservation easements. A specific example is land used for timber production, permanently protected through a conservation easement held by a public entity or a private land trust.
- **Urban:** The urban land-use category includes all land uses commonly found within the umbrella of urban use. These include single family and multi-family residential, office and commercial, retail, industrial, and institutional uses. Urban parks and recreational areas like golf courses are also included in this category.

After developing suitability, the researcher determines the preference to capture community values while assessing locations that have already been identified through suitability analysis (Carr & Zwick, 2007). The LUCIS process used to capture preference is the analytical hierarchy process (AHP), which “employs a sequence of pairwise comparisons to derive weights. The weights determine the strength individual goals and their associated suitability rasters exert on the final land-use preference raster” (Carr & Zwick, 2007, p. 128).

The LUCIS Model: Land-Use Suitability

The LUCIS model determines suitability by specifically defining land-use categories and criteria and evaluating how effectively land can be used for a specific purpose. Within this process, raster layers are created using Geographic Information Systems (GIS) spatial data and combined for suitability analysis. Criteria are determined at the beginning of the LUCIS suitability analysis process to identify utility values. The identification and assignment of utility according to location and feature attributes is critical to the development of a land-use analysis tool (Carr & Zwick, 2007, p. 58).

The assignment of utility values within an individual raster layer is called a *single utility assignment* (SUA). The combination of multiple SUA layers creates a *simple multiple utility assignments* (MUA) and the combination of multiple MUAs creates a *complex multiple utility assignments*. Carr & Zwick (2007) describe the technical requirements for creating an SUA: “(1) if the source data is vector, convert it to raster, (2) define the level of measurement for the raster layer, (3) select the appropriate ranking strategy for utility assignment, an (4) assign utility values for individual features in the raster layer using reclassification” (p. 58).

Suitability is then ranked in order to create SUA raster layers. Ranking strategies are based on the level of measurement of the original data, which will be interval/ratio data or nominal/ordinal data. Various strategies include: modeler assignment of utility and the usefulness of features; group voting technique to base utility on an established voting pattern; the modified Delphi process which relies on group consensus to assign utility; and pairwise comparison which is a form of the analytical hierarchy process (AHP). By combining multiple SUA layers, you can find the land that is most suitable overall and the methods for creating an MUA are weighted combination of multiple SUA layers or the conditional statement to satisfy a condition or set of conditions.

Figure C-28 shows the urban suitability for Hillsborough, County. Within the Urban Suitability Raster Layer, the green areas show higher urban suitability. The dark brown area shows lower urban suitability.

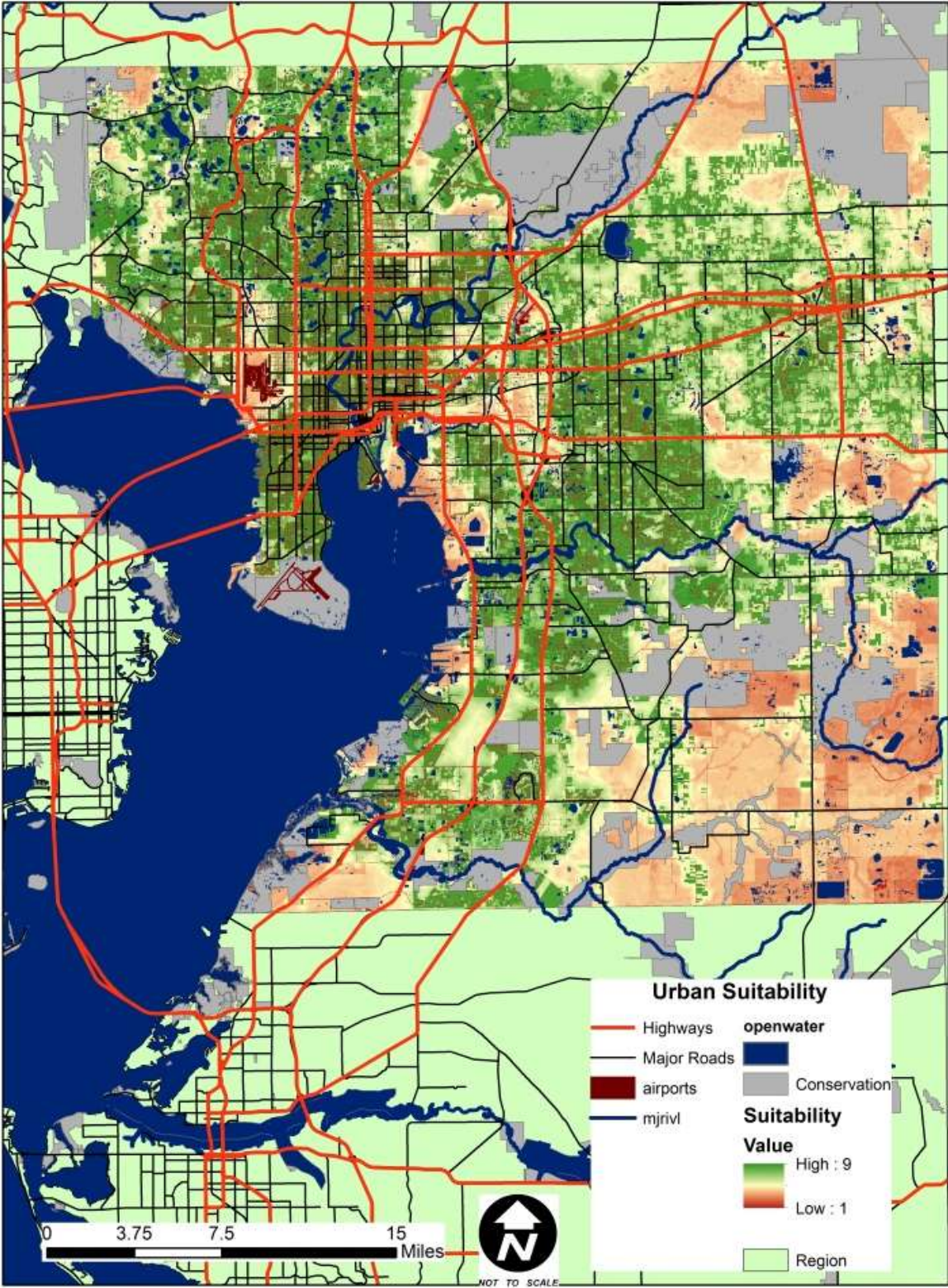


Figure C - 28: Hillsborough County Urban Suitability Raster Layer (Source: UF GeoPlan Center)

The LUCIS Model: Land-Use Preference

The results of suitability analysis are used to develop land-use preference. To find preference, “goal suitability rasters are combined using weighted values (determined by the stakeholder community) to create one land-use preference raster for each land-use category” (Carr & Zwick, 2007, p. 128). Preference can be determined in two ways: the group of individuals used to derive preference can be the same stakeholder group that assisted with the suitability analysis or you can use a more diverse group of participants who represents the larger community. Using the analytical hierarchy process (AHP), a sequence of pairwise comparisons is made to derive weights which determine “the strength individual goals and their associated suitability rasters exert on the final land-use preference raster” (Carr & Zwick, 2007, p. 128). Ultimately, preference is then collapsed into three final categories low, moderate, and high preference.

Figure C-29 shows the urban preference categories for Hillsborough, County. The map shows three categories of low (red), moderate (yellow), and high (green) urban preferences.

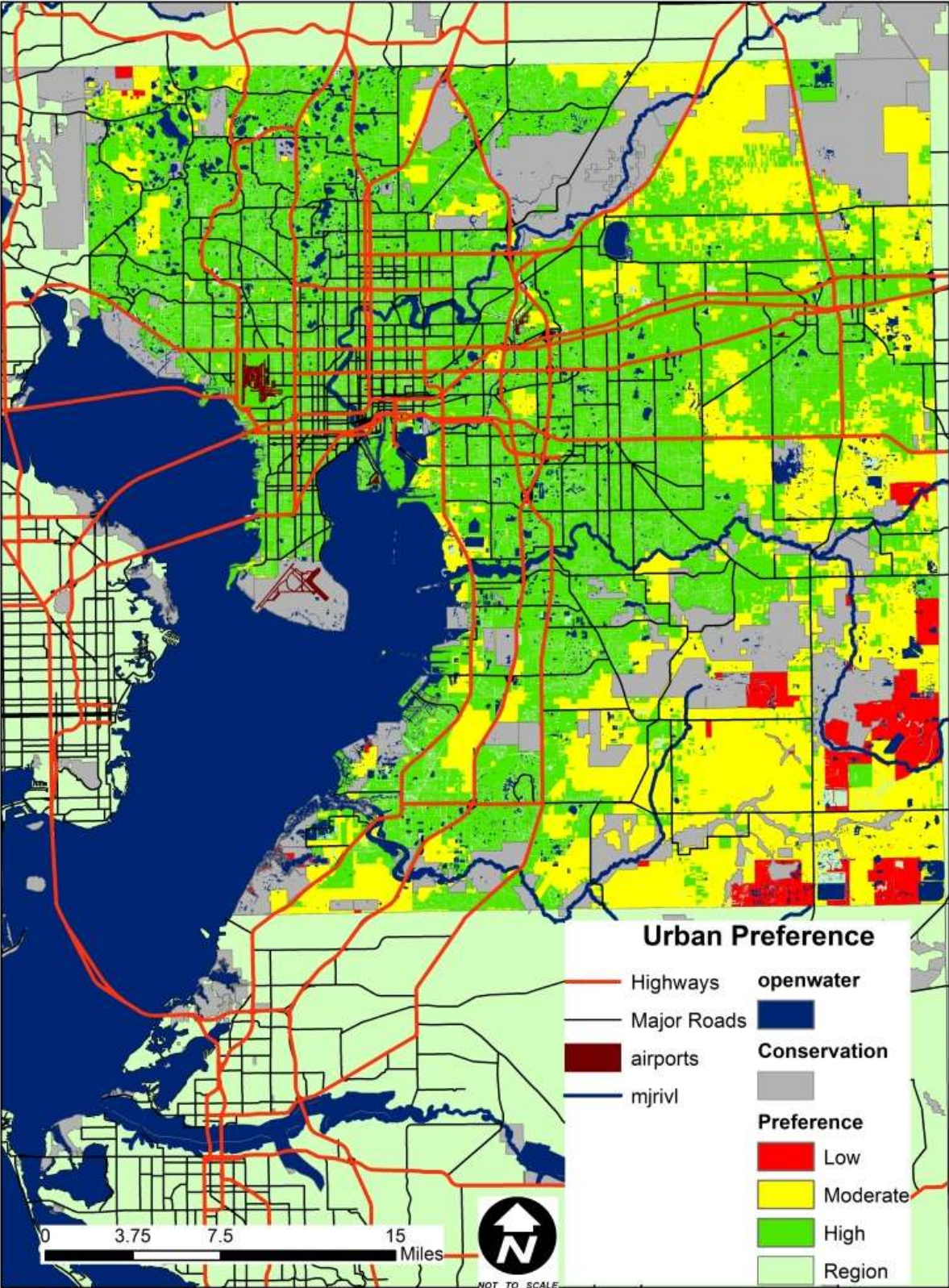


Figure C - 29: Hillsborough, County Urban Preference Created from Collapsed Suitability (Source: UF GeoPlan Center)

The LUCIS Model: Land-Use Conflict

There are three tasks that are completed to identify potential land-use conflict. First, it is necessary to remove lands whose use will not change. Conflict cannot occur on these lands because they already have a permanent land-use designation and development does not have the potential to occur, such as protected conservation land or existing urban areas. Agricultural lands are not included in this step of the process because these lands are potentially desirable for both urban and conservation uses. The next step involves normalizing and collapsing preference results. It is important to normalize the values for relative suitabilities because it is unlikely that at least one cell in the study area will be optimally suited for every measure of suitability included in the goals, objectives, and sub-objectives for the land-use category (Carr & Zwick, 2007, p. 139).

Carr & Zwick (2007) explain “collapsed preference” in the following way:

To simplify comparison among the normalized results, the normalized preference values are collapsed into three classes that correspond to high, medium, and low preferences. The strength of mapping collapsed preference is that the preference values may be easily combined to show different relationships among the three categories. Collapsed preference mapping allows the community and its leaders to rapidly identify preference areas, and then to identify places where conflict between land-use categories exists and how strong the conflict might be (p. 139).

Raster reclassification is used to reassign raster values in order to create new categories (Carr & Zwick, 2007, p.39). The reclassification method used to collapse values in this case study is equal interval classification. Carr & Zwick (2007) explain “equal interval classification” in the following way:

“The range of values in each raster is divided into three equal intervals by the software. The first interval does not automatically begin at 0, but at the lowest cell value in the raster. In the same manner, the last interval ends with the highest cell value in the raster, which may not be the highest possible number. However, when the data values are normalized...the highest value will always be 1. The ranges are determined by the number of classes selected and the overall range of observed values within the raster (p. 142). The transformed/normalized raster layers are then combined with the three land-use preference rasters and reclassified into areas of conflict and areas of no conflict. Conflict occurs any time “(1) three cells sharing the same spatial location have equal collapsed preference values (major conflict), or (2) two cells have equal collapsed preference values, and the third cell has a lower collapsed preference (moderate conflict)” (Carr & Zwick, 2007, p. 147).

In general, combinations of preference produce rankings to denote major conflict, moderate conflict, or no conflict. Reclassification creates codes composed of three indexes, where the first number equals agricultural preference, the second number equals ecological significance preference, and the third number equals urban preference. For example, code 132 indicates low preference for agriculture, high preference for ecological significance, and moderate preference for urban.

The following table provides the 27 conflict/preference categories which are three digit numbers with the first digit representing agricultural preference, the second digit representing ecological significance preference and the third digit representing urban preference.

The 27 categories have unique numeric identifiers that also indicate the type of land use preference or conflict.

Conflict/Preference Number	Description
111	Low preference for all major conflict by definition
112	Moderate urban preference
113	High urban preference
121	Moderate eco significance preference
122	Moderate eco significance and urban preference moderate conflict
123	High urban preference moderate eco significance preference
131	High eco significance moderate urban preference
132	High eco significance cultural preference moderate urban preference
133	High eco significance and urban preference moderate conflict
211	Moderate agricultural preference
212	Moderate agricultural and urban preference moderate conflict
213	High urban preference moderate agricultural preference
221	Moderate agricultural and eco significance preference
222	Moderate preference for all three major conflict by definition
223	High urban preference moderate other two
231	High eco significance preference moderate agriculture
232	High eco significance preference moderate preference others
233	High eco significance and agriculture preference
311	High agricultural preference
312	High agricultural preference moderate urban preference
313	High agricultural and urban preference
321	High agricultural and moderate eco significance preference
322	High agricultural preference moderate preference other two
323	High agricultural and urban preference
331	High agricultural and eco significance preference
332	High agricultural and eco significance preference moderate urban
333	High preference all three major conflict by definition

**Table C - 8: LUCIS Conflict/Preference for Greenfields Development
(Source: UF GeoPlan Center)**

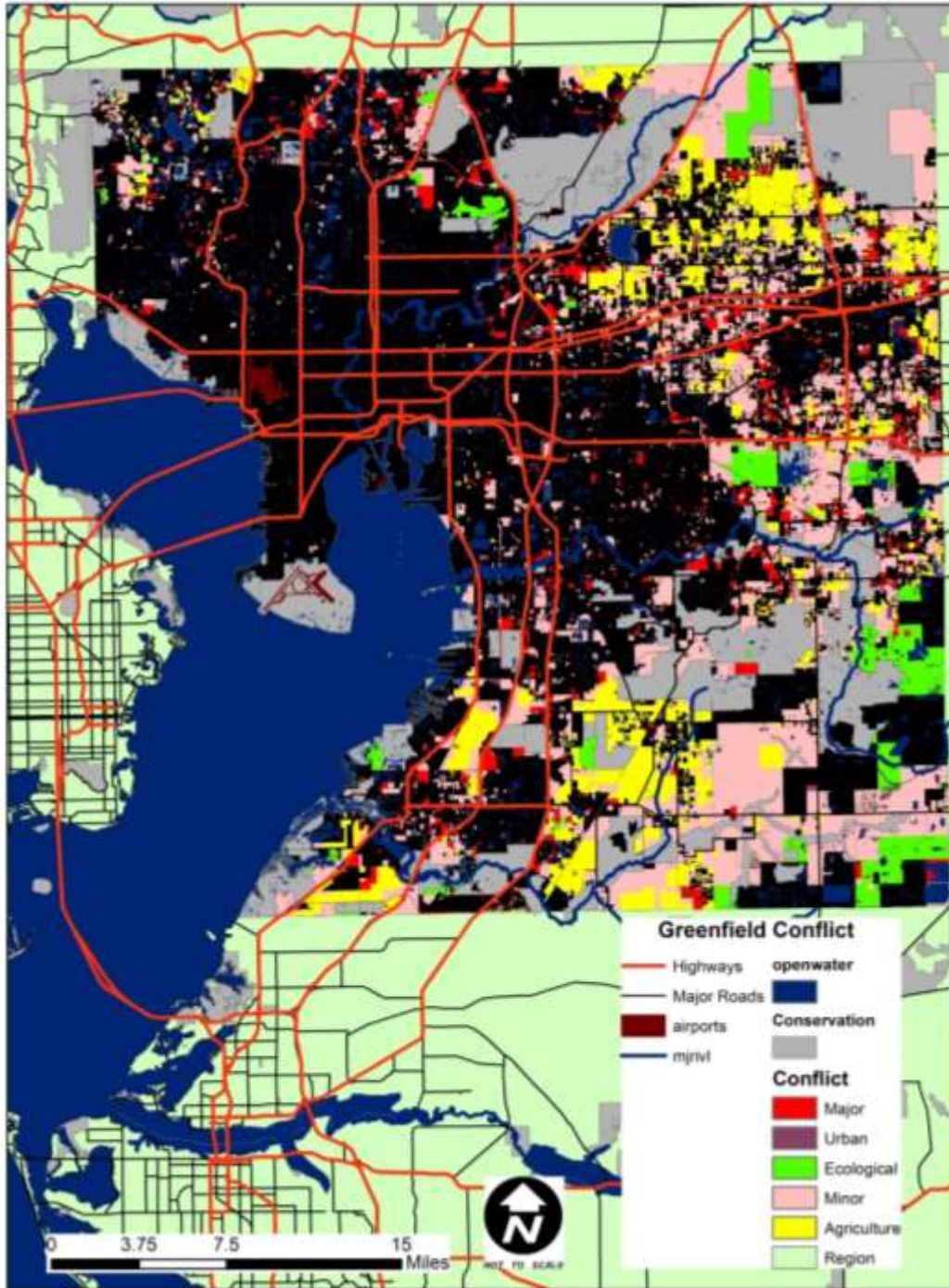


Figure C - 30: Hillsborough County Greenfields Conflict/Preference Map (Source: UF GeoPlan Center)

Within the Greenfields Conflict/Preference Map for Hillsborough County (Figure C-30), the black area shows existing urban/suburban uses; the red area indicates LUCIS major land use conflict and the pink area indicates LUCIS minor land use conflict. The yellow area is preferred for agricultural use, while the light green area indicates locations preferred as ecologically significant. Conservation areas (gray) are locations withheld from development. The brown area is identified as preferred for urban uses.

The LUCIS Model: Scenario Allocations

It is important to understand the schema for both Greenfields conflict and Redevelopment Mixed-use because it plays a major role in the location of future land use for transit. The process for Mixed-use opportunity or Redevelopment preference follows the same concept as Greenfields conflict and produces 27 categories for urban mixed use redevelopment opportunity (Table C-9). Again following the same numeric schema, the first digit is commercial use, the second digit is multi-family use and the third digit is retail/service use. Therefore, a mixed use opportunity number of 223 indicates moderate preference for commercial and multi-family and high preference for retail/service use. While the general LUCIS land use conflict (for the three major use categories) is used for Greenfields land use allocations, the LUCIS mixed use redevelopment opportunity is used for urban redevelopment. In Table C-9, the 27 LUCIS Redevelopment opportunity/preference categories describe the combination for the level of preference for commercial, multi-family, and retail/service uses.

Mixed Use Opportunity Number	Description
111	Low preference for all three mixed-uses categories
112	Moderate retail preference
113	High retail preference
121	Moderate multi-family preference
122	Moderate multi-family and retail preference
123	High retail and moderate multi-family preference
131	High multi-family and moderate retail preference
132	High multi-family and moderate retail preference
133	High multi-family and retail preference
211	Moderate commercial preference
212	Moderate commercial and retail preference
213	High retail and moderate commercial preference
221	Moderate commercial and multi-family preference
222	Moderate preference for all three mixed-uses categories
223	High retail and moderate preference commercial and multi-family
231	High multi-family moderate commercial preference
232	High multi-family and moderate preference retail/commercial
233	High multi-family and retail with moderate commercial preference
311	High commercial preference
312	High commercial and moderate retail preference
313	High commercial and retail preference
321	High commercial and moderate multi-family preference
322	High commercial and moderate preference retail/commercial
323	High commercial and retail with moderate multi-family preference
331	High commercial and multi-family preference
332	High commercial and multi-family with moderate retail preference
333	High preference all three mixed-uses categories

Table C - 9: LUCIS Redevelopment Opportunity/Preference Categories
 (Source: UF GeoPlan Center)

Allocating Land Uses and Population

The process for allocation of land uses and population begins with residential development and uses three “Criteria Evaluation Matrices” (CEM) raster layers.

The three CEM raster GIS data layers are;

- (1) Greenfields,
- (2) Infill and
- (3) Redevelopment.

Greenfields

The Greenfields CEM is used for new residential development primarily in existing open spaces. So Greenfields development is for new development on land not categorized in the property appraiser’s files for residential use.

Infill

The Infill CEM is used to allocate new residential use on lands categorized in the property appraiser’s files as vacant residential. Vacant residential land is platted and zoned for residential use and requires no new permitting. Also vacant residential land is generally readily available for use and has existing infrastructure support and accessibility.

Redevelopment

Finally, the Redevelopment CEM is use to redevelop existing land in new or higher density uses. Redevelopment requires that the structure be removed and replaced with a new structure. For example a commercial building may be replaced with a new mixed-use structure with commercial and multi-family uses, thereby increasing residential density while maintaining commercial uses.

Given those three basic assumptions residential development was allocated to accommodate the increase in population for Hillsborough County, Florida from 2015 to 2045 of 711,210 persons. The population distribution placed 248,924 persons in urban redevelopment, 227,580 persons in existing infill opportunities, and 234,706 in Greenfields development.

All three types of residential allocation were within some or all of the transit stations identified for the three proposed BTL transit networks.

The Criteria Evaluation Matrix

The LUCIS allocations are completed using a structured methodology for allocating residential population and employment spatially within a complex raster called a “CEM”. A CEM is constructed by combining multiple raster layers into a complex raster containing multiple variables which describe uses for each individual cell in the layer. The process begins by combining **conflict or opportunity information** generated using the LUCIS process.

The next portion of the CEM has **location variables**. Examples for location include the influence boundaries for the new transit stations, census block group identifiers, transportation analysis zone identifiers, city boundaries, zoning classifications, property parcel identifiers and areas identified as urban, transitional, or rural. The third portion of the CEM contains **joined information** like future land use unit density, average household size, property structure information like year built and parcels market value, as well as parcel use codes. Joined information is additional data that is added to assist in identifying each cell’s value for land use allocation. Finally the CEM has information that assists with **allocations based upon policy**. For example a policy that stipulates increased unit density above the existing future land use unit density because of proximity to a transit station, or proximity to city centers, economic development zones, and areas designated for increased unit density not within proposed transit stations.

The flexibility of using the LUCIS CEM is it has spatial locations because of GIS and a spreadsheet structure that allows complex query based upon the LUCIS conflict, LUCIS location data, the additional joined information, and policy information. Those complex queries inform the selection (spatial locations) of raster cells for future allocations of residential development and employment opportunity.

The joined information such as average household size for each census block group (2010) can be employed to calculate the allocation opportunity (people per unit). Spatially, that means that each block group or TAZ combined with LUCIS conflict criteria in the CEM has a potential number of residential units and a potential residential population and employment that may be allocated to the area. The next step is simply to make a decision (a structured sequential query) within the CEM identifying the areas that best support development and then to allocate the necessary number of residential units and jobs.

Finally, the CEM also allow the LUCIS modeler to **summarize allocations** by transportation analysis zones (TAZ), census block groups (CBG), city boundaries and other spatial destinations like transit stations, or specific economic zones. These sub areas typically have multiple allocations of residential population and employment. Therefore summaries for sub areas or multiple overlapping political boundaries can be accomplished easily and without needing to redefine or reorganize multiple areas in political units.

Population Projection

Residential population projections were taken from the TAZ data.

Year	Population	Range Change
2006	1,150,538	0
2010	1,223,483	72,945
2015	1,314,663	164,125
2025	1,497,025	182,362
2035	1,679,387	182,362
2045	1,861,748	182,362

Table C - 10: Population Projections Used for The LUCIS Land Use Modeling (Source: UF GeoPlan Center)

As Figure C-31 indicates the population projections are linear. The residential population allocations lag below the projections for the years 2015 and 2025 primarily to take into account the significant decrease in population growth because of the economic downturn. That was a decision made by the LUCIS modeling team and presented a more conservative allocation in the years from 2010-2015 and 2015-2025. Ultimately the population projections were allocated within the error of the allocation techniques (the final allocation was approximately 2,500 persons lower than the projections) which is an allocation error of 0.13 percent.

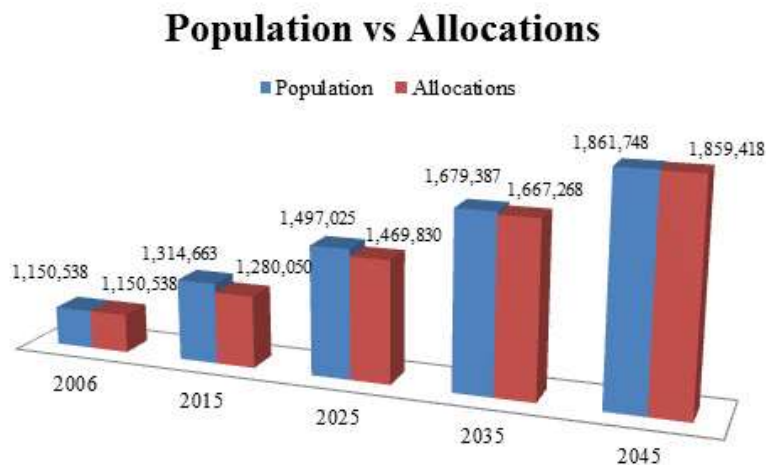


Figure C - 31: Population Projections with Allocations (Source: UF GeoPlan Center)

Residential Redevelopment Allocation

In this section the residential redevelopment allocations are briefly described. This example was chosen because it explains the process and is of greater interest to this project than are the Greenfields and infill residential development allocations. Also the residential redevelopment allocation leads into the second example allocation - the redevelopment employment mixed-use allocations.

Redevelopment population allocations were based upon the following allocation assumptions: 1) that the redevelopment portion of total residential population change was 35 percent, 2) that the infill proportion of total residential population change was 40 percent, and 3) the Greenfields proportion of total residential population change was 25 percent. A ten year analysis of the property appraisal data from 1995 to 2005 provided the proportions. That ten year increment was selected because the population projections provided were from the TAZ data for the years from 2006 to 2049.

Again remember redevelopment results in a change for the existing land use. Infill development resulted in a change in land use for property parcels identified as vacant residential to property identified as residential with a residential structure. Finally, Greenfields development was identified as property that changed from existing open space such as agricultural use to residential use.

Residential Redevelopment Mixed Use

Residential redevelopment mixed use allocation (Figure C-32) uses the redevelopment CEM structure. Residential redevelopment is completed for 2015, then 2025, next 2035, and finally for 2045. The process begins by querying the LUCIS residential redevelopment mixed use opportunity in the redevelopment CEM, followed by the year built for structures greater than 40 years old, the land value less than median value, the location near Tampa city center, the proximity to transit stations, and redevelopment locations within the county's city boundaries. Finally the process utilizes areas identified within economic development zones.

The allocation query chooses the highest preference areas using a sequential query that loops through the process until the required population allocation for 2010-2015 is attained. Once the allocation selections are completed for 2010-2015 the process moves to allocation for 2015-2025. The redevelopment CEM variable identifies the decade the residential redevelopment allocations occurred. The process continued using the same conceptual query with the addition requirement that no location already chosen can be allocated for the next decade. As a result no residential allocations for the decade from 2015-2025 would be allocated for residential development during the period from 2022-2035.

Residential Greenfields

Residential greenfields allocation (within Figure C-32) uses the LUCIS Greenfields conflict described in Table C-8. The allocation process is again a sequential process much like the redevelopment mixed use residential allocation. The process uses LUCIS conflict, proximity to urban areas, areas identified as urban transitional by the county planning department, and proximity to employment centers. The process also placed high preference on areas within transit stations that also had Greenfields development opportunities in the Greenfields CEM.

Residential Infill

Residential infill allocations (within Figure C-32) works slightly differently than the redevelopment or Greenfields allocations. Infill allocations do not utilize the Table C-8 conflict categories because the areas have already been identified in the future residential land use by the county, or are zoned as available for future residential use. Therefore LUCIS infill allocations use the single family suitability and multi-family suitability raster layers to determine the highest available suitable vacant residential properties. Once again preference for locations within transit station areas were accommodated but not to the exclusion of properties external to those locations with higher residential suitability.

Final Residential Allocation Map 2015-2045

The residential allocation map (Figure C-32) shows all residential land use allocations for the period from 2015-2045.

As shown in Figure C-32, the residential allocations are complex. The high density residential mixed use development is shown in yellow. The infill allocations occupy areas that are already in the county's future land use plan and are the orange shaded areas. Greenfields residential development is on newly developed open space such as existing agricultural lands and is shaded olive green.

The brown circular areas are the parcel boundary lines within 1-quarter, 1-third, 1-half, and 3 miles of station centers. The yellow shaded areas are the redevelopment residential population allocations (approximately 123,000 dwelling units) and were allocated using the highest unit densities (units per acre). The black shaded areas are part of the LUCIS redevelopment opportunity area (the CEM). It should be noted that the black redevelopment areas are also available for employment allocation (which will be shown in the employment map).

Also please note a clear indication that there is some remaining capacity for residential high density development beyond that allocated. The light blue points are the station locations and clearly indicate overlapping station areas (station parcels) for the proposed routes. Finally the orange areas are the infill residential allocations areas (approximately 91,000 dwelling units) and the olive green areas are the Greenfields residential population allocations (approximately 68,000 dwelling units). Therefore the high density residential redevelopment allocations occupy approximately 32 percent of the newly proposed residential development.

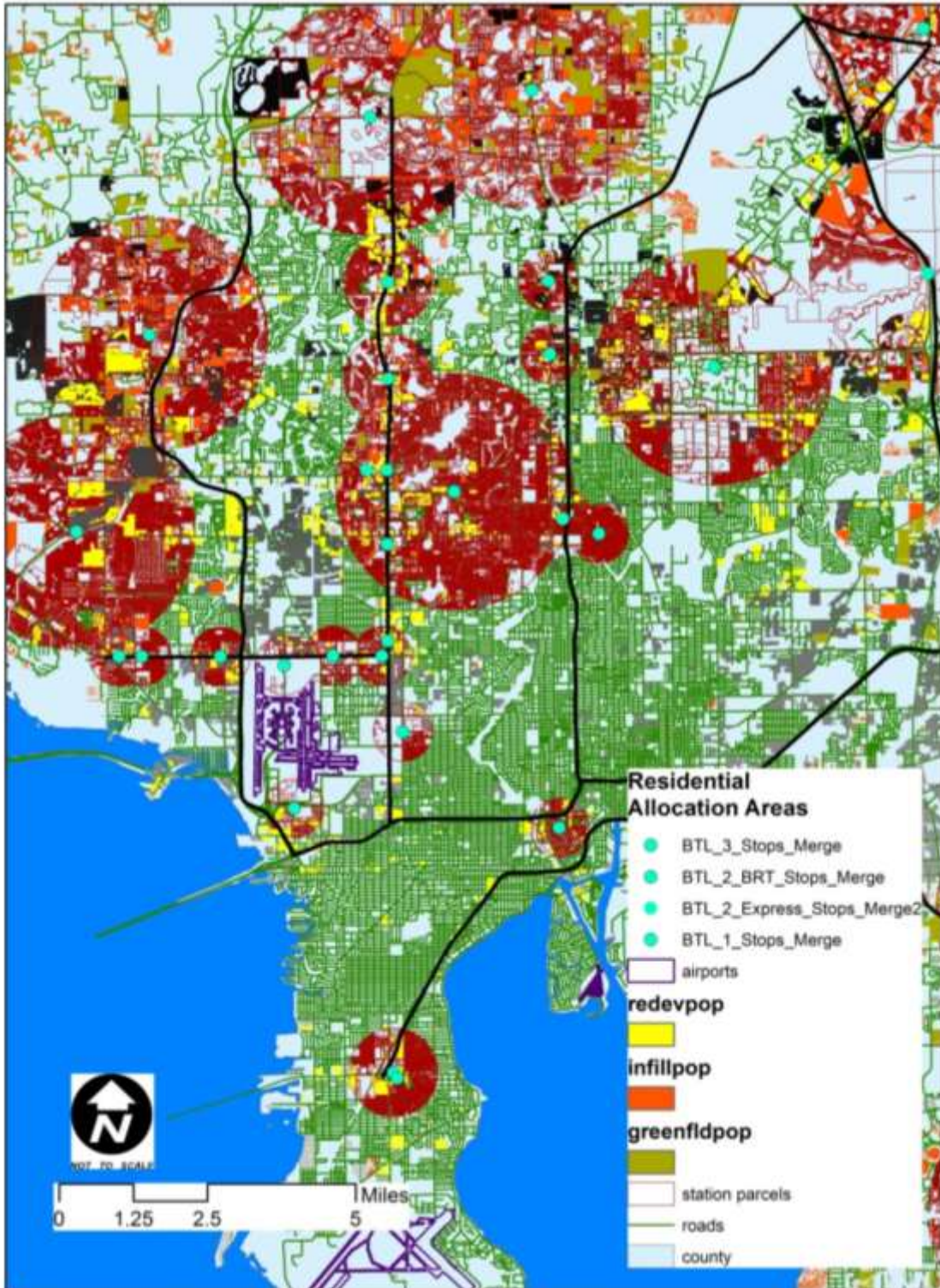


Figure C - 32: Residential Allocations (Source: UF GeoPlan Center)

Redevelopment Mixed Use Employment Allocation

The redevelopment mixed use employment allocations are shown in the employment maps and indicate the spatial locations of the commercial, service, and industrial employment. The redevelopment mixed use employment example was chosen because it explains the process and is of greater interest for this project than are the Greenfields or infill employment allocations. Again Appendix A contains a description of the redevelopment, infill, and Greenfields CEM(s) schemas. Appendix C shows the employment projections for Hillsborough County, as well as the redevelopment, infill and Greenfields portions for those allocations.

Commercial Employment

Commercial employment allocation is accomplished using a similar sequential process as explained for residential redevelopment allocation. Commercial employment also uses the redevelopment, infill, and Greenfields CEM(s) for employment allocations. For redevelopment commercial employment we again look for the highest preference for commercial mixed use opportunity then for high preference commercial-only opportunity. The transit stations are once again preferred because of policy to develop TOD opportunities within the transit station areas.

The employment allocation process sequences by decade for 2010-2015, then 2015-2025, followed by 2025-2035, and finally 2035-2045 until the total project employment has been allocated. The individual CEM(s) contain regional and local commercial and service employment densities. Employment densities were calculated by identifying land use classifications that fit the North American Industry Classification System (NAICS) Employment Codes for the region and dividing the employment by category by the total acreage per category.

As shown in Figure C-33, the commercial regional and local use allocations are complex. The redevelopment commercial allocation is shown in yellow. The infill commercial allocations occupy areas that are already in the county's future land use plan or property appraiser vacant commercial use category. Greenfields commercial development is on newly developed open space perhaps in existing agricultural lands.

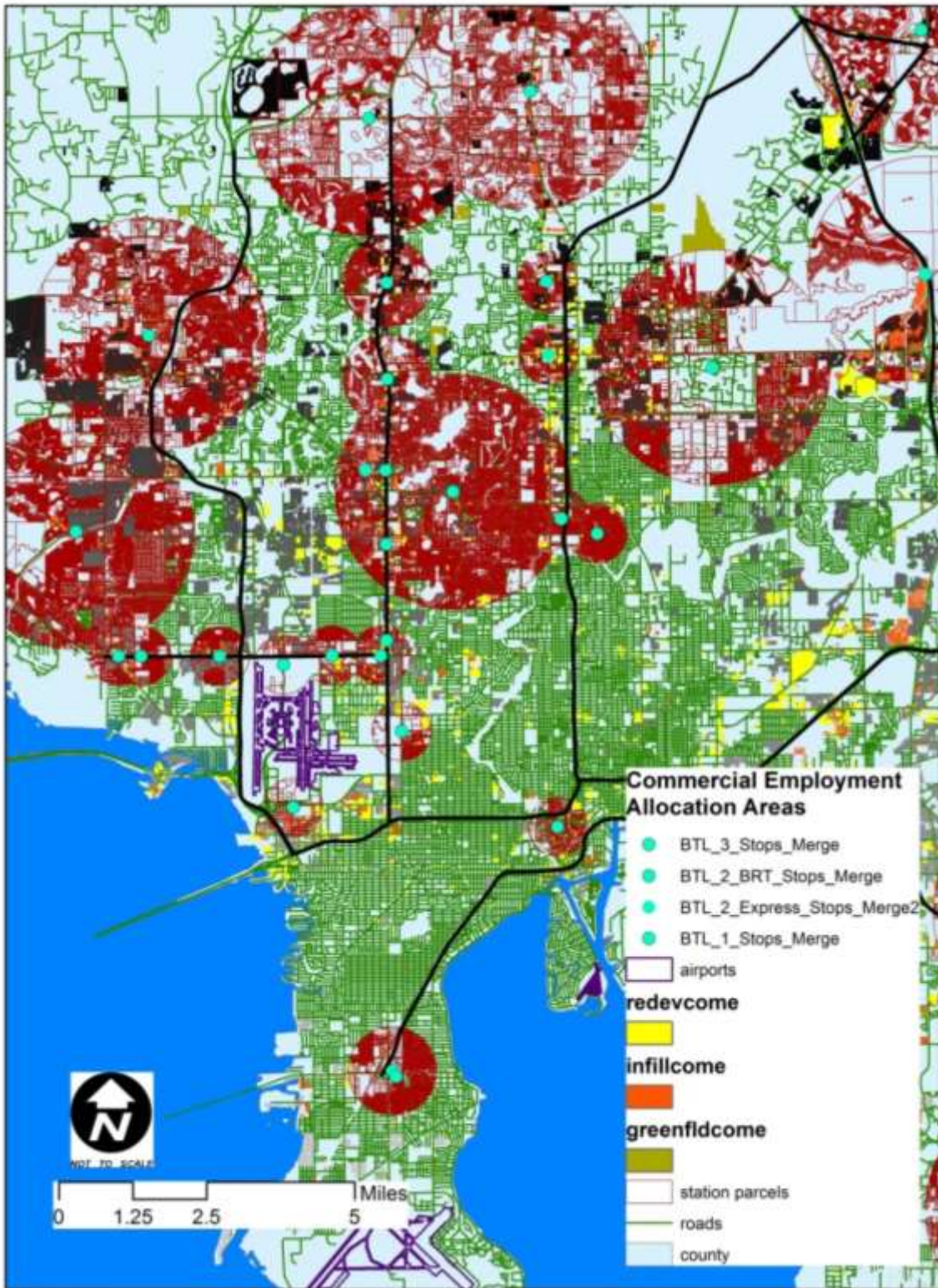


Figure C - 33: Commercial Employment Allocations (Source: UF GeoPlan Center)

Service Employment

Service employment allocation is accomplished following the same process as commercial but utilizes different redevelopment opportunity, infill parcels, and Greenfields conflict. The infill parcels use both vacant commercial and vacant institutional properties while sequentially selecting the highest service suitability cells.

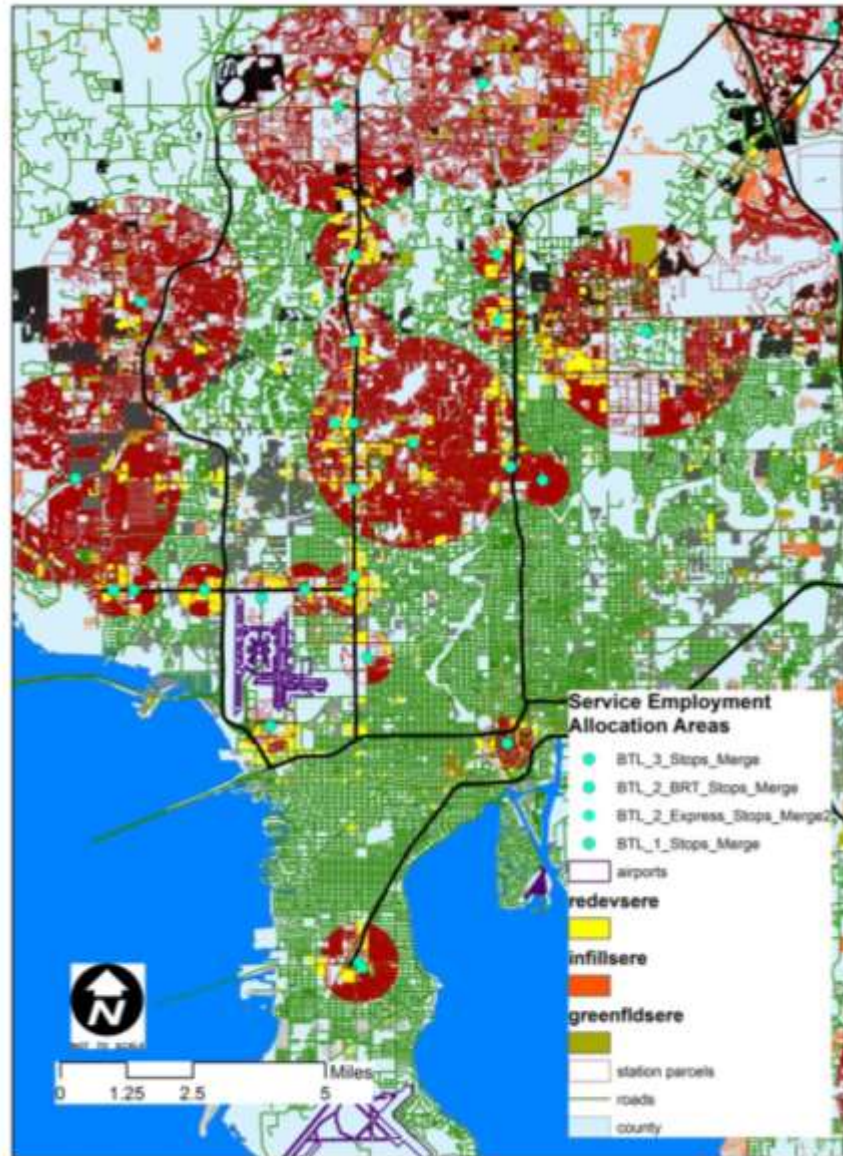


Figure C - 34: Service Employment (Source: UF GeoPlan Center)

The service regional and local use allocations are complex. In Figure C-34, the redevelopment commercial allocation is shown in yellow. The infill service allocations occupy areas that are already in the county's future land use plan or property appraiser vacant commercial or institutional use categories. Greenfields service development is on newly developed open space perhaps in existing agricultural lands.

Industrial Employment

Industrial employment allocation again follows the same process sequential infill and Greenfields conflict. However with industrial infill the process only looks at vacant industrial parcels. In Greenfields industrial employment allocation the process finds areas of high urban preference with highest industrial suitability.

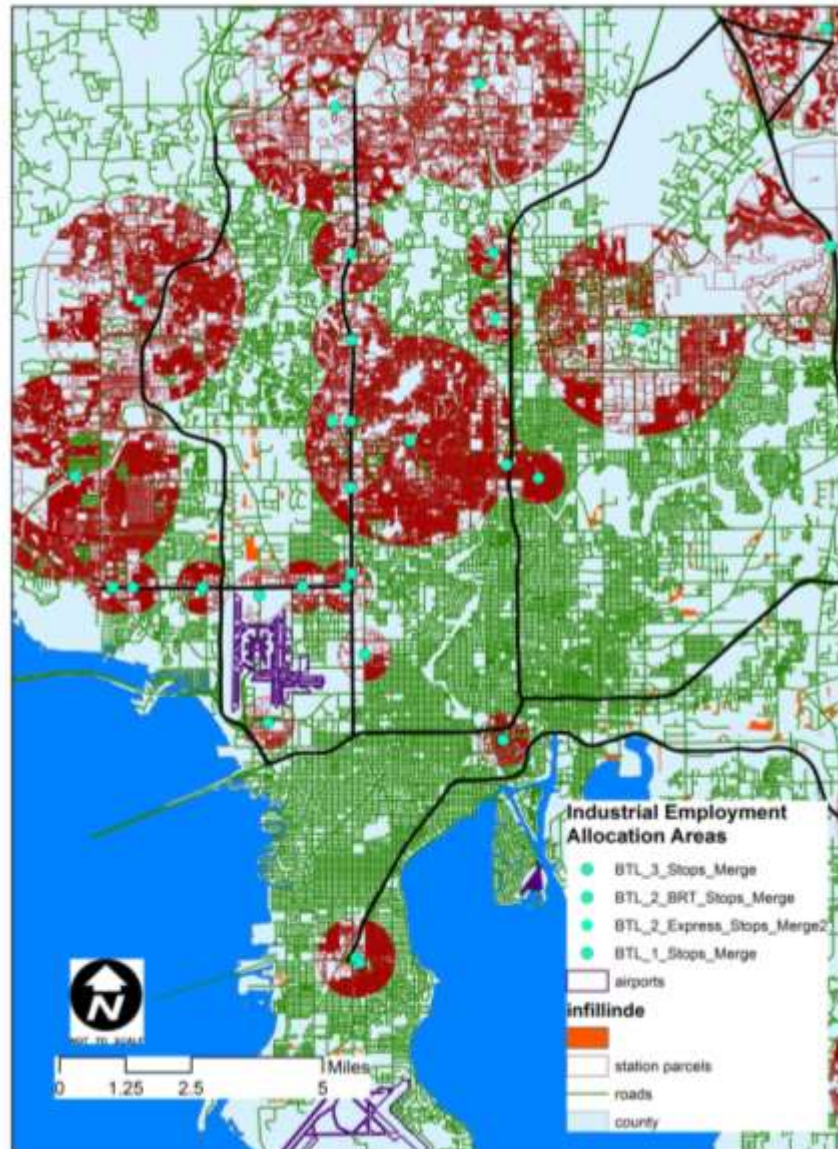


Figure C - 35: Industrial Employment Allocations (Source: UF GeoPlan Center)

As shown in Figure C-35, the industrial use allocations are not as complex. Industrial employment allocations were accommodated within the infill allocations. Essentially the county has enough industrial lands allocated to accommodate the projected industrial employment.

Combined Residential and Commercial Land Use

Figure C-36 shows all new development both residential and employment. The dark brown circles represent the transit oriented development areas formed around the center of the BTL transit stations with the size of the circle based on the types of transit stations and stops. Within the circles, the yellow areas are new urban redevelopment, the orange areas are new infill development, and the olive green areas are new greenfield development. The dark brown area is remaining development capacity, clearly indicating the opportunity to increase urban density and to increase transit opportunities for the proposed transit stations.

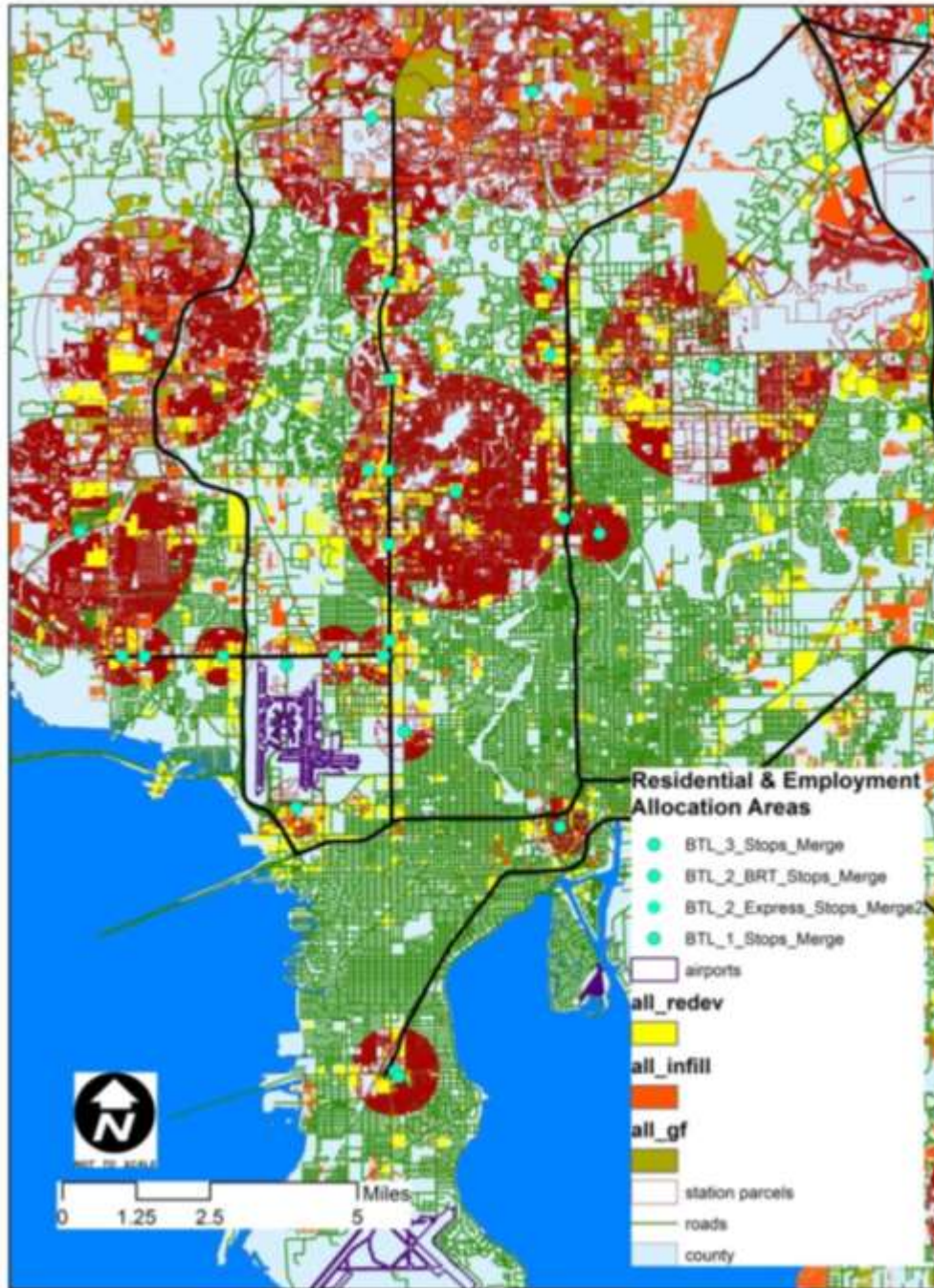


Figure C - 36: Combined Residential and Commercial Allocations
 (Source: UF GeoPlan Center)

4. Phase 2: Travel Demand Modeling

During the development of the UF land use, population and employment projections, the TBRTM model was coded for the highway and transit networks based the information from the study team review meeting that revised the routing and configuration of the BTL alternatives as identified in the scope and as represented in the earlier unconstrained scenarios.

Initial transit network definitions were obtained for coding and details for the land-use input requirements and formats for the TBRTM were finalized with UF to facilitate integration of the revised BTL land use inputs. A modeling and land-use team meeting was held review the land use modeling inputs and the coding details of the three BTL network scenarios to ensure the proper integration of the LUCIS information with the TBRTM model.

In addition, several corrections, modifications and additions to the network maps provided were provided by the study team. UF also provided Hillsborough county zonal data in a geodatabase for the years 2006, 2015, 2025, 2035 and 2045. For the overall county, the UF forecasts were found to be marginally lower than the regional forecasts.

The 2025, 2035 and 2045 regional land-use files were generated by merging the revised Hillsborough county data with land-use data for other counties from the 2025 TBRPM and the 2035 TBRTM datasets. For the year 2045, Renaissance Planning Group's (RPG) forecasts for the years 2035 and 2049 were used to compute the land use for other counties.

BTL Network Modeling

The highway and transit network for all the three BTL networks for the year 2035 was then prepared. These networks were also used for 2045 because both TBRTM and TBRPM do not have a network representation for the year 2045. A semi-automated approach was developed by prepare the 2025 TBRTM highway networks for the three BTL scenarios from the source 2025 TBRPM highway networks.

For the transit networks, BTL stop and route location maps were provided by the study team as shown on Figures C-22 through C-25. The service frequency assumptions for the BTL routes approximated existing HART express bus and BRT routes for Hillsborough County (between 30 and 45 minutes for the peak periods and over two hours for the off-peak period). The BTL routes were also modeled with a premium fare rate and in several cases there was a bus rapid transit (BRT) line available on a nearby parallel roadway. For these first transit runs, the background transit service was kept constant for each of these years to better track the impact of land use and highway network changes.

Based on the assumptions regarding bus routes, fares and service levels provided by the study team, the information was integrated into the modeling process and the three BTL scenarios, two land-use scenarios, and four time-of-day periods for three analysis years were modeled (72 model runs). For these runs, a fixed toll rate of \$0.15/mile was used on the BTLs for all of the analysis years. This rate was consistent with the existing toll rates on the Selmon Expressway.

The results from the second round of forecasts were summarized and presented to the study team in order to refine the analysis assumptions for input to the final round of model runs. These runs identified two major issues with the original BTL analysis assumptions. (1) the BTL links attracted more traffic than they could handle based on the minimum speed criteria of 50 mph and (2) transit ridership appeared unexpectedly low.

The V/C ratios on the several BTL links in the year 2045 were found to be very high which consequently brought down their operating speeds as low as 20 mph. The fact that V/C ratios were high was not a surprise considering the initial runs used a fixed toll rate at current levels. What was surprising was the magnitude of the demand at that toll rate. This issue only confirmed the desirability of variable pricing as the solution for the final model runs

The second issue was that the transit ridership seemed extremely low, in some cases as low as 5 to 10 passengers in the entire off-peak period. The low transit ridership was partly attributed to the low speeds on the BTL facilities (created by the high V/C ratios), but the more significant factors were found to be the service frequency assumptions for the BTL routes, the premium fare rates and the competing BRT routes in some of the BTL corridors.

As a consequence of the low transit ridership estimates for the three BTL alternatives, an additional task was added to the study to evaluate how the regional travel model would respond to more highly favorable transit scenarios.

To better understand the possibilities for transit, these forecasts were designed to maximize transit ridership by providing frequent service, zero fares, and free flowing BTL facilities with high tolls. These runs were made using the Tampa Bay Regional Transit Model (TBRTM) and the land-use data provided by the University of Florida for the year 2045 for all three BTL networks.

Revised Transit Modeling

As part of this effort, a thorough review of the transit network coding and the support files used by the TBRTM mode choice model was undertaken. A few cases were identified where an additional stop could be added to a route to provide better access to a park-&-ride facility or to facilitate transfers to other routes. Additional stops were added to the routes in downtown Tampa to support additional walk access and transfer opportunities.

The walk and drive links automatically generated by the model and the percentage of each zone with walk access to transit were also evaluated. For a number of suburban zones the percent walk to transit was quite small and the walk distances from the relatively large zones to the BTL stops were quite long. The TBRTM model also limited the distance a person can drive to a park-and-ride lot within Hillsborough County.

Since walk or drive accessibility at both ends of a trip are critical for transit trips, the path traces from a wide variety of origins and destinations were examined to confirm that logical paths could be built using the network. There were a number of places served by BTL routes where paths were difficult to build due to walk access distances.

One point of some importance is that the TBRTM 2035 TSM alternative formed the base network for the BTL study. This network includes a light rail line to the Airport and bus rapid transit lines on Nebraska and Selmon Expressway. These routes were attracting significant ridership and competing with BTL routes.

Based on the results of these examinations of the existing TBRTM and the overall network coding, three maximum transit tests were performed. These tests included the following assumptions:

- **Transit Maximizing Run #1**
 - The choice set mode choice methodology (the “Charlotte” method) that attracts additional ridership to “premium” modes;
 - \$1/mile BTL toll rates to keep the BTL speeds high for buses while increasing congestion and reducing speeds on non-BTL facilities;
 - Zero transit fares for all transit routes in the region;
 - 15 minute headways for all non-BTL routes; and
 - 5 minute headways for all BTL routes.
- **Transit Maximizing Run #2**
 - Same as Run #1, and
 - 100% percent walk assumed for all zones.
- **Transit Maximizing Run #3**
 - Same as Run #2, and
 - BTL route modes changed from express bus to in-street BRT.

The first run represents the specifications outlined at the team meeting on September 14th. The second run attempted to compensate for the walk access distances by increasing the overall walk accessibility of each zone. The third run attempted to attract more riders to the BTL routes by taking advantage of the premium mode bias factors built into the mode choice model.

BTL Route and Ridership Summaries

The summaries shown in Tables C-11 through C-13 list the routes and the ridership estimated by the maximum transit runs in BTL Networks #1, #2 and #3 respectively. The tables also include the existing ridership for express bus routes that were re-routed onto BTL facilities.

The results for BTL Network #1 show a low of 9,185 riders per day for maximum transit run #1 to a high of 20,582 riders per day when the BTL routes are classified as premium modes. This is an increase of 180 to 530 percent over the existing express bus routes serving these corridors.

Bus Toll Lane Network Alternative 1 Existing Ridership Summary			Estimated Model Daily Riders		
Corridor	Existing Express Route #	Average Weekday Boardings**	Transit Maximizing Run 1	Transit Maximizing Run 2	Transit Maximizing Run 3
Apollo Beach/Gibsonton to MacDill		N/A	178	182	385
Brandon to Westshore		N/A	47	51	209
Northwest County to Westshore		N/A	3	3	54
North Brandon to MacDill		N/A	201	204	463
Lutz Express	20	68	98	104	363
Dover - Brandon Express	22	60	704	708	1,650
Fishhawk-Riverview-MacDill	24	115	488	497	1,053
Bradon-MacDill	25	148	877	916	2,096
Fishhawk-South Brandon	27	123	713	721	1,450
East County	28	34	299	302	887
Brandon-Southshore	35*	15	296	353	709
Southshore Limited	47	85	60	66	201
Citrus Park-Carrollwood	50	45	82	81	196
New Tamp-Pasco	51	45	131	136	574
Oldsmar-Town 'n' Country	59*	47	845	890	1,961
Clearwater Express	200	97	202	217	546
PSTA 100X	100X***	207	2,118	2,181	4,428
PSTA 300X	300X***	149	1,148	1,203	1,830
MetroRapid - Hillsborough Ave		2,045	695	703	1,527
Northwest Limited Express (#)	61	42	152	155	568
Total		3,283	9,185	9,518	20,582
*Terminated by HART on July 10, 2011; ridership reflects average weekday boardings from 10/10 - 02/11.					
**Reflects the existing express route stop APC boarding data collected in 11/2011.					
***Reflects PSTA 100X and 300X average weekday boardings for FY 2011					
#) Also part of this alternative					

Table C - 11: BTL Network #1 Ridership Estimates (Source: AECOM)

BTL Network #2 estimated 13,990 daily riders for maximum transit run #1 and 21,580 daily riders for the premium mode alternative. This is an increase of 170 to 322 percent over the existing express bus routes serving these corridors.

Bus Toll Lane Network Alternative 2 Existing Ridership Summary			Estimated Model Daily Riders		
Corridor	Existing Express Route #	Average Weekday Boardings**	Transit Maximizing Run 1	Transit Maximizing Run 2	Transit Maximizing Run 3
New tampa-Westshore		N/A	204	220	426
Brandon to Westshore		N/A	82	86	160
Northwest County to USF		N/A	271	294	438
Northwest County to Westshore		N/A	147	159	22
USF to Westshore		N/A	160	166	450
North Brandon to MacDill		N/A	367	373	1,172
Lutz Express	20	68	1,143	1,194	1,596
Dover - Brandon Express	22	60	657	663	818
Fishhawk-Riverview-MacDill	24	115	267	272	430
Bradon-MacDill	25	148	506	539	794
Fishhawk-South Brandon	27	123	652	661	786
East County	28	34	186	188	554
Brandon-Southshore	35*	15	1,042	1,120	656
Southshore Limited	47	85	104	109	92
Citrus Park-Carrollwood	50	45	666	677	1,546
New Tamp-Pasco	51	45	138	142	670
Oldsmar-Town 'n' Country-Alt1	59*	47	475	500	756
Oldsmar-Town 'n' Country-Alt2	59*	47	752	823	2,030
Northwest Limited Express	61	42	192	194	642
Clearwater Express	200	97	205	222	224
PSTA 100X	100X***	207	2,378	2,437	928
PSTA 300X	300X***	149	1,142	1,193	410
MetroRapid - Hillsborough Ave		2,045	668	679	1,446
MetroRapid - Dale Mabry Hwy		1,804	1,586	1,627	4,534
Total		5,176	13,990	14,538	21,580

*Terminated by HART on July 10, 2011; ridership reflects average weekday boardings from 10/10 - 02/11.
 **Reflects the existing express route stop APC boarding data collected in 11/2011.
 ***Reflects PSTA 100X and 300X average weekday boardings for FY 2011

Table C - 12: BTL Network #2 Ridership Estimates (Source: AECOM)

BTL Network #3 estimated 10,355 riders per day for the run #1 and 23,032 riders per day for the premium mode test. This is an increase of 720 to 1,700 percent over the existing express bus routes serving these corridors.

Bus Toll Lane Network Alternative 3 Existing Ridership Summary			Estimated Model Daily Riders		
Corridor	Existing Express Route #	Average Weekday Boardings**	Transit Maximizing Run 1	Transit Maximizing Run 2	Transit Maximizing Run 3
New Tampa-Westshore		N/A	82	87	237
Brandon to Westshore		N/A	5	5	75
Northwest County to USF		N/A	199	214	430
Northwest County to Westshore		N/A	366	381	704
USF to Westshore		N/A	117	120	479
North Brandon to MacDill		N/A	395	400	840
Lutz Express	20	68	582	633	1,050
Dover - Brandon Express	22	60	623	631	1,595
Fishhawk-Riverview-MacDill	24	115	257	262	587
Bradon-MacDill	25	148	588	633	1,480
Fishhawk-South Brandon	27	123	621	632	1,397
East County	28	34	216	221	860
Brandon-Southshore	35*	15	272	307	514
Southshore Limited	47	85	59	63	193
Citrus Park-Carrollwood	50	45	603	606	1,233
New Tamp-Pasco	51	45	505	516	936
Oldsmar-Town 'n' Country	59*	47	371	428	1,601
Northwest Limited Express	61	42	343	348	1,138
Clearwater Express	200	97	246	265	651
PSTA 100X	100X***	207	2,618	2,667	4,927
PSTA 300X	300X***	149	1,287	1,340	2,105
Total		1,280	10,355	10,759	23,032

*Terminated by HART on July 10, 2011; ridership reflects average weekday boardings from 10/10 - 02/11.
 **Reflects the existing express route stop APC boarding data collected in 11/2011.
 ***Reflects PSTA 100X and 300X average weekday boardings for FY 2011

Table C - 13: BTL Network #3 Ridership Estimates (Source: AECOM)

Phase 2 Modeling Conclusions

Tolled Guideway and Impact of Transit Oriented Development (TOD)

The second round of modeling indicated strong demand from toll payers for access to higher levels of service during the peak hour operation of the BTL guideways.

The alternative UF TOD land-use scenario resulted in a reduction in vehicle trip demand of as much as 10-20% and significant increases in transit demand (as shown above) over the existing MPO land-use because of the more compact, higher densities of the UF mixed-use approach. It was therefore decided to use the UF land-use future with the lower trip demands for the final model runs in Phase 3 thus making the toll revenue outcome more conservative.

Transit Ridership

Increasing the level of service and reducing fares attracted significant transit ridership to BTL routes. The greatest increase, however, was found in the way the BTL routes were branded. The ridership more than doubled when the bus routes were re-classified from express bus to in-street BRT routes. This ridership increases further if the routes are properly classified as fixed-guideway BRT routes.

What this basically means is that the BTL routes need to be branded and marketed as premium transit modes and that travelers need to perceive them as better or different from local or express bus services to capture significant ridership.

Section D

Phase 3 Study Methodology and Results

Final BTL Networks with Forecasts of Traffic Demand, Ridership, Revenue and Costs

1. Final BTL Study Alternatives

Conceptual Designs

To establish the basis for estimating the costs of construction, final lane configurations were developed for all guideways using the second round of traffic projections combined with final design concepts for each if the corridor connections within the BTL networks. While underpass queue jumps may be advisable in some locations, as previously discussed, due to the conceptual nature of this study, sufficient detail on utility and similar issues was not gathered to determine underpass costs, which can vary widely due to these issues. “Underpass” or “tunnel” has been indicated in locations where this may be particularly desirable, but costs were determined for all locations based on overpass grade separations.

BTL Network #1

The final BTL Network #1 is comprised of the following major elements:

- Veterans Expressway Mainline Limited-Access BTL (Reversible)
- Hillsborough Avenue Arterial Queue Jumps
- Airport to I-275 South BTL Connector (Combination of Arterial and Elevated 2-way)
- I-275 South Mainline Limited-Access BTL (2-way)
- Interchange of I-275 South to Downtown, I-275 North and I-4 (2-way and Reversible)
- I-4 Mainline Limited –Access BTL (Reversible)
- I-4 to I-75 North Connection (Reversible)
- I-75 North Mainline BTL (Reversible)
- I-75 North Connection to New Tampa Boulevard
- I-75 South Mainline BTL (Reversible)
- I-75 South BTL Connection to Selmon Expressway (Reversible)

The guideway termini, access points and lane configurations for the corridors within BTL Network #1 are presented on Figures D-1 through D-11 on the following pages.

Veterans Expressway Mainline Limited-Access BTL (BTL#1)

The Veterans Expressway BTL features a reversible guideway generally within the median. Direct access is provided from the Suncoast Parkway and SR 568 from the north to two BTL lanes.

A set of slip ramps from the outside lanes into the BTL is located south of Gunn Highway where the BTL increases to three lanes. The BTL reversible operations ends north of Hillsborough Avenue where the BTL would transition back to the future configuration within existing FDOT and FTE plans.

An elevated section is identified over the Anderson Road interchange and toll plaza negating the need to rebuild either for the construction of the BTL.



Figure D - 1: BTL#1 Veterans Expressway Mainline BTL (Reversible) Source: Parsons Brinckerhoff

Hillsborough Avenue Arterial Queue Jumps (BTL#1)

Hillsborough Avenue provides enhanced access to the BTL Network #1 by employing a series of grade-separated queue jumps and priority signalization that would significantly increase the flow of traffic on this arterial highway. The queue jumps are located at:

- Sheldon Road
- Hanley Road
- George Road to Hoover Road
- Anderson Road

Special signalization is recommended at Weber Road with a left-turn prohibition.



Figure D - 2: BTL#1 Hillsborough Avenue Arterial Queue Jumps (2-way)
Source: Parsons Brinckerhoff

Airport to I-275 South BTL Connector (BTL#1)

The connection of the Airport to BTL Network #1 is accomplished on the west through an arterial connection to the existing ramps of the Airport Interchange and to the east using a combination of an arterial and then elevated connection to the I-275 South BTL. All of these guideways involve 2-way operations. The key elements include a multi-modal transfer center on the north side of Spruce Street providing direct access and transit exchange into Tampa International Airport. This element is incorporated into the Airport long range plan. Additional at-grade lanes are added to the Spruce Street arterial from the Airport Interchange to west of Westshore Boulevard where a 2-way BTL guideway would be elevated over the Westshore intersection and remain elevated along Spruce Street/Boy Scout Boulevard/Columbus Drive – passing over Dale Mabry Highway and then turning south along the Himes Avenue alignment with an eventual flyover connection to the I-275 South 2-way BTL.



Figure D - 3: BTL#1 Airport to I-275 South BTL Connector (Combination of Arterial and Elevated 2-way) Source: Parsons Brinckerhoff

I-275 South Mainline Limited-Access BTL (BTL#1)

The I-275 South BTL follows the basic alignment defined in FDOT plans for three two-way special use lanes within I-275. The BTL concept provides for access from the elevated connection to the Airport identified in Figure D-4 and for direct access slip ramps from the I-275 South general use lanes west of Himes Avenue.

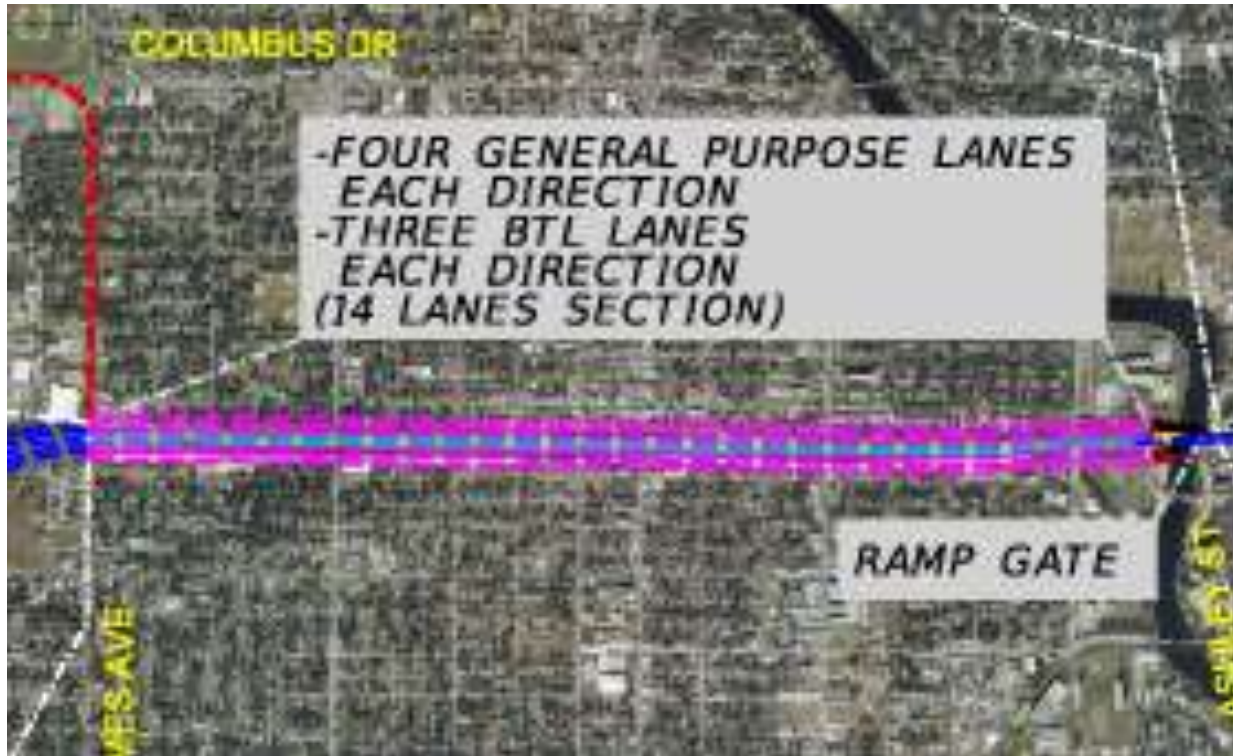


Figure D - 4: BTL#1 I-275 South Mainline Limited-Access BTL (2-way)
Source: Parsons Brinckerhoff

Interchange of I-275 South to Downtown, I-275 North and I-4 (BTL#1)

As shown on Figure D-5, the interchange of the I-275 South BTL for Network #1 with I-275 North and with the I-4 BTL is accomplished mostly on structure. Ramp gates provide protection for the reversible connection from the I-4 reversible BTL to both the I-275 South BTL and to the I-275 north and south general purpose lanes. Access into and out of downtown Tampa from the I-275 South BTL is handled as an underpass connecting directly to Orange Avenue. Access into downtown from I-4 is provided by the I-4/Selmon Connector project that is already under construction.

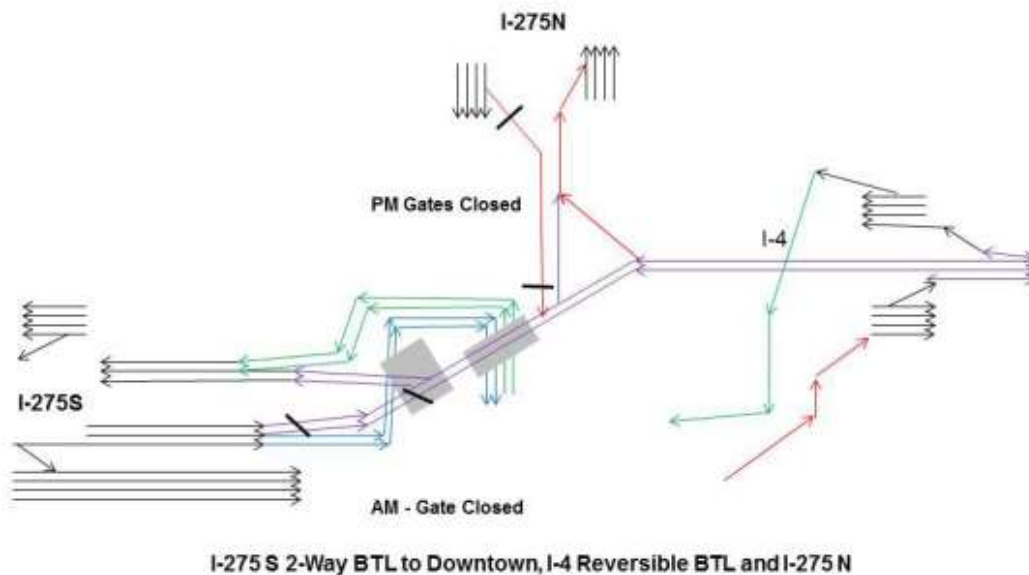


Figure D - 5: BTL#1 Interchange of I-275 South to Downtown, I-275 North and I-4 (2-way and Reversible) Source: Parsons Brinckerhoff

I-4 Mainline Limited –Access BTL (BTL#1)

The I-4 BTL guideway includes three reversible lanes between I-75 and the I-4/Selmon connector and the downtown Tampa interchange between I-275 North and South. Slip ramps to the east of the I-4/Selmon Connector allow traffic to exit to use the connector for direct access to downtown or to use the I-4 general purpose lanes for access to downtown or access to the I-275 north and south general purpose lanes through the downtown junction.

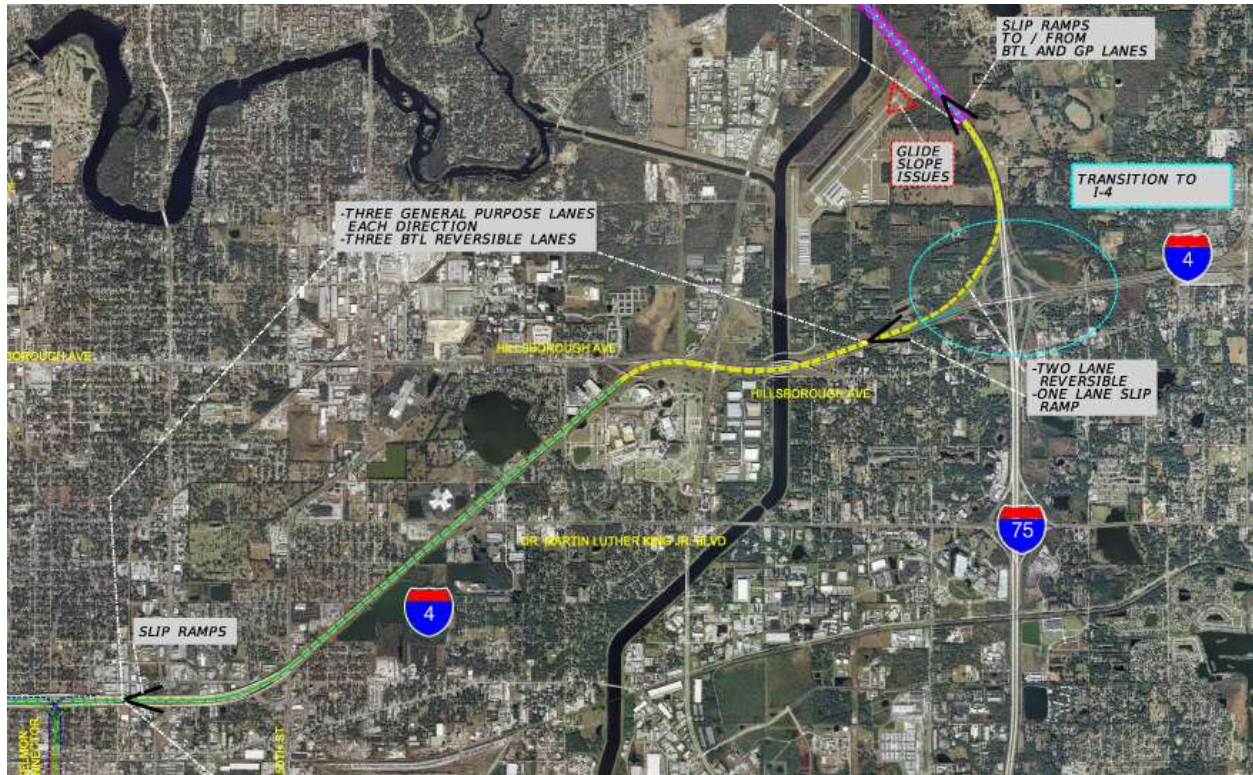


Figure D - 6: BTL#1 I-4 Mainline Limited –Access BTL (Reversible)
Source: Parsons Brinckerhoff

I-4 to I-75 North Connection (BTL#1)

The interchange of the I-4 BTL with the I-75 North and South and I-4 to the east uses the existing I-4/I-75 interchange and a set of slip ramps to provide the required access for all directions. The I-4 BTL guideway is elevated over the interchange and provides a free flow for traffic to and from the I-75 North reversible BTL. Traffic wishing to move between the BTL and the general purpose lanes for I-4 to the west and I-75 to the north would use the slip ramps. Westbound traffic on I-4 wishing to use the I-4 BTL would use the I-4 slip ramps for system entry and exit.



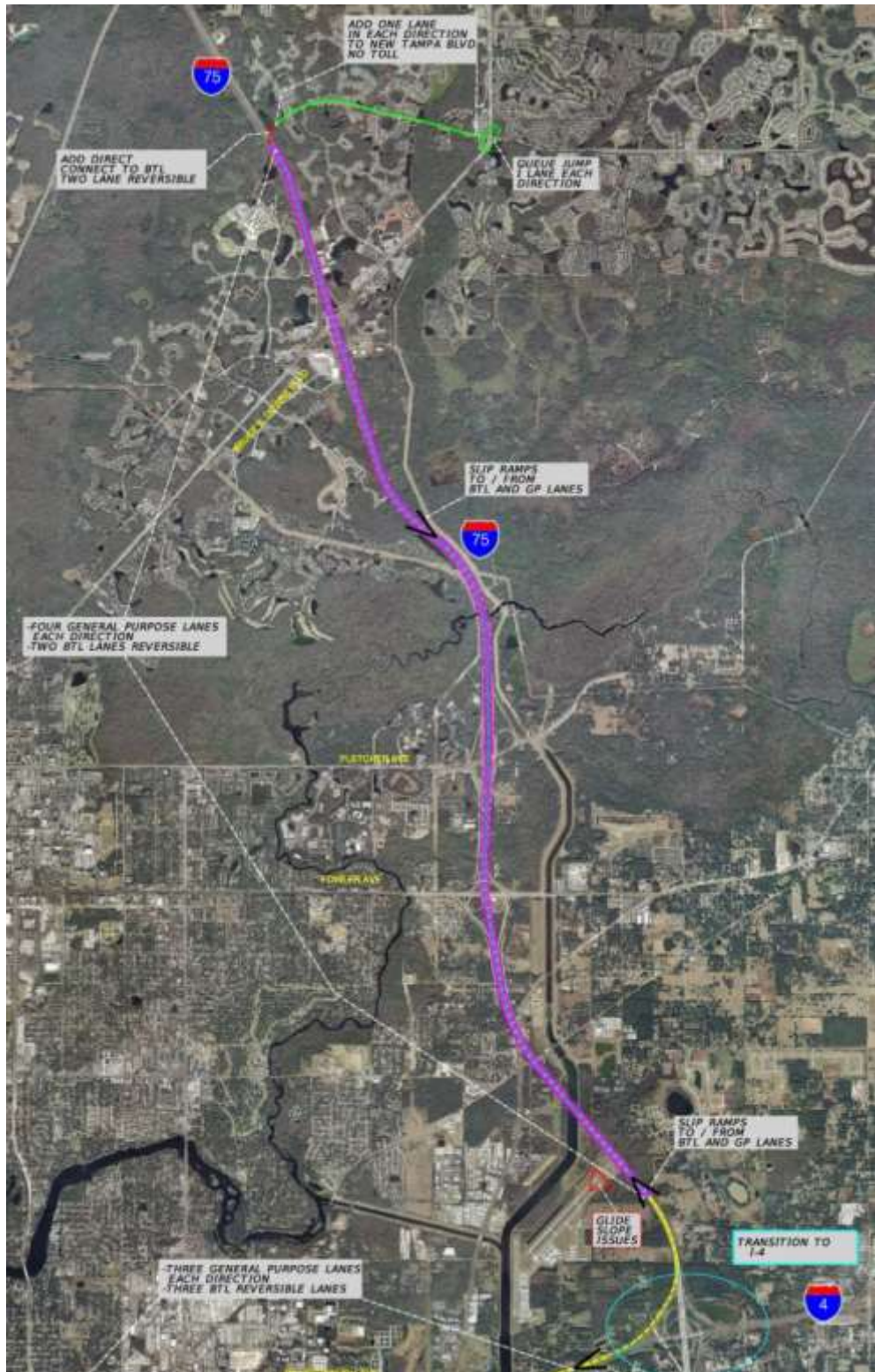
Figure D - 7: BTL#1 I-4 to I-75 North Connection (Reversible)
Source: Parsons Brinckerhoff

I-75 North Mainline BTL (BTL#1)

The I-75 North BTL guideway features two reversible lanes in the middle of four general purpose lanes which are planned by FDOT.

Slip ramps south of Bruce B. Downs Boulevard and north of I-4 provide access to the BTL.

At the north end of the BTL, direct access is provided for I-75 traffic as well as an elevated entry based on a structural revision to the New Tampa Boulevard Bridge. A more detailed view of the north end access is provided in Figure D-9.



**Figure D - 8:
BTL#1 I-75N
Mainline BTL
(Reversible)
Source:
Parsons
Brinckerhoff**

I-75 North BTL Connection to New Tampa Boulevard (BTL#1)

The connection to the I-75 North BTL guideway in Network #1 includes the addition of one lane in each direction along New Tampa Boulevard and a queue jump at the intersection of new Tampa Boulevard and Bruce B. Downs Boulevard.

The connection to the BTL is provided by a structural revision to the New Tampa Boulevard bridge overpass of I-75.



Figure D - 9: BTL#1 I-75 North BTL Connection to New Tampa Boulevard (Source: Parsons Brinckerhoff)

I-75 South Mainline BTL (BTL#1)

The I-75 South BTL guideway provides a two-lane reversible operation from north of SR 674 to a connection to the Selmon Expressway. Slip ramps north of the Alafia River provide additional access to and from the I-75 general purpose lanes. A more detailed view of the Selmon Expressway connection is provided in Figure D-11.

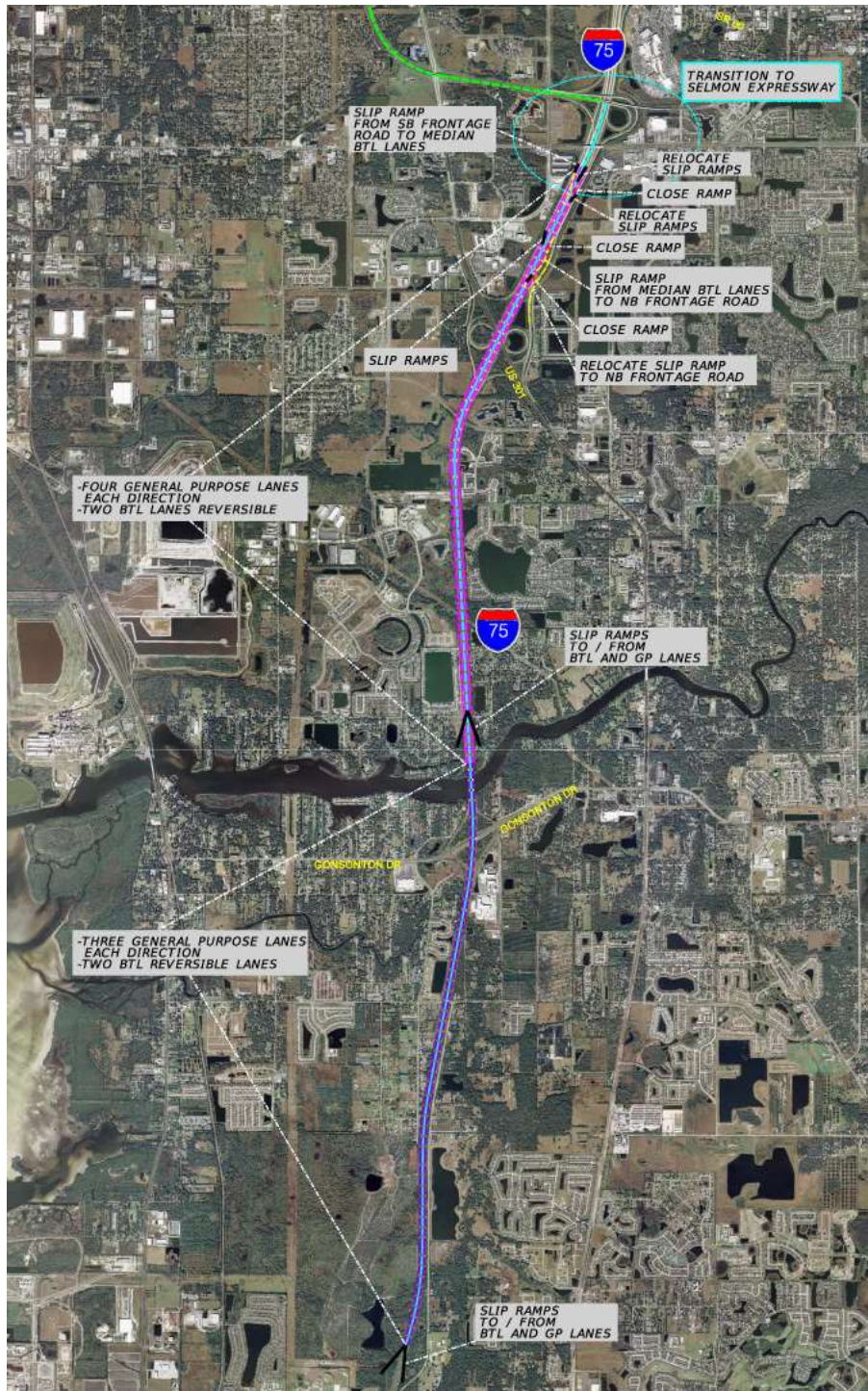


Figure D - 10: BTL#1 I-75 South Mainline BTL (Reversible)
 Source: Parsons Brinckerhoff

I-75 South BTL Connection to Selmon Expressway (BTL#1)

The connection between the I-75 South BTL guideway and the Selmon Expressway includes a number of structures and braided ramps that involve closing or relocating existing ramp facilities and construction of new access points.

This approach will provide a direct freeway-to-freeway connection to the Selmon Expressway while also providing direct slip ramp access to and from I-75 to the north of the BTL guideway.



Figure D - 11: BTL#1 I-75 South BTL Connection to Selmon Expressway (Reversible)
Source: Parsons Brinckerhoff

BTL Network #2

The final BTL Network #2 is comprised of the following major elements:

- Dale Mabry Highway Arterial Queue Jumps and Traffic Systems Management (2-way)
- Airport to Dale Mabry Highway to I-275 South BTL Connector (Combination of Arterial and Elevated 2-way)
- Hillsborough Avenue Arterial Queue Jumps (2-way)
- I-275 South Mainline Limited-Access BTL (2-way)
- Interchange of I-275 South to Downtown, I-275 North and I-4 (2-way and Reversible)
- I-4 Mainline Limited-Access BTL (Reversible)
- I-4 to I-75 North Connection (Reversible)
- I-75 North Mainline BTL (Reversible)
- I-75 North BTL Connection to Bruce B. Downs Boulevard

The termini, access points and lane configurations for the corridors within BTL Network #2 are presented on Figures D-12 through D-20 on the following pages.

Note: While underpass queue jumps may be advisable in some locations, as previously discussed, due to the conceptual nature of this study, sufficient detail on utility and similar issues was not gathered to determine underpass costs, which can vary widely due to these issues. “Underpass” or “tunnel” has been indicated in locations where this may be particularly desirable, but costs were determined for all locations based on overpass grade separations.

Dale Mabry Highway Arterial Queue Jumps and Traffic Systems Management (BTL#2)

The Dale Mabry Highway arterial BTL is composed of a combination of queue jumps, priority signalization and access management techniques that will create a virtual busway for those riding premium transit systems and a free-flowing corridor for those willing to pay tolls at the queue jumps.

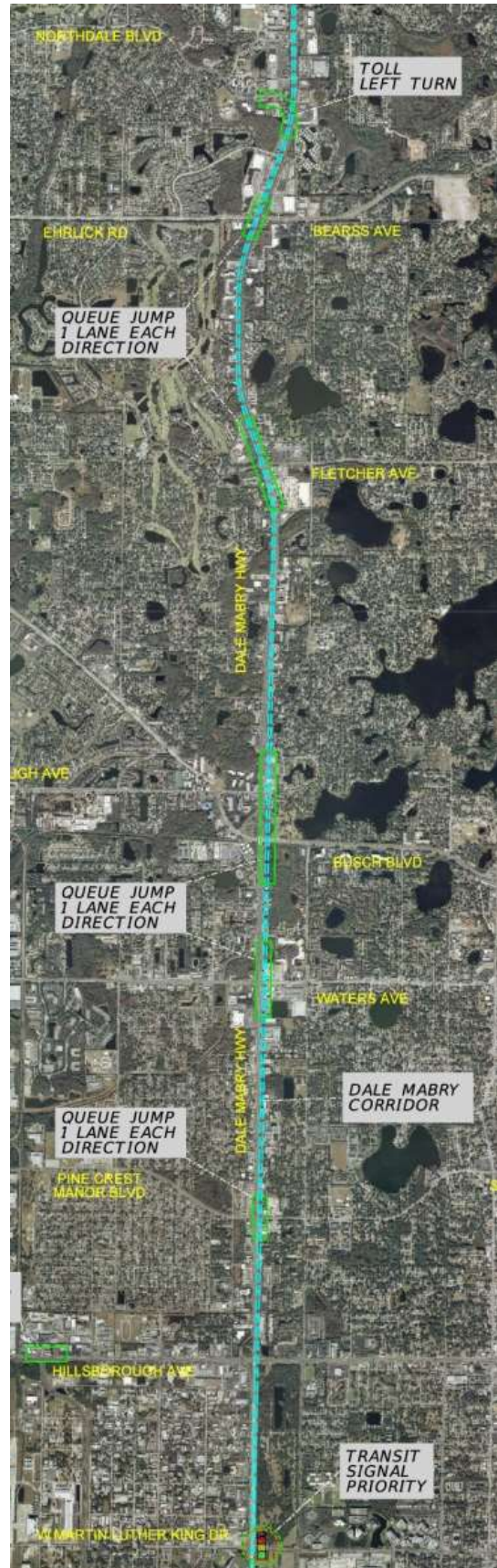
The elements of the Dale Mabry Highway BTL include:

- Northdale Boulevard Queue Jump (elevated left-turn)
- Bearss Avenue Queue Jump
- Fletcher Avenue Queue Jump
- (elevated section from north of Fletcher avenue to south of Stahl Road)
- Busch Boulevard Queue Jump (elevated section from north of Linebaugh Avenue to a merge with the Busch Boulevard overpass)
- Waters Avenue Queue Jump
- Sligh Avenue Queue Jump
- Martin Luther King Boulevard signal priority
- Columbus Avenue Queue Jump

In addition, access management techniques consisting primarily of median closures at lower volume crossing points with the installation of downstream channelized u-turns would be employed between the queue jumps to ensure free flowing traffic movement.

Figure D - 12: BTL#2 Dale Mabry Highway Arterial Queue Jumps and Traffic Systems Management (2-way)

Source: Parsons Brinckerhoff



Airport to Dale Mabry Highway to I-275 South BTL Connector (BTL#2)

The connection of the Airport to BTL Network #2 is accomplished on the west through an arterial connection to the existing ramps of the Airport Interchange and to the east using a combination of an arterial and then an elevated connection to both Dale Mabry Highway and the I-275 South BTL guideway. All of these roadways involve 2-way operations. The key elements include a multi-modal transfer center on the north side of Spruce Street providing direct access and transit exchange into Tampa International Airport. This element is part of the Airport long range plan. Additional at-grade lanes are added to the Spruce Street arterial from the Airport Interchange to west of Westshore Boulevard where a 2-way BTL guideway would be elevated over the Westshore intersection and remain elevated along Spruce Street/Boy Scout Boulevard where the alignment then cuts behind a group of commercial properties, interchanges with Dale Mabry Highway and then turns south along the Himes Avenue alignment with an eventual flyover connection to the I-275 South BTL guideway.



Figure D - 13: BTL#2 Airport to Dale Mabry Highway to I-275 South BTL Connector (Combination of Arterial and Elevated 2-way) Source: Parsons Brinckerhoff

Hillsborough Avenue Arterial Queue Jumps (BTL#2)

Hillsborough Avenue also provides enhanced access to the BTL Network #2 by employing a series of grade-separated queue jumps and priority signalization that would significantly increase the flow of traffic on this arterial highway.

The queue jumps are located at:

- Sheldon Road
- Hanley Road
- George Road to Hoover Road
- Anderson Road

Special signalization is recommended at Weber Road with a left-turn prohibition.



Figure D - 14: BTL#2 Hillsborough Avenue Arterial Queue Jumps (2-way)
Source: Parsons Brinckerhoff

I-275 South Mainline Limited-Access BTL (BTL#2)

The I-275 South BTL guideway follows the basic alignment defined in FDOT plans for three two-way special use lanes within I-275. The BTL concept provides for access from the elevated connection to the Airport identified in Figure D-13 and for direct access slip ramps from the I-275 South general use lanes west of Himes Avenue.

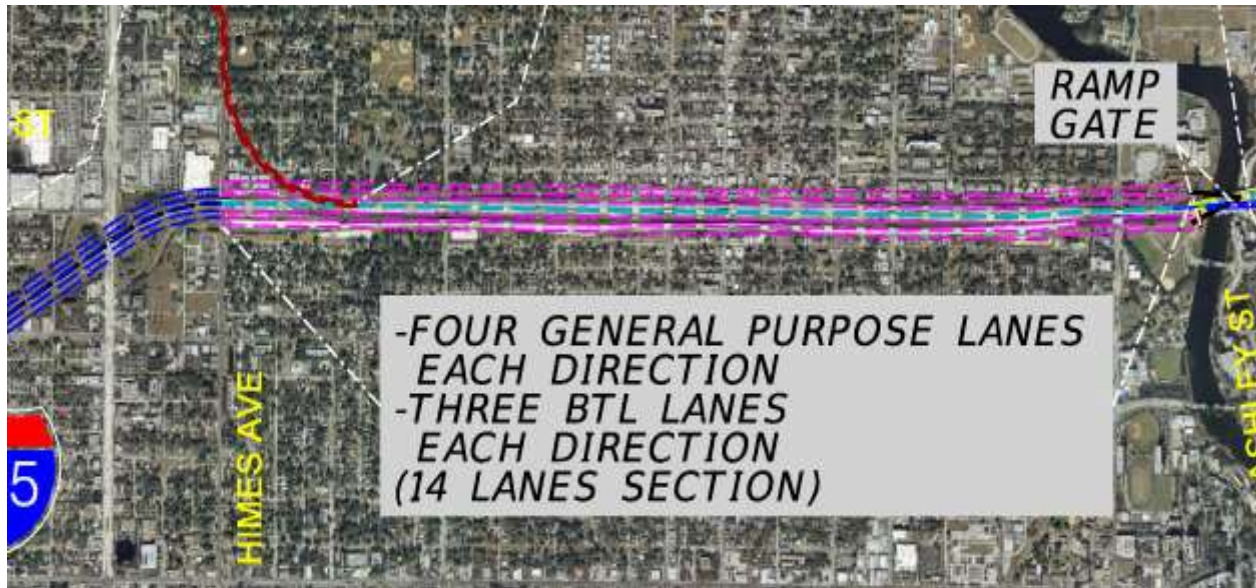


Figure D - 15: BTL#2 I-275 South Mainline Limited-Access BTL (2-way)
Source: Parsons Brinckerhoff

Interchange of I-275 South to Downtown, I-275 North and I-4 (BTL#2)

As shown on Figure D-16, the interchange of the I-275 South BTL guideway with I-275 North and with I-4 for Network #2 is essentially the same as that for Network #1. It is accomplished mostly on structure. Ramp gates provide protection for the reversible connection from the I-4 reversible BTL to both the I-275 South BTL guideway and to the I-275 North general use lanes. Access into and out of downtown Tampa from the I-275 South BTL is handled as an underpass connecting directly to Orange Avenue. Access into downtown from I-4 is provided by the I-4/Selmon Connector project that is already under construction.

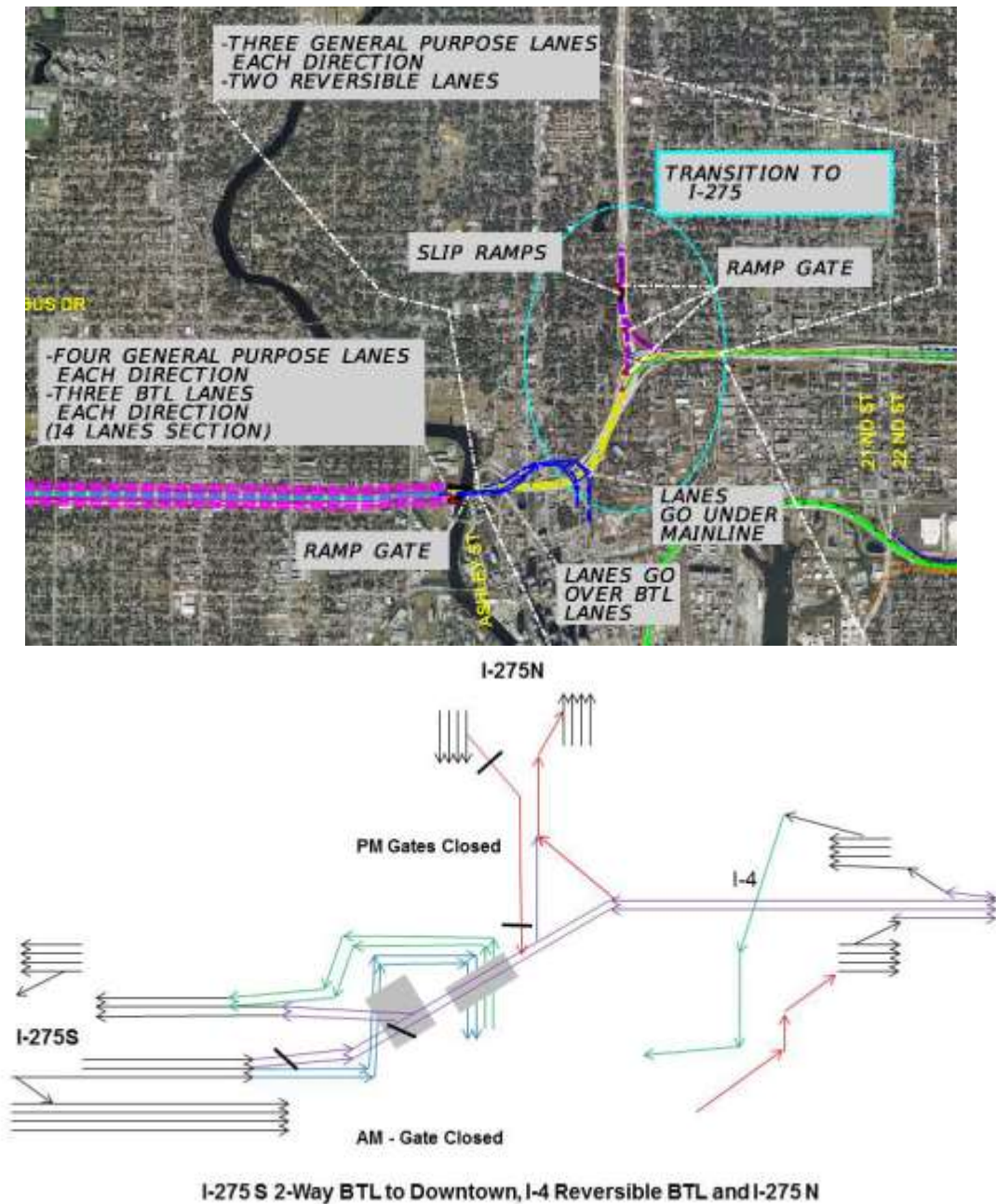


Figure D - 16: BTL#2 Interchange of I-275 South to Downtown, I-275 North and I-4 (2-way and Reversible) Source: Parsons Brinckerhoff

I-4 Mainline Limited –Access BTL (BTL#2)

The I-4 BTL guideway concept for Network #2 is essentially the same as that for Network #1 - three reversible lanes between I-75 and the I-4/Selmon connector and the downtown Tampa interchange between I-275 North and South. Slip ramps to the east of the I-4/Selmon Connector allow traffic to exit to use the connector for direct access to downtown or to use the I-4 general purpose lanes for access to downtown or access to the I-275 North and south general purpose lanes through the downtown junction.

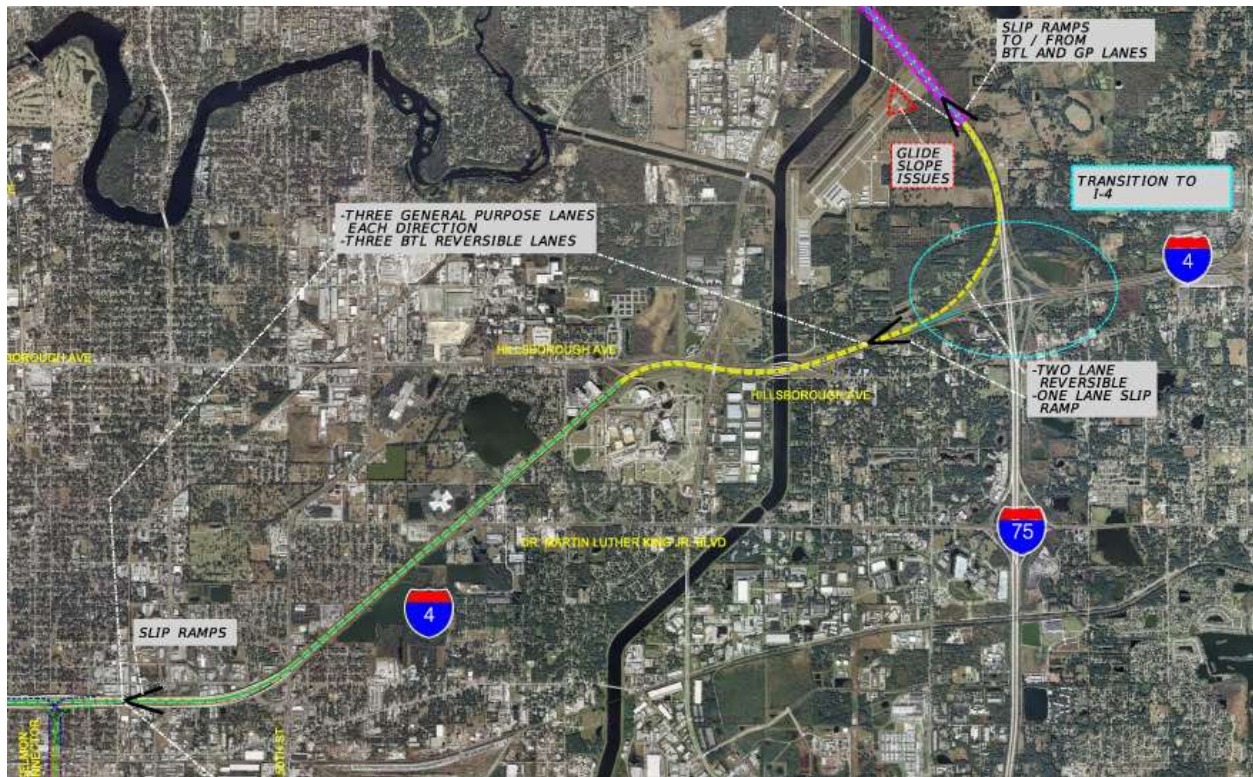


Figure D - 17: BTL#2 I-4 Mainline Limited –Access BTL (Reversible)
 Source: Parsons Brinckerhoff

I-4 to I-75 North Connection (BTL#2)

The interchange of the I-4 BTL with the I-75 North and South and I-4 to the east for Network #2 is essentially the same as that for Network #1. It uses the existing I-4/I-75 interchange and a set of slip ramps to provide the required access for all directions. The I-4 BTL guideway is elevated over the interchange and provides a free flow for traffic to and from the I-75 North reversible BTL. Traffic wishing to move between the BTL and the general purpose lanes for I-4 to the west and I-75 to the north would use the slip ramps. Westbound traffic on I-4 wishing to use the I-4 BTL would use the I-4 slip ramps for system entry and exit.



Figure D - 18: BTL#2 I-4 to I-75 North Connection (Reversible)
Source: Parsons Brinckerhoff

I-75 North Mainline BTL (BTL#2)

The I-75 North BTL guideway features two reversible lanes in the middle of four general purpose lanes which are planned by FDOT.

Slip ramps south of Bruce B. Downs Boulevard and north of I-4 provide access to the BTL guideway.

At the north end of the BTL, direct access is provided for I-75 traffic as well as an entry to Bruce B. Downs Boulevard based on using the existing flyover access to the I-75 general use lanes.

A more detailed view of the north end access and the queue jumps employed on Bruce B. Downs Boulevard is provided in Figure D-20.

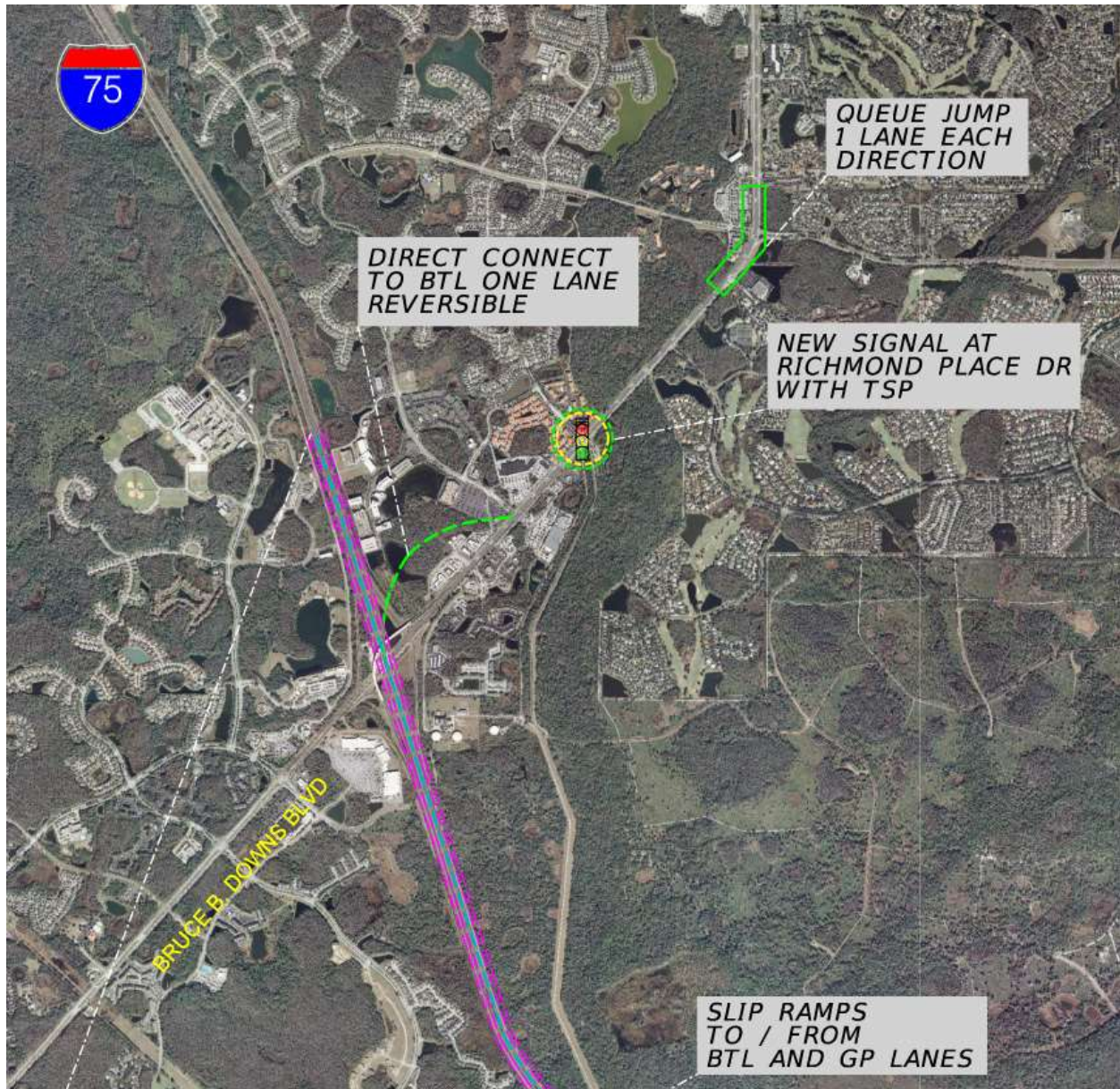
**Figure D - 19:
BTL#2 I-75N
Mainline BTL
(Reversible)
Source: Parsons
Brinckerhoff**



I-75 North BTL Connection to Bruce B. Downs Boulevard (BTL#2)

The connection to the I-75 North BTL guideway in Network #2 includes the addition a queue jump to Bruce B. Downs Boulevard at New Tampa Boulevard and a new traffic signal at Richmond Place with priority signalization for the peak-hour peak direction at all signals on Bruce B. Downs Boulevard.

The connection to the BTL is provided by using the Bruce B. Downs flyover in combination with the slip ramps south of the Bruce B. Downs/I-75 interchange.



**Figure D - 20: BTL#2 I-75 North BTL with Connection to Bruce B. Downs Boulevard
(Source: Parsons Brinckerhoff)**

BTL Network #3

BTL Network #3 is comprised of the following major elements:

- Airport to I-275 South BTL Connector (Combination of Arterial and Elevated 2-way)
- I-275 South Mainline Limited-Access BTL (2-way)
- I-275 North Mainline Limited-Access BTL
- I-275 North BTL Connection to East-West Road and New Tampa Boulevard
- Interchange of I-275 South to Downtown, I-275 North and I-4 (2-way and Reversible)
- I-75 South Mainline BTL (Reversible)
- I-75 South Connection to Selmon Expressway (Reversible)

The termini, access points and lane configurations for the corridors within BTL Network #3 are presented on Figures D-21 through D-27 on the following pages.

Airport to I-275 South BTL Connector (BTL#3)

The connection of the Airport to BTL Network #3 is essentially the same as Network #1. It is accomplished on the west through an arterial connection to the existing ramps of the Airport Interchange and to the east using a combination of an arterial and then elevated connection to the I-275 South BTL guideway. All of these roadways involve 2-way operations. The key elements include a multi-modal transfer center on the north side of Spruce Street providing direct access and transit exchange into Tampa International Airport. This element is in the Airport long range plan. Additional at-grade lanes are added to the Spruce Street arterial from the Airport Interchange to west of Westshore Boulevard where a 2-way BTL guideway would be elevated over the Westshore intersection and remain elevated along Spruce Street/Boy Scout Boulevard/Columbus Drive – passing over Dale Mabry Highway and then turning south along the Himes Avenue alignment with an eventual flyover connection to the I-275 South 2-way BTL.



Figure D - 21: BTL#3 Airport to I-275 South BTL Connector (Combination of Arterial and Elevated 2-way) Source: Parsons Brinckerhoff

I-275 South Mainline Limited-Access BTL (BTL#3)

The I-275 South BTL guideway follows the basic alignment defined in FDOT plans for three 2-way special use lanes within I-275. The BTL concept provides for access from the elevated connection to the Airport identified in Figure D-22 and for direct access slip ramps from the I-275 South general use lanes west of Himes Avenue.

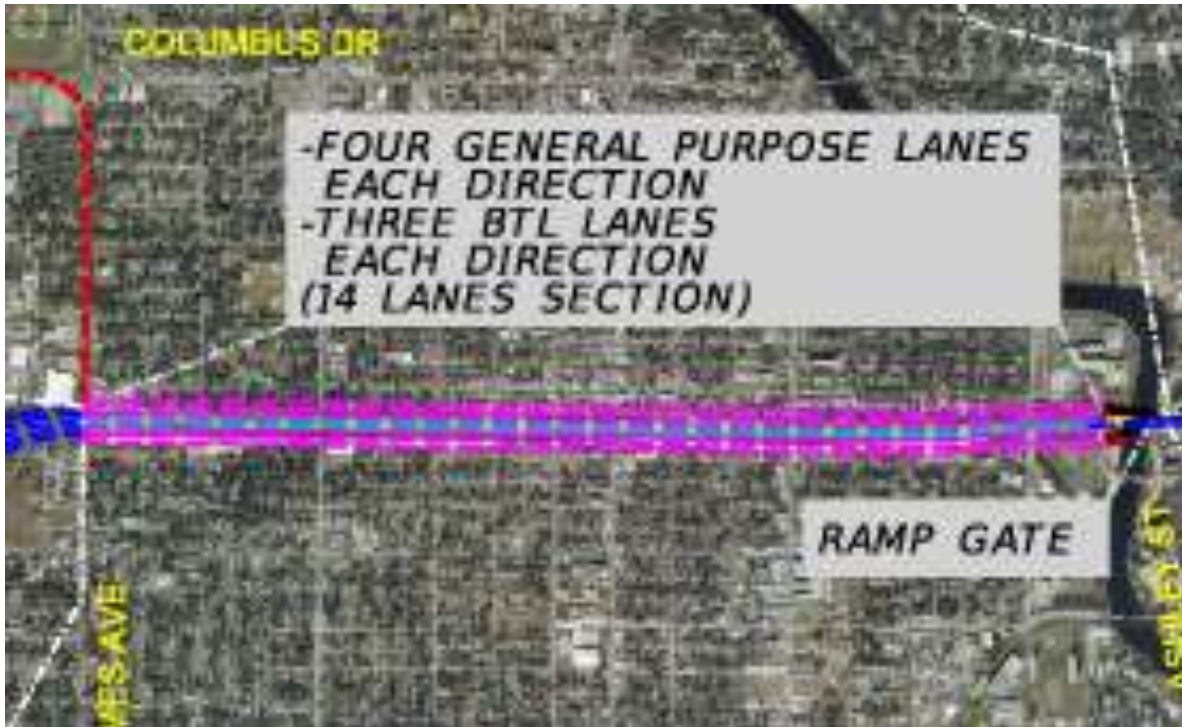
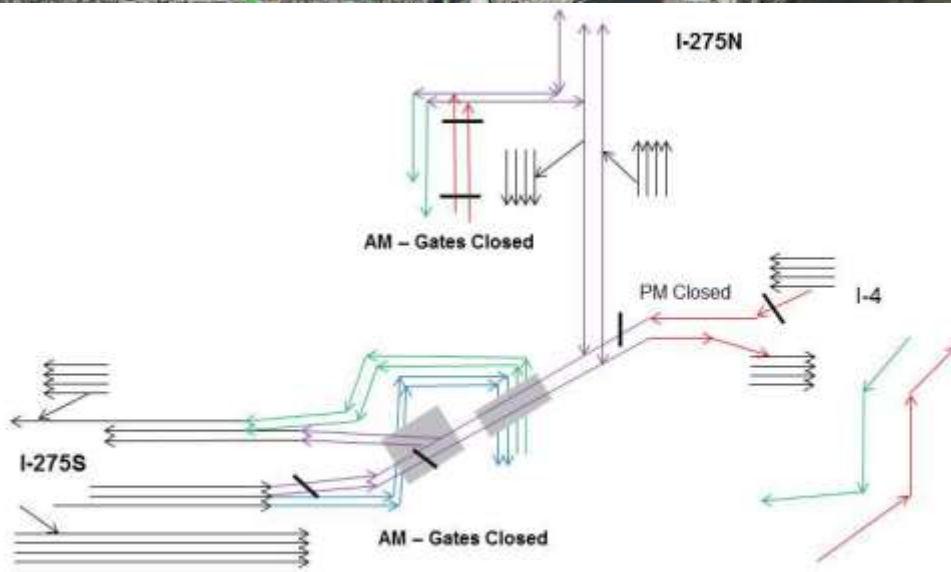


Figure D - 22: BTL#3 I-275 South Mainline Limited-Access BTL (2-way)
Source: Parsons Brinckerhoff

Interchange of I-275 South to Downtown, I-275 North and I-4 (BTL#3)

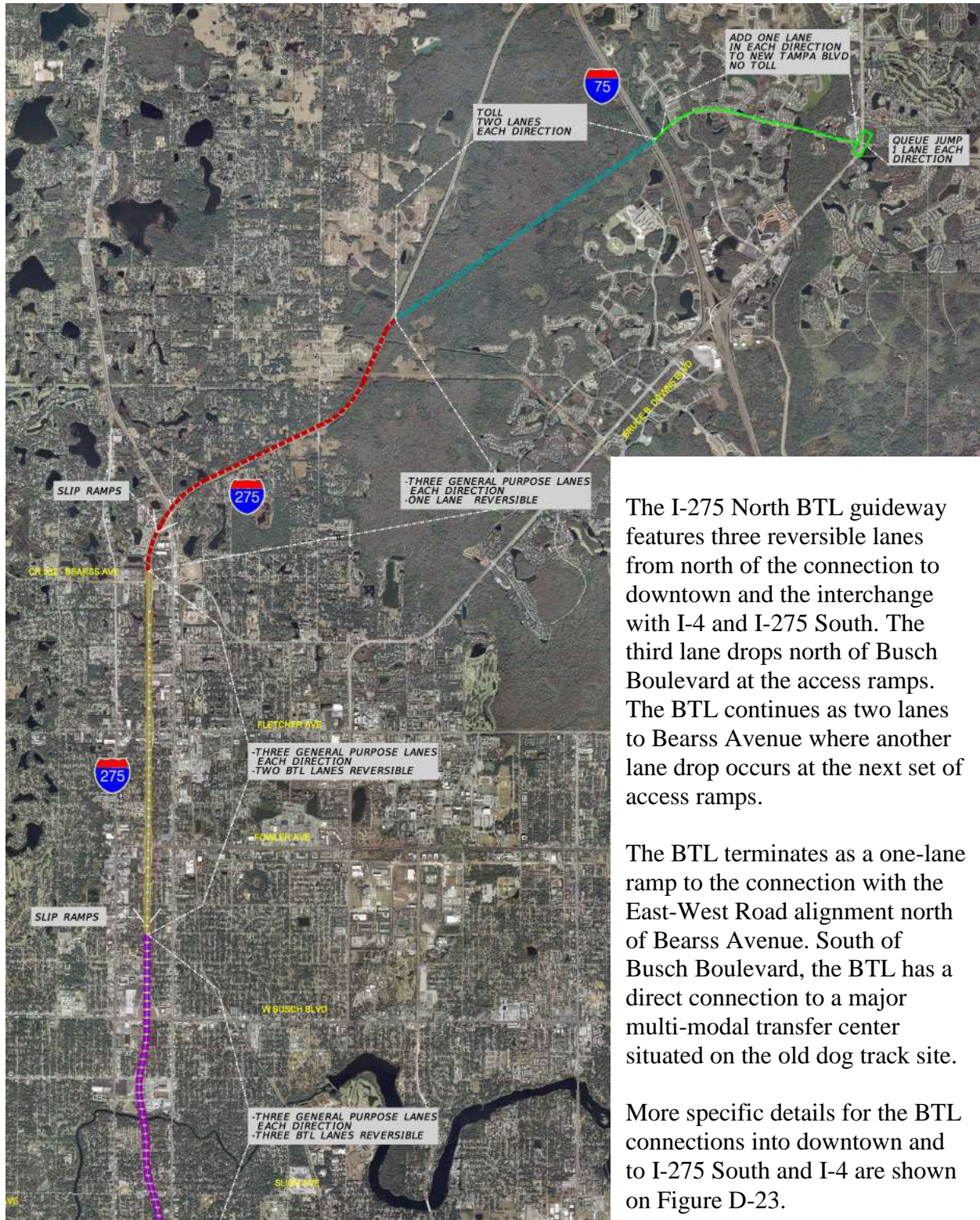
As shown on Figure D-23, the interchange of the I-275 South BTL guideway for Network #3 with the I-275 North BTL guideway and with I-4 is accomplished mostly on structure. Ramp gates provide protection for the reversible connection from the I-275 North reversible BTL to both the I-275 South BTL and to the I-4 general purpose lanes. Access into and out of downtown Tampa from the I-275 South BTL is handled as an underpass connecting directly to Orange Avenue. Access into downtown from I-4 is provided by the I-4/Selmon Connector project that is already under construction.



I-275 S 2-Way BTL to Downtown, I-275 N Reversible BTL and I-4

Figure D - 23: BTL#3 Interchange of I-275 South to Downtown, I-275 North and I-4 (2-way and Reversible) Source: Parsons Brinckerhoff

I-275 North Mainline Limited-Access BTL (BTL#3)



The I-275 North BTL guideway features three reversible lanes from north of the connection to downtown and the interchange with I-4 and I-275 South. The third lane drops north of Busch Boulevard at the access ramps. The BTL continues as two lanes to Bearss Avenue where another lane drop occurs at the next set of access ramps.

The BTL terminates as a one-lane ramp to the connection with the East-West Road alignment north of Bearss Avenue. South of Busch Boulevard, the BTL has a direct connection to a major multi-modal transfer center situated on the old dog track site.

More specific details for the BTL connections into downtown and to I-275 South and I-4 are shown on Figure D-23.

Figure D - 24: BTL#3 I-275 North Mainline Limited-Access BTL (Reversible) Source: Parsons Brinckerhoff

I-275 North BTL Connection to East-West Road and New Tampa Blvd (BTL#3)

The connection of the I-275 North BTL guideway in Network #3 to the New Tampa area includes the inclusion of the East-West Road alignment identified in the Hillsborough County MPO LRTP and investigated by the City of Tampa and THEA in previous environmental studies. That alignment is a two-lane 2-way limited access toll road that would be incorporated into the BTL #3 Network. The BTL would directly connect the final one-lane BTL ramp to the alignment of the East-West Road. The concept also includes an addition of one lane in each direction along New Tampa Boulevard from the connection of the east terminus of the East-West Road to Bruce B. Downs Boulevard and a queue jump (underpass) at the intersection of New Tampa Boulevard and Bruce B. Downs Boulevard.

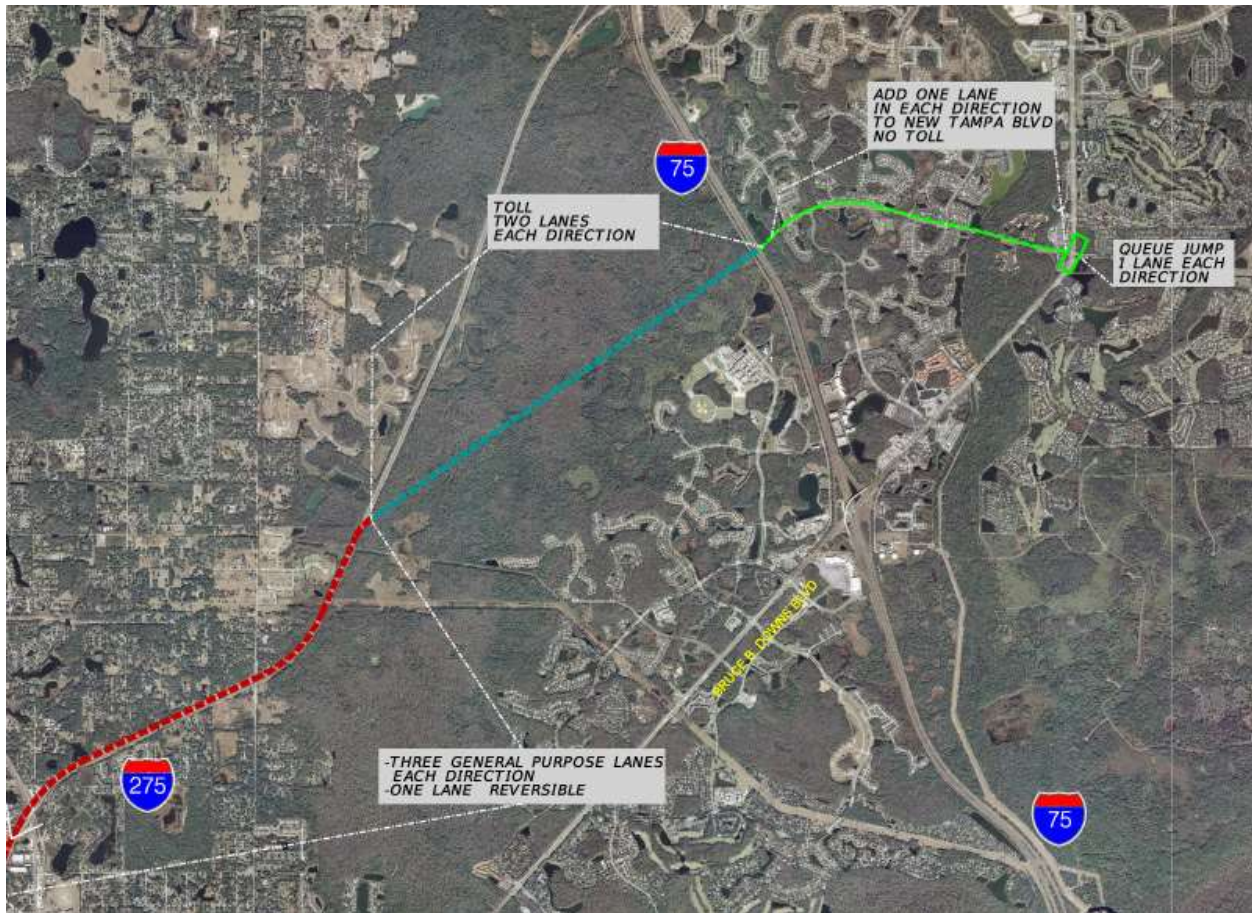


Figure D - 25: BTL#3 I-275 North BTL Connection to East-West Road and New Tampa Boulevard (Source: Parsons Brinckerhoff)

I-75 South Mainline BTL (BTL#3)

The I-75 South BTL guideway provides a two-lane reversible operation from north of SR 674 to a connection to the Selmon Expressway. Slip ramps north of the Alafia River provide additional access to and from the I-75 general purpose lanes. A more detailed view of the Selmon Expressway connection is provided in Figure D-27.

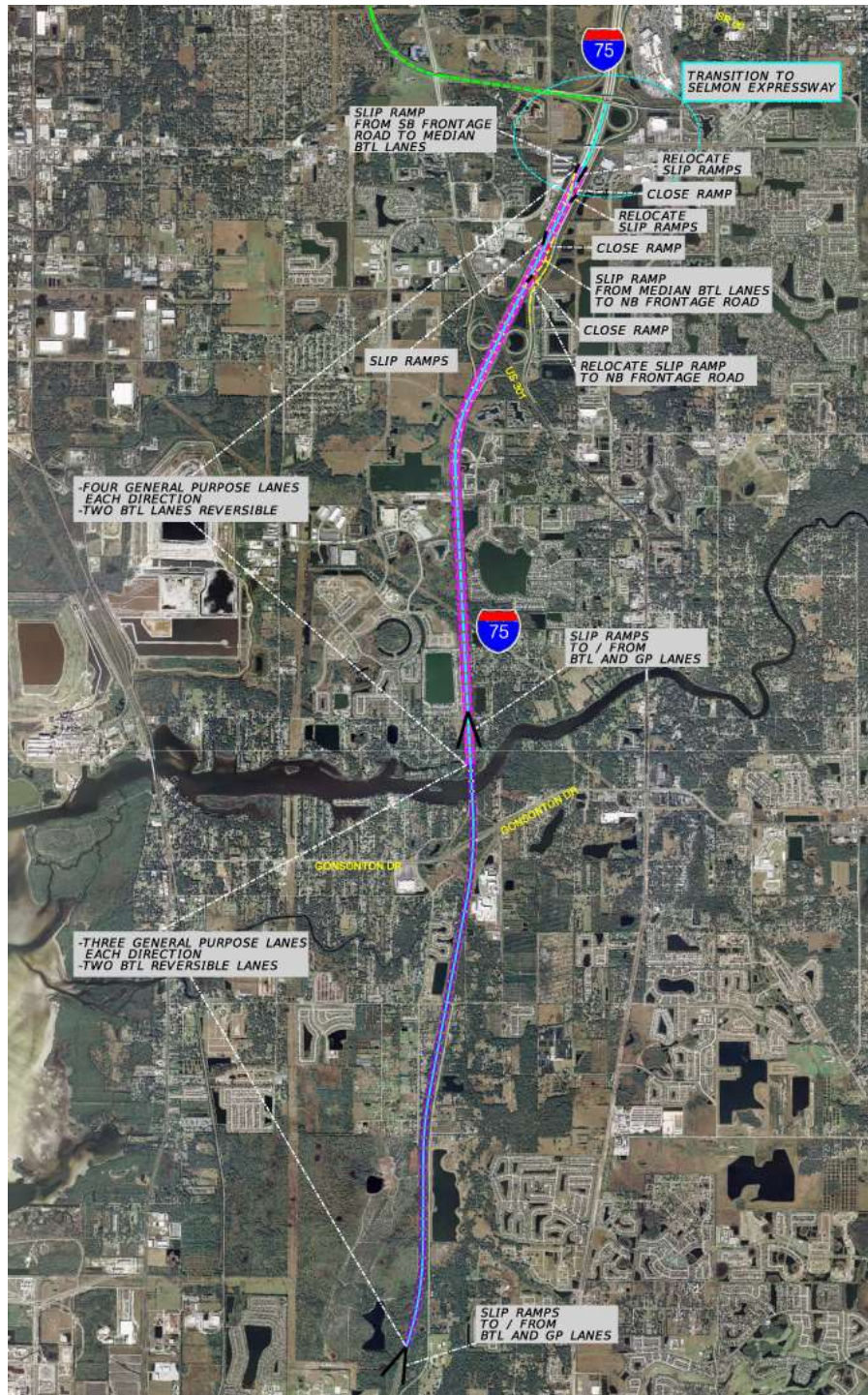


Figure D - 26: BTL#3 I-75 South Mainline BTL (Reversible)

Source: Parsons Brinckerhoff

I-75 South Connection to Selmon Expressway (BTL#3)

The connection between the I-75 South BTL guideway and the Selmon Expressway includes a number of structures and braided ramps that involve closing or relocating existing ramp facilities and construction of new access points.

This approach will provide a direct freeway-to-freeway connection to the Selmon Expressway while also providing direct slip ramp access to and from I-75 to the north of the BTL.



Figure D - 27: BTL#3 I-75 South Connection to Selmon Expressway (Reversible)
Source: Parsons Brinckerhoff

Final Traffic, Ridership and Revenue Estimates

Based on a review of the maximum transit findings by the study team, a set of assumptions were defined for the final set of transit and highway model runs and revenue forecasts. These assumptions are discussed in detail in the following sections.

Transit Assumptions

The model runs designed to maximize transit ridership by providing frequent service, zero fares, and free flowing BTL facilities with a high toll revealed a good deal about the sensitivity of the modeling process and the background transit routes included in the model. For example, changing the mode assigned to BTL routes from express bus to in-street BRT (bus rapid transit) more than doubled the ridership captured by the BTL network. An in-depth review of the model indicated that TBRTM 2035 base network for the BTL study included six BRT routes that attracted significant ridership and in some cases competed directly with BTL routes. In addition, the model also included a light rail line to the Airport that was actually no longer considered part of the cost feasible long range plan. The combination of the background light rail and BRT routes are highlighted by the heavy green lines in Figure D-28.

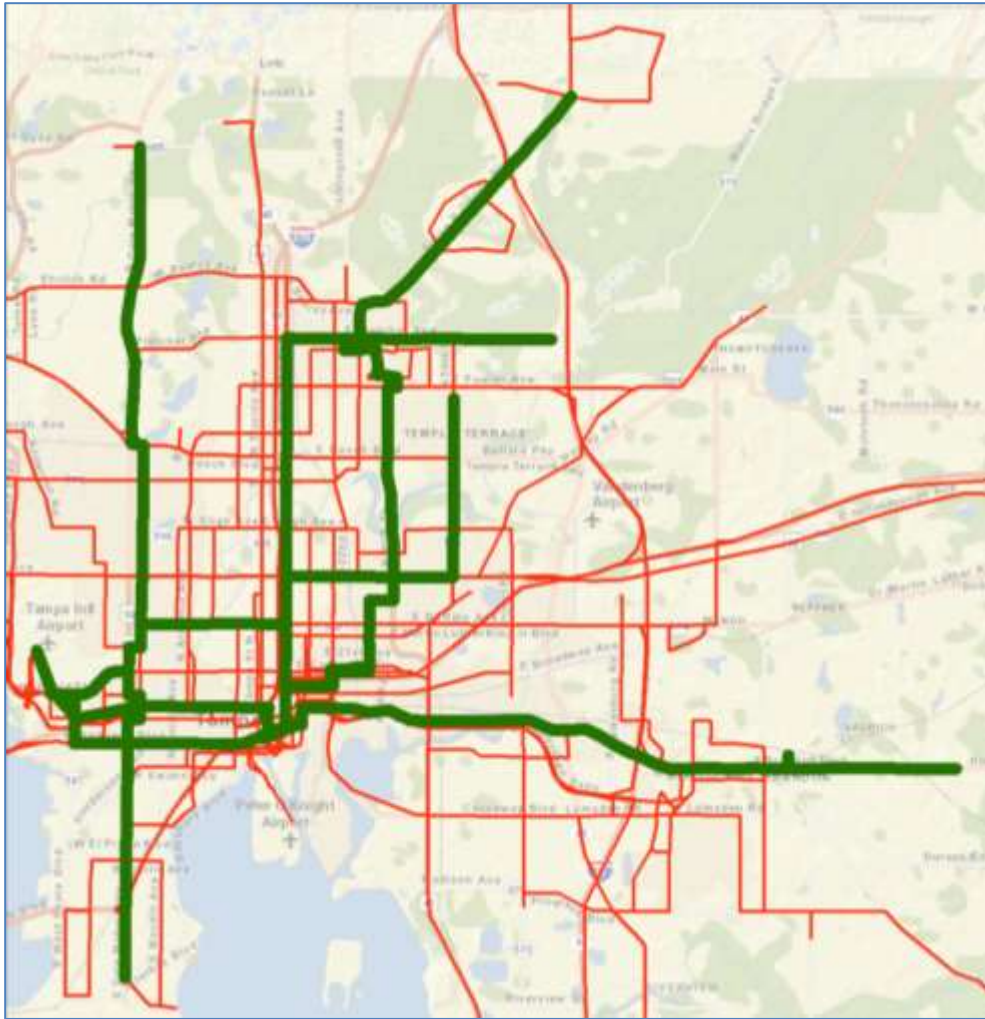


Figure D - 28: Background BRT and Light Rail Routes (Source: AECOM)

BTL Transit Modeling Strategy

For the purposes of testing the feasibility of the BTL networks, the study team modeled the final set of BTL alternatives using the following transit assumptions:

- Use the choice set mode choice methodology;
- Adjust the BTL cost per mile to maintain a speed of no less than 50 mph on any BTL freeway link for a given BTL network, time period, and analysis year;
- Set the transit fare for all transit routes that use a BTL facility to \$1.00 and provide free transfers to all other routes in the HART system;
- Set the local bus fare to \$2.00 and the express bus fare to \$3.00 for all routes that do not use the BTL facilities;
- Set the peak period headways to 10 minutes and the off-peak headways to 15 minutes for all routes that use the BTL facilities;
- Set the peak period headways to 20 minutes and the off-peak headways to 30 minutes for all local bus routes that do not use the BTL facilities;
- Leave the headways for express bus routes that do not use the BTL facilities to the values assumed in the background transit network;
- Assume all routes that use a BTL facility are considered “premium” modes in the modeling process (i.e., mode 12);
- Remove the light rail route (W-3: I-275 to Airport) from the network;
- Assume any BRT route that closely parallels a BTL facility will be re-routed onto the BTL facility or reconfigured as a non-premium mode in the modeling process.

The BRT routes in the current model include:

- HART 405: MetroRapid: Downtown to Brandon
- HART 404: MetroRapid: East-West
- HART 403: MetroRapid: Downtown to Tampa Airport
- HART 402: MetroRapid: Dale Mabry/Himes Ave.
- HART 411: Route 2 - Nebraska Avenue (UATC to Downtown)
- HART 410: Route 5 - 40th St (Cross Creek to Downtown)

A number of BRT routes (Routes 405, 403, 402, and 411) were re-routed or reconfigured in one or more of the BTL networks to either remove competing routes or include them as part of the BTL networks.

BTL Highway and Pricing Modeling Strategy

Pricing of the toll portion of the BTL is a key element in achieving the sustainability of the operation as well as the financial feasibility of the concept. As demonstrated in Table D-1, there were a number of components that led to the setting of toll rates for applying variable pricing to the BTL networks. The example shown here is for BTL Network #1.

Table D-1: BTL #1 Components of Variable Pricing Evaluation with Toll Rate Variance of \$.05 for 2045 (Source: AECOM)

Toll Rate	BUS TOLL LANE NETWORK #1					NON-TOLLED LANES			
	Revenue	VMT	Max Fwy V/C	VOR	Lane Speed	Max V/C	VOR	Lane Speed	
0.20	\$ 103,967	519,836	1.28	1.25	38.2	2.33	1.25	36.6	
0.25	\$ 114,189	480,412	1.22	1.26	39.9	2.32	1.25	36.5	
0.30	\$ 124,412	440,988	1.15	1.27	41.7	2.31	1.25	36.4	
0.35	\$ 134,634	401,564	1.09	1.27	43.4	2.30	1.25	36.2	
0.40	\$ 144,856	362,139	1.02	1.28	45.1	2.29	1.25	36.1	
0.45	\$ 146,274	334,325	0.98	1.29	46.5	2.28	1.25	36.0	
0.50	\$ 147,693	306,512	0.93	1.31	47.9	2.28	1.25	35.9	
0.55	\$ 149,112	278,698	0.89	1.32	49.3	2.27	1.25	35.7	
0.60	\$ 150,530	250,884	0.84	1.33	50.7	2.26	1.25	35.6	
0.65	\$ 147,594	231,533	0.80	1.35	51.4	2.25	1.25	35.5	
0.70	\$ 144,658	212,183	0.77	1.36	52.1	2.23	1.25	35.5	
0.75	\$ 141,721	192,832	0.73	1.38	52.8	2.22	1.25	35.4	
0.80	\$ 138,785	173,481	0.69	1.39	53.5	2.20	1.25	35.3	
0.85	\$ 133,356	159,379	0.66	1.41	53.8	2.19	1.25	35.3	
0.90	\$ 127,928	145,276	0.62	1.43	54.1	2.18	1.25	35.3	
0.95	\$ 122,499	131,173	0.59	1.45	54.3	2.16	1.25	35.2	
1.00	\$ 117,071	117,071	0.55	1.47	54.6	2.15	1.25	35.2	

As indicated in the table, as the price changes, the model can be used to optimize for one or more of the following outcomes:

- a. **Revenue:** The amount of revenue generated by applying a per-mile rate to the amount of vehicle miles traveled (generally, as revenue increases, VMT will decrease and continues to decrease even after revenue reaches the highest point and begins to diminish)
- b. **Vehicle Miles Traveled (VMT):** The total amount of vehicle miles traveled is generally a function of the amount of demand, price, available capacity and level of service (generally, the greatest VMT will be at the lowest revenue point and at the worst operating conditions)
- c. **Volume-to-Capacity Ratio (V/C):** The amount of vehicles in a travel lane compared to the capacity of the lane – with numbers at or above one indicating unacceptable levels of service conditions (the V/C normally decreases as prices increase and volumes decrease, which results in improvement of the level of service)
- d. **Vehicle Occupancy Rate (VOR):** The average amount of passengers within a vehicle which normally increases as the cost of travel increases (follows the V/C characteristic)
- e. **Speeds:** Identified for freeway mainline, ramp and arterial highway conditions – speeds generally increase as volumes and V/C decrease (follows the V/C characteristic)

The optimization process can then incorporate project objectives. For the BTL study, the objective was to create a multi-modal outcome that significantly improved transportation within the BTL networks and was financially sustainable. The goal was to create a project that promoted higher throughput within the BTL networks by shifting auto passengers to a competitive premium bus system – but to do so in a manner that produced enough demand for toll service at rates that would guarantee free-flow service conditions within the toll lanes – and ultimately provide enough revenue to cover BTL road and transit operations costs. This is sometimes referred to as finding the “sweet spot” – the price that provides good speed and significant increases in corridor passenger throughput.

To achieve these goals, it was important to understand the trade-offs that occur between all of the variables. To that end, the study employed a modeling dashboard that brought travel demand, operating conditions and revenue information together to allow for optimizing to these goals.

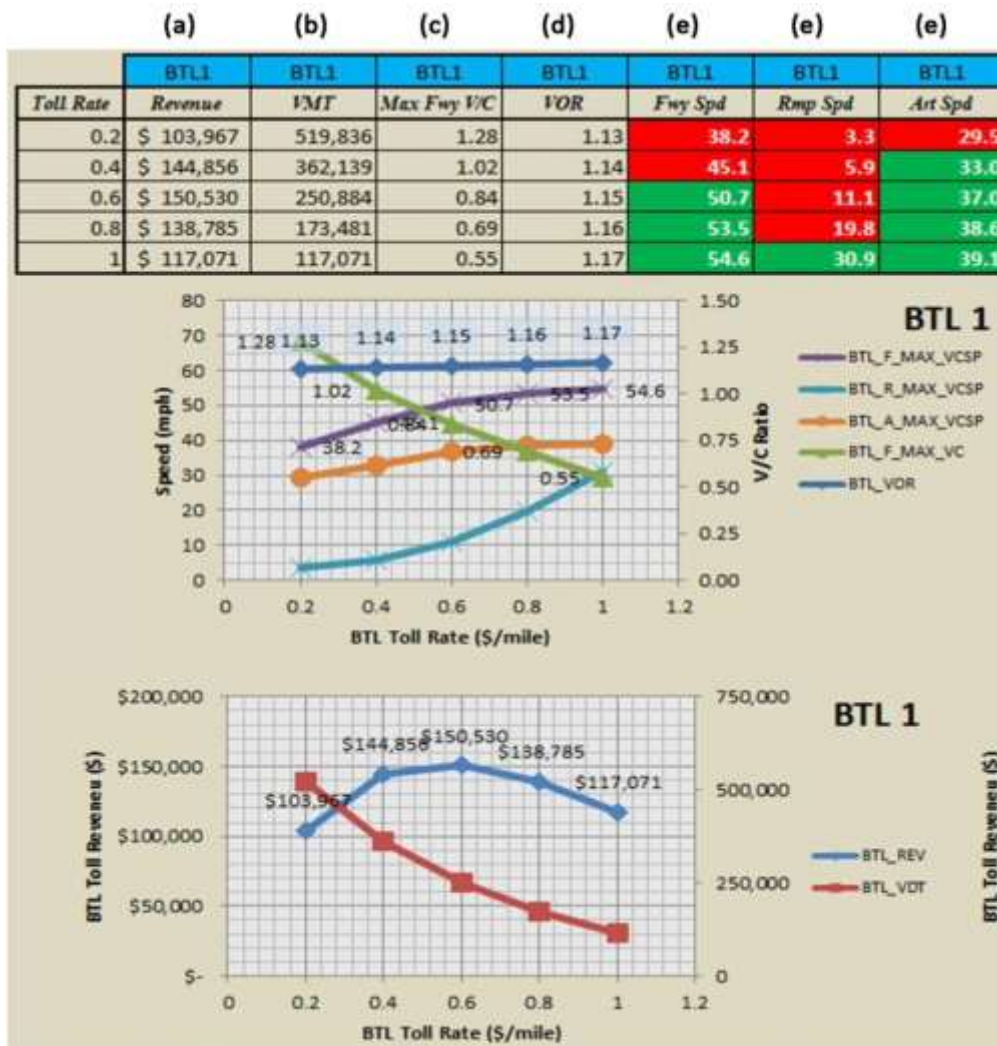


Figure D-29 presents an example of a dashboard output for BTL #1 from the analysis.

Figure D-29: BTL #1 Optimization Dashboard for Toll Rates, Lane Operations, Traffic and Transit Demand and Revenue
(Source: AECOM)

Highway and Toll Revenue Assumptions

The process for estimating a toll rate and revenue for four time periods, four analysis years, and three BTL alternatives was based on a value of time (VOT) distribution provided by CDM Smith (traffic and revenue consultant to THEA). Based on data collected in Tampa in 2009, CDM Smith calculated an average VOT of \$11.60 per hour for passenger cars and \$23.40 per hour for commercial vehicles. Given the study team’s experience in other regions, these values appeared to be conservatively low. Since the final cost feasibility model typically uses minimum, most-likely, and maximum revenue estimates, the study team decided to use the CDM Smith value of time for the minimum revenue estimate and base the maximum revenue estimate on a VOT equal to 75 percent of the Tampa wage distribution. This resulted in a maximum VOT of \$15.05/hour in 2010. To be consistent with the high-level planning approach of the BTL study, the mode choice process was applied to generate transit ridership estimates using the base (minimum) VOT scenario and then the trip tables were frozen for use with the maximum VOT model runs.

The final low and high value of time distributions are depicted in Figure D-30 and are listed on the following page.

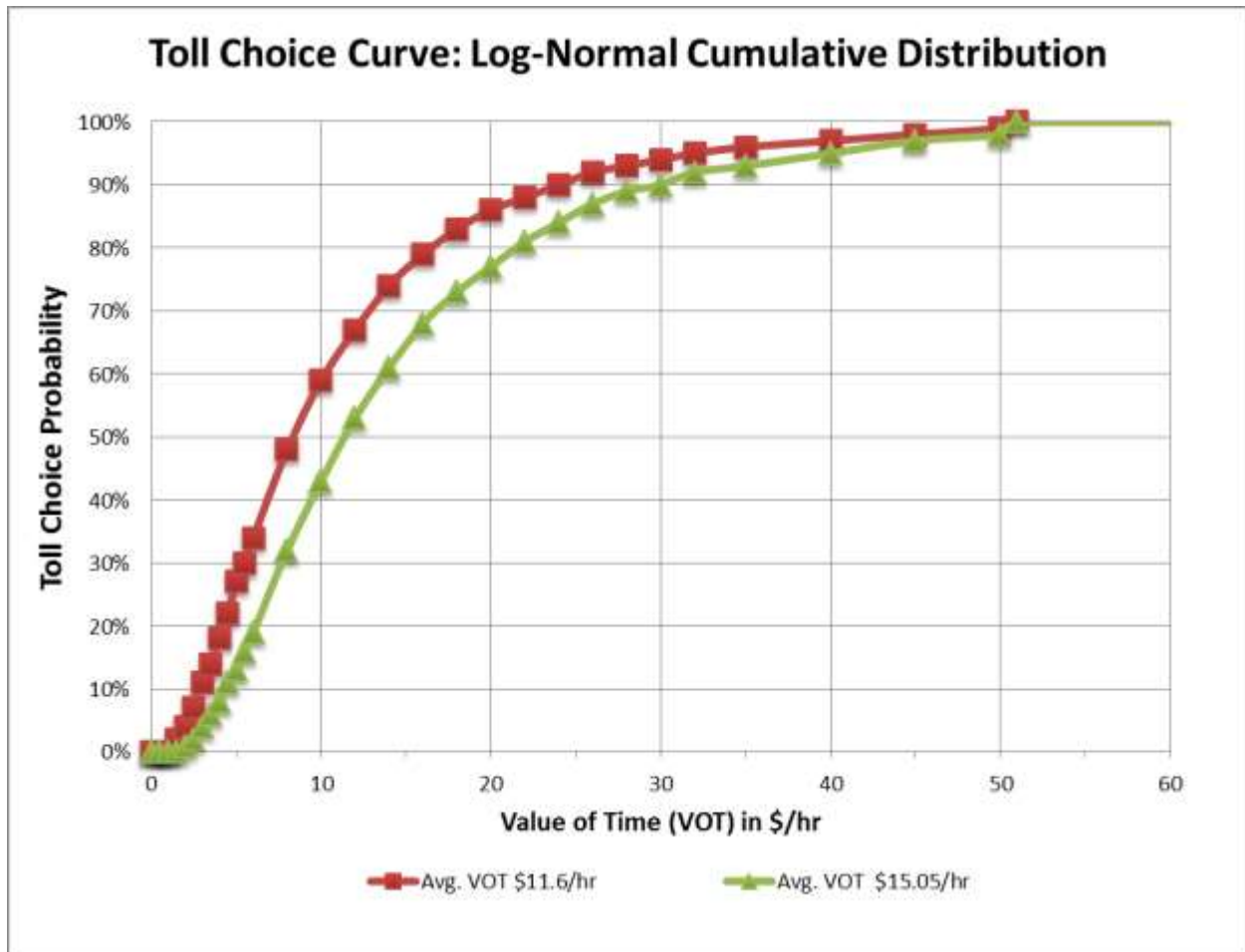


Figure D - 30: Toll Choice Curve: Log-Normal Cumulative Distribution (Source: AECOM)

- Low Value of Time Distribution
 - Average VOT = \$11.60/hour
 - Median VOT = \$8.36/hour
 - Mode = \$4.27/hour

- High Value of Time Distribution
 - Average VOT = \$15.05/hour
 - Median VOT = \$11.40/hour
 - Mode = \$6.54/hour

Final Roadway Traffic and Revenue Results

For the final set of runs, the highway and transit network configurations were adjusted and the fare and service assumptions to the model were incorporated. A series of runs were performed with five different toll rates (ranging from \$0.20/mile to \$1.00/mile in increments of \$0.20/mile) and two different value-of-time distributions (low and high) for every year-alternative-time period combination to identify the rate that generates an acceptable level of service on the bus toll facilities while maximizing revenue and vehicle occupancy.

The results from the 480 model runs were put into an Excel-based “dashboard” application that enables the analyst to vary the assumptions and performance criteria and calculate the resulting revenue and demand by scenario, year, time period, and value of time assumption. The spreadsheets were provided to the study team for comments and questions resulting in several refinements.

The final BTL toll rates in 5-cents increments were computed by means of interpolating between the known model runs and maximizing a function weighing the BTL vehicle-miles traveled (VMT) and the BTL vehicle-occupancy ratio (VOR) all the while maintaining a threshold speed set of 50 mph for the freeways, 25 mph for ramps and 30 mph for the arterials (primarily queue jumps).

Figures D-31 through D-33 are from the Excel-based “dashboard” and Table D-2 presents the interpolations based on the dashboard results and maximizing function. The speeds above threshold values are shown in green and the ones below are shown in red.

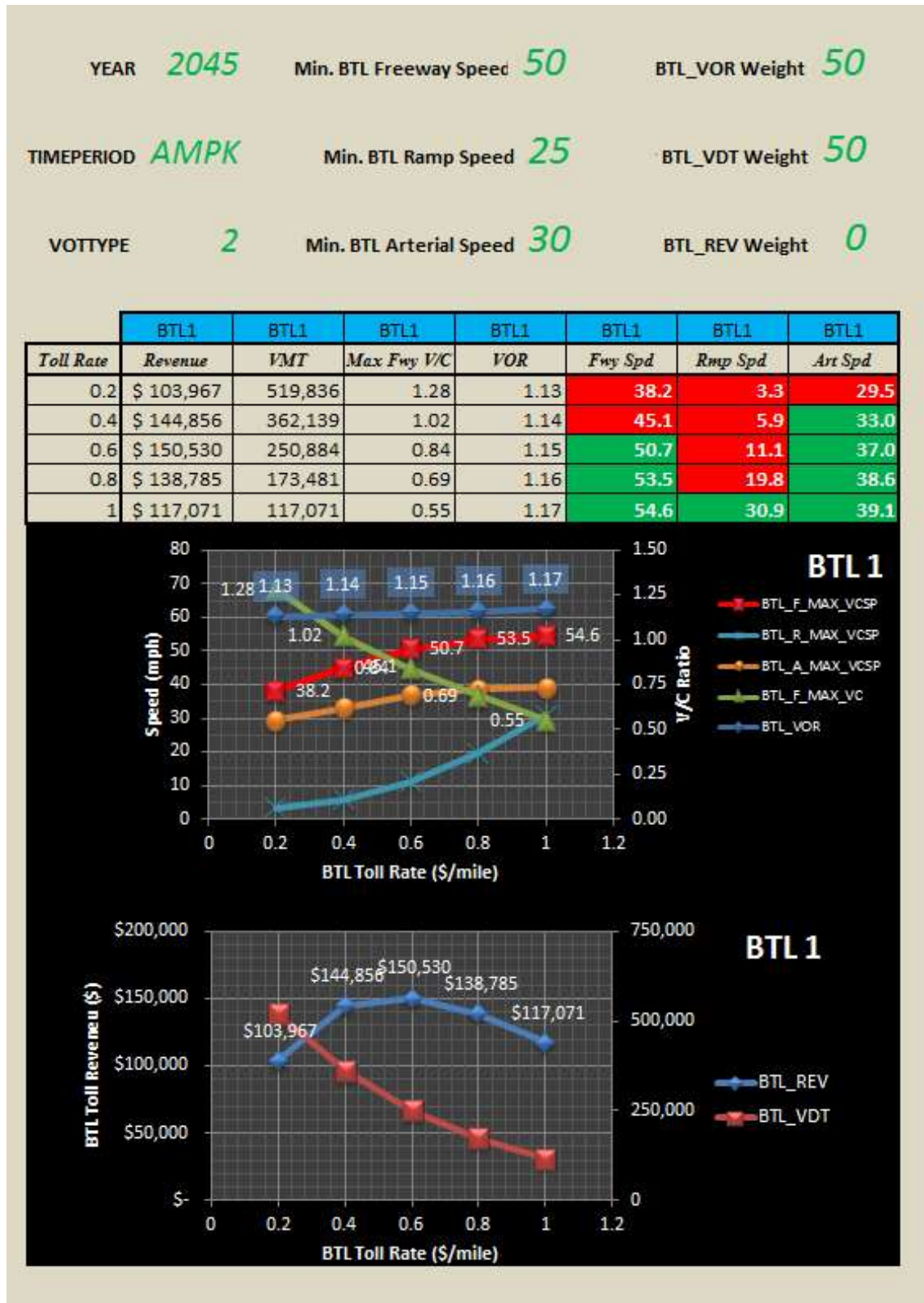


Figure D - 31: Highway Performance Dashboard – BTL #1 (Source: AECOM)

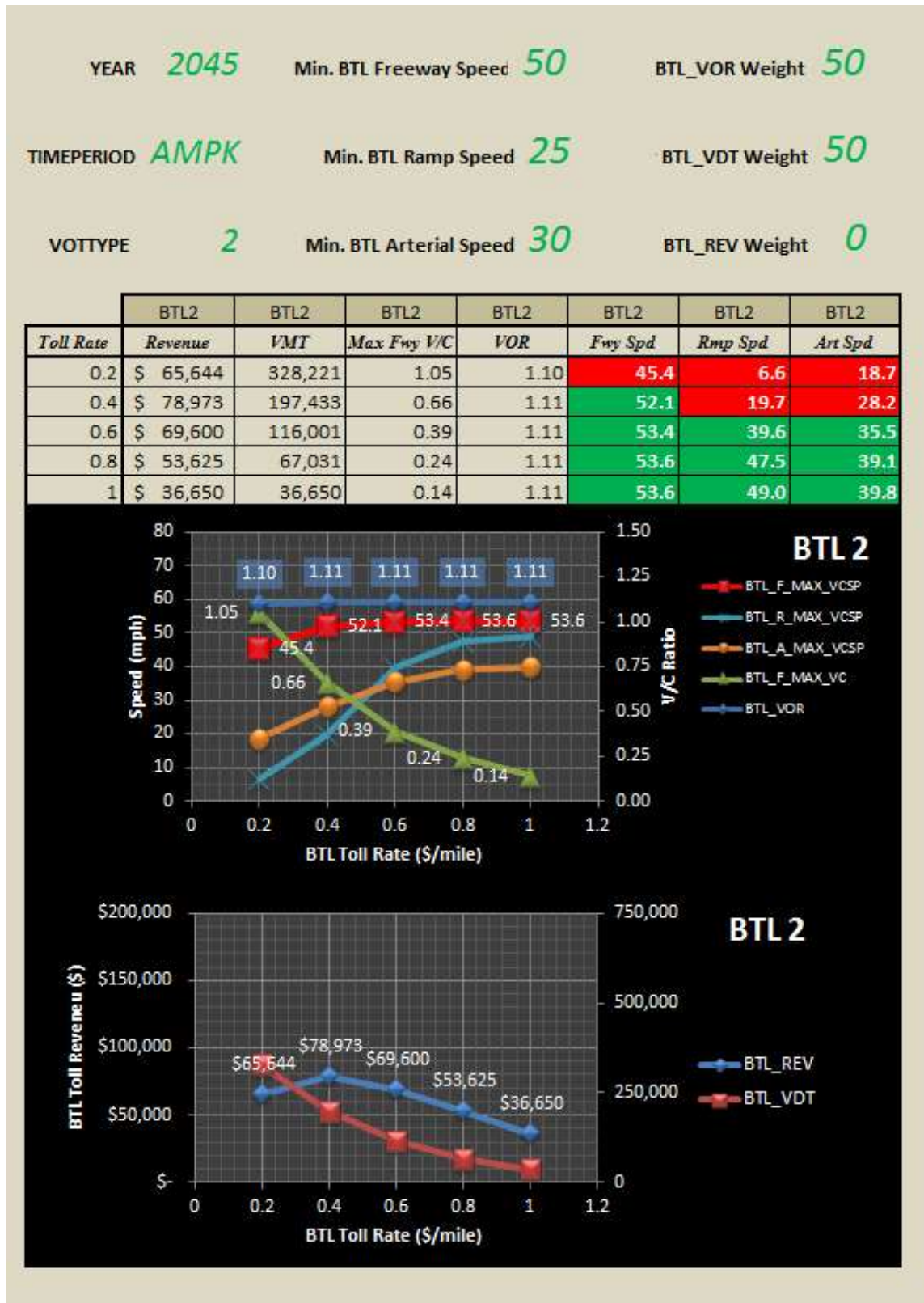


Figure D - 292: Highway Performance Dashboard – BTL #2 (Source: AECOM)

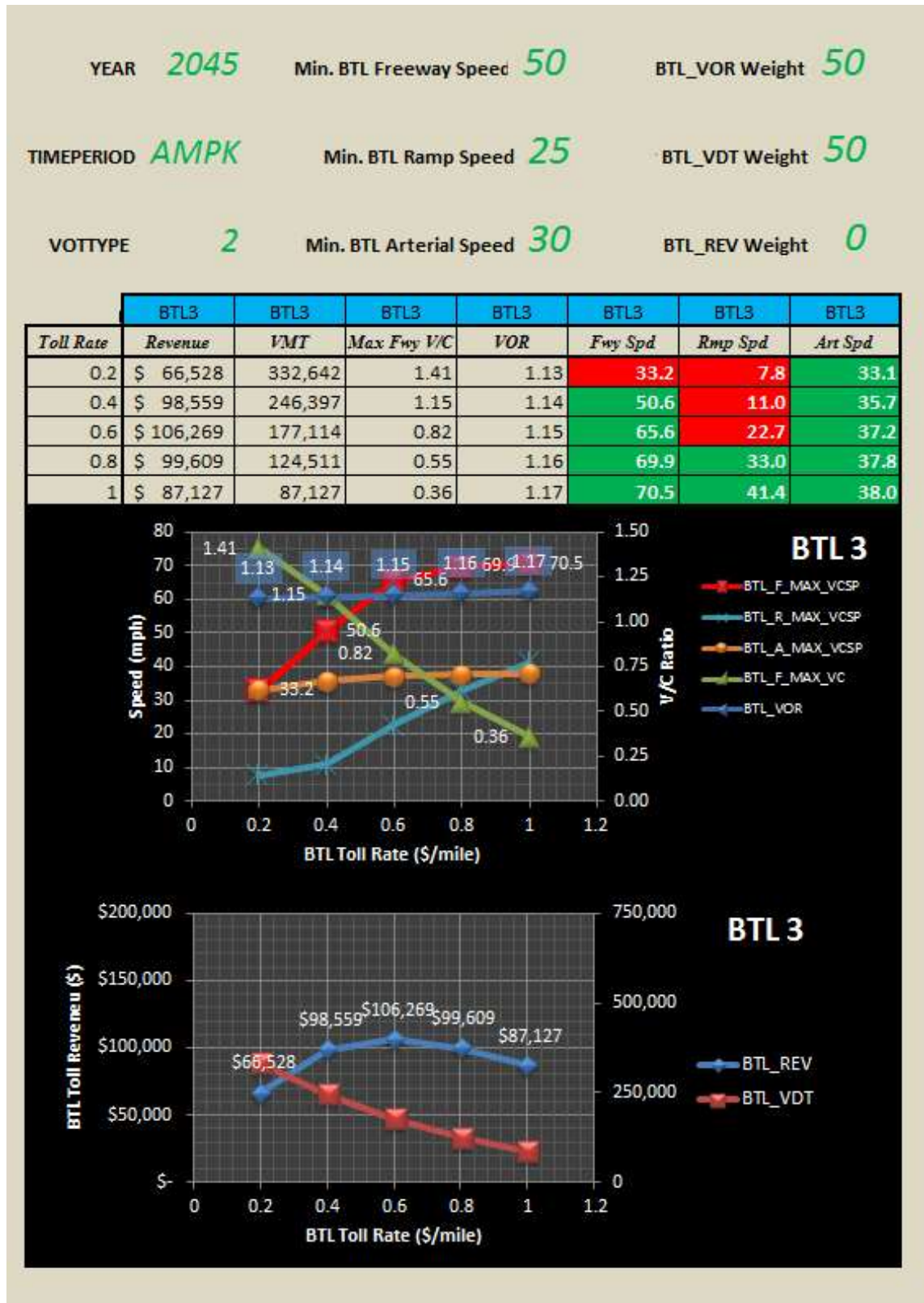


Figure D - 303: Highway Performance Dashboard – BTL #3 (Source: AECOM)

**Table D - 2: Interpolations to Obtain 5-Cent Toll Increments
(Source: AECOM)**

INTERPOLATION VALUES FOR 5 CENT TOLL INCREMENTS								
	BTL1	BTL1	BTL1	BTL1	BTL1	BTL1	BTL1	BTL1
Toll Rate	Revenue	VMT	Max Fwy V/C	VOR	Fwy Spd	Rmp Spd	Art Spd	Max_Func
0.20	\$ 103,967	519,836	1.28	1.13	38.2	3.3	29.5	
0.25	\$ 114,189	480,412	1.22	1.13	39.9	4.0	30.4	
0.30	\$ 124,412	440,988	1.15	1.14	41.7	4.6	31.3	
0.35	\$ 134,634	401,564	1.09	1.14	43.4	5.3	32.1	
0.40	\$ 144,856	362,139	1.02	1.14	45.1	5.9	33.0	
0.45	\$ 146,274	334,325	0.98	1.14	46.5	7.2	34.0	
0.50	\$ 147,693	306,512	0.93	1.15	47.9	8.5	35.0	
0.55	\$ 149,112	278,698	0.89	1.15	49.3	9.8	36.0	
0.60	\$ 150,530	250,884	0.84	1.15	50.7	11.1	37.0	
0.65	\$ 147,594	231,533	0.80	1.15	51.4	13.3	37.4	
0.70	\$ 144,658	212,183	0.77	1.16	52.1	15.5	37.8	
0.75	\$ 141,721	192,832	0.73	1.16	52.8	17.6	38.2	
0.80	\$ 138,785	173,481	0.69	1.16	53.5	19.8	38.6	
0.85	\$ 135,856	159,379	0.66	1.16	53.8	22.6	38.7	
0.90	\$ 127,928	145,276	0.62	1.17	54.1	25.4	38.9	✓
0.95	\$ 122,499	131,173	0.59	1.17	54.3	28.1	39.0	
1.00	\$ 117,071	117,071	0.55	1.17	54.6	30.9	39.1	

	BTL2	BTL2	BTL2	BTL2	BTL2	BTL2	BTL2	BTL2
Toll Rate	Revenue	VMT	Max Fwy V/C	VOR	Fwy Spd	Rmp Spd	Art Spd	Max_Func
0.20	\$ 65,644	328,221	1.05	1.10	45.4	6.6	18.7	
0.25	\$ 68,976	295,524	0.95	1.10	47.1	9.9	21.1	
0.30	\$ 72,309	262,827	0.86	1.11	48.8	13.2	23.5	
0.35	\$ 75,641	230,130	0.76	1.11	50.4	16.4	25.8	
0.40	\$ 78,973	197,433	0.66	1.11	52.1	19.7	28.2	
0.45	\$ 76,630	177,075	0.59	1.11	52.4	24.7	30.0	
0.50	\$ 74,287	156,717	0.53	1.11	52.8	29.7	31.9	✓
0.55	\$ 71,944	136,359	0.46	1.11	53.1	34.6	33.7	
0.60	\$ 69,600	116,001	0.39	1.11	53.4	39.6	35.5	
0.65	\$ 65,606	103,758	0.35	1.11	53.5	41.6	36.4	
0.70	\$ 61,613	91,516	0.32	1.11	53.5	43.6	37.3	
0.75	\$ 57,619	79,273	0.28	1.11	53.6	45.5	38.2	
0.80	\$ 53,625	67,031	0.24	1.11	53.6	47.5	39.1	
0.85	\$ 49,381	59,436	0.22	1.11	53.6	47.9	39.3	
0.90	\$ 45,137	51,840	0.19	1.11	53.6	48.3	39.5	
0.95	\$ 40,893	44,245	0.17	1.11	53.6	48.6	39.6	
1.00	\$ 36,650	36,650	0.14	1.11	53.6	49.0	39.8	

	BTL3	BTL3	BTL3	BTL3	BTL3	BTL3	BTL3	BTL3
Toll Rate	Revenue	VMT	Max Fwy V/C	VOR	Fwy Spd	Rmp Spd	Art Spd	Max_Func
0.20	\$ 66,528	332,642	1.41	1.13	33.2	7.8	33.1	
0.25	\$ 74,536	311,081	1.35	1.13	37.6	8.6	33.8	
0.30	\$ 82,544	289,520	1.28	1.14	41.9	9.4	34.4	
0.35	\$ 90,551	267,958	1.22	1.14	46.3	10.2	35.1	
0.40	\$ 98,559	246,397	1.15	1.14	50.6	11.0	35.7	
0.45	\$ 100,486	229,076	1.07	1.14	54.4	13.9	36.1	
0.50	\$ 102,414	211,756	0.99	1.15	58.1	16.9	36.5	
0.55	\$ 104,341	194,435	0.90	1.15	61.9	19.8	36.8	
0.60	\$ 106,269	177,114	0.82	1.15	65.6	22.7	37.2	
0.65	\$ 104,604	163,964	0.75	1.15	66.7	25.3	37.4	✓
0.70	\$ 102,939	150,813	0.69	1.16	67.8	27.9	37.5	
0.75	\$ 101,274	137,662	0.62	1.16	68.8	30.4	37.7	
0.80	\$ 99,609	124,511	0.55	1.16	69.9	33.0	37.8	
0.85	\$ 96,489	115,165	0.50	1.16	70.1	35.1	37.9	
0.90	\$ 93,368	105,819	0.46	1.17	70.2	37.2	37.9	
0.95	\$ 90,248	96,473	0.41	1.17	70.4	39.3	38.0	
1.00	\$ 87,127	87,127	0.36	1.17	70.5	41.4	38.0	

Table D-3 presents the final recommended BTL toll rates along with the BTL toll revenue and BTL VMT. Note that these tables do not include toll inflation and weekday representations for the corresponding time periods.

Table D - 3: Recommended BTL Toll Rates (Source: AECOM)

Year	TimePeriod	VOT-TYPE 1=Low, 2=High	BTL1	BTL1	BTL1	BTL1	BTL2	BTL2	BTL2	BTL2	BTL3	BTL3	BTL3	BTL3
			BTL_RATE (\$/mi)	BTL_VOR (veh occ. rate)	BTL_REV (\$)	BTL_VMT (veh- miles)	BTL_RATE (\$/mi)	BTL_VOR (veh occ. rate)	BTL_REV (\$)	BTL_VMT (veh- miles)	BTL_RATE (\$/mi)	BTL_VOR (veh occ. rate)	BTL_REV (\$)	BTL_VMT (veh- miles)
2015	AMPK	1	0.45	1.13	\$ 41,782	97,229	0.40	1.10	\$ 21,335	53,338	0.50	1.12	\$ 23,376	50,203
2015	PMPK	1	0.30	1.16	\$ 20,962	84,377	0.25	1.11	\$ 14,825	67,695	0.30	1.15	\$ 16,686	66,760
2015	MDOP	1	0.35	1.14	\$ 18,732	64,826	0.30	1.09	\$ 14,971	61,147	0.40	1.09	\$ 15,944	39,661
2015	EVOP	1	0.20	1.15	\$ 15,983	79,914	0.20	1.10	\$ 9,758	48,788	0.35	1.13	\$ 8,271	29,240
2015	AMPK	2	0.55	1.13	\$ 51,233	97,448	0.50	1.10	\$ 24,966	53,887	0.60	1.12	\$ 28,731	47,918
2015	PMPK	2	0.55	1.16	\$ 26,937	86,756	0.30	1.14	\$ 18,178	72,128	0.35	1.14	\$ 21,041	68,906
2015	MDOP	2	0.40	1.15	\$ 22,881	57,202	0.40	1.10	\$ 16,184	40,459	0.55	1.08	\$ 13,903	28,036
2015	EVOP	2	0.25	1.15	\$ 20,119	93,109	0.20	1.10	\$ 13,222	66,108	0.35	1.13	\$ 11,910	41,464
2025	AMPK	1	0.60	1.13	\$ 54,023	90,038	0.30	1.10	\$ 30,101	116,665	0.40	1.11	\$ 38,551	96,377
2025	PMPK	1	0.20	1.10	\$ 33,354	166,768	0.20	1.14	\$ 18,377	91,885	0.25	1.15	\$ 24,097	108,610
2025	MDOP	1	0.30	1.14	\$ 33,529	139,867	0.30	1.09	\$ 19,648	82,926	0.50	1.11	\$ 18,582	41,841
2025	EVOP	1	0.20	1.18	\$ 15,917	79,584	0.20	1.11	\$ 7,673	38,364	0.30	1.17	\$ 9,940	41,963
2025	AMPK	2	0.75	1.14	\$ 62,803	86,045	0.35	1.10	\$ 38,377	121,600	0.50	1.11	\$ 46,752	96,907
2025	PMPK	2	0.30	1.16	\$ 37,170	146,255	0.25	1.14	\$ 22,076	101,116	0.30	1.15	\$ 29,771	114,818
2025	MDOP	2	0.35	1.15	\$ 40,012	137,821	0.35	1.09	\$ 22,638	78,397	0.55	1.10	\$ 22,658	45,748
2025	EVOP	2	0.20	1.18	\$ 22,063	110,313	0.20	1.11	\$ 10,603	53,016	0.35	1.16	\$ 11,689	40,954
2035	AMPK	1	0.60	1.14	\$ 77,005	128,342	0.35	1.10	\$ 42,133	132,204	0.45	1.14	\$ 52,375	121,108
2035	PMPK	1	0.30	1.18	\$ 44,670	173,036	0.25	1.14	\$ 26,155	118,220	0.30	1.18	\$ 32,609	125,281
2035	MDOP	1	0.40	1.14	\$ 56,202	140,506	0.40	1.09	\$ 30,465	76,163	0.60	1.10	\$ 23,924	39,874
2035	EVOP	1	0.20	1.19	\$ 34,688	173,439	0.20	1.10	\$ 15,069	75,344	0.35	1.17	\$ 19,619	64,986
2035	AMPK	2	0.75	1.14	\$ 91,304	124,826	0.50	1.10	\$ 50,495	107,470	0.55	1.14	\$ 65,376	123,163
2035	PMPK	2	0.35	1.18	\$ 57,437	183,458	0.30	1.14	\$ 32,181	125,035	0.35	1.18	\$ 42,216	132,084
2035	MDOP	2	0.50	1.16	\$ 59,465	132,937	0.50	1.10	\$ 31,081	70,054	0.70	1.09	\$ 25,953	39,961
2035	EVOP	2	0.25	1.19	\$ 42,207	191,453	0.20	1.10	\$ 20,584	102,922	0.40	1.17	\$ 25,365	63,414
2045	AMPK	1	0.75	1.16	\$ 93,482	127,444	0.40	1.11	\$ 48,827	122,067	0.55	1.16	\$ 68,834	129,221
2045	PMPK	1	0.35	1.19	\$ 52,435	166,266	0.30	1.14	\$ 27,394	107,329	0.30	1.19	\$ 41,304	155,278
2045	MDOP	1	0.50	1.15	\$ 88,127	192,674	0.45	1.11	\$ 54,144	127,742	0.70	1.11	\$ 38,444	59,121
2045	EVOP	1	0.35	1.21	\$ 42,558	137,901	0.20	1.11	\$ 22,334	111,672	0.35	1.20	\$ 32,430	103,509
2045	AMPK	2	0.90	1.17	\$ 112,344	127,557	0.50	1.11	\$ 59,416	125,414	0.65	1.15	\$ 86,944	136,371
2045	PMPK	2	0.35	1.19	\$ 68,934	214,974	0.33	1.14	\$ 34,854	111,447	0.40	1.18	\$ 54,879	137,157
2045	MDOP	2	0.60	1.15	\$ 98,286	163,810	0.55	1.11	\$ 61,976	120,594	0.80	1.10	\$ 38,871	46,089
2045	EVOP	2	0.40	1.21	\$ 55,284	138,209	0.25	1.11	\$ 26,841	121,856	0.35	1.20	\$ 42,432	133,624

Final Transit Ridership and Revenue Results

Given the results of the toll rate calculations and the related transit assumptions, the final set of model runs to estimate the transit ridership for each scenario were performed. The resulting peak, off-peak and daily ridership values are shown in Tables D-4 through D-6 for BTL Networks #1, #2 and #3 respectively.

Table D - 4: BTL Network #1 Transit Ridership Results (Source: AECOM)

Bus Toll Lane Network Alternative 1 Existing Ridership Summary			Estimated Model Peak Ridership (2-way)				Estimated Model Off-Peak Ridership (2-way)			
Corridor	Existing Express Route #	Average Weekday Boardings**	2015	2025	2035	2045	2015	2025	2035	2045
Apollo Beach/Gibsonton to MacDill		N/A	41	28	43	47	22	22	26	28
Brandon to Westshore		N/A	6	5	4	3	123	143	170	183
Northwest County to Westshore		N/A	189	200	214	234	165	181	186	207
North Brandon to MacDill		N/A	61	71	69	69	126	145	167	190
Lutz Express	20	68	670	744	811	862	389	393	428	433
Dover - Brandon Express	22	60	1,358	1,174	1,408	1,357	514	522	675	732
Fishhawk-Riverview-MacDill	24	113	346	124	280	263	194	148	186	196
Brandon-MacDill	25	148	823	267	827	823	347	285	387	400
Fishhawk-South Brandon	27	123	872	684	930	936	449	460	602	643
East County	28	34	358	370	283	275	210	245	285	286
Brandon-Southshore	35*	15	250	218	329	432	149	130	156	174
Southshore Limited	47	85	242	204	195	182	49	54	59	71
Citrus Park-Carrollwood	50	45	464	377	340	375	102	100	111	126
New Tampa-Pasco	51	45	695	836	876	854	238	226	307	298
Oldsmar-Town 'n' Country	59*	47	351	408	398	441	908	964	1,024	1,090
Clearwater Express	200	97	282	239	229	225	170	156	183	186
PSTA 100X	100X***	207	797	800	1,053	1,074	835	920	1,263	1,317
PSTA 300X	300X***	149	302	313	371	377	300	285	334	343
MetroRapid - Hillsborough Ave		2,045	312	350	376	406	290	334	342	366
Northwest Limited Express (R)	61	42	394	360	340	357	352	335	360	364
Sub Total		3,325	8,817	7,784	9,326	9,612	5,932	6,058	7,251	7,642
HART 405: MetroRapid: Downtown to Brandon										
HART 404: MetroRapid: East-West										
HART 403: MetroRapid: Downtown to Tampa Airport			740	640	752	746	217	249	253	261
HART 402: MetroRapid: Dale Mabry/Himes Ave.										
HART 411: Route 2 - Nebraska Avenue (UATC to Downtown)										
HART 410: Route 5 - 40th St (Cross Creek to Downtown)			740	640	752	746	217	249	253	261
Sub Total			740	640	752	746	217	249	253	261
Grand Total			9,557	8,424	10,078	10,358	6,149	6,307	7,504	7,903

Bus Toll Lane Network Alternative 1 Existing Ridership Summary			Estimated Model Daily Ridership (2-ww)			
Corridor	Existing Express Route #	Average Weekday	2015	2025	2035	2045
Apollo Beach/Gibsonton to MacDill		N/A	63	50	69	75
Brandon to Westshore		N/A	129	148	174	186
Northwest County to Westshore		N/A	354	381	400	441
North Brandon to MacDill		N/A	189	218	236	259
Lutz Express	20	68	1,059	1,137	1,239	1,315
Dover - Brandon Express	22	60	1,872	1,696	2,083	2,089
Fishhawk-Riverview-MacDill	24	113	540	272	466	459
Brandon-MacDill	25	148	1,170	552	1,234	1,232
Fishhawk-South Brandon	27	123	1,321	1,144	1,532	1,579
East County	28	34	568	615	568	561
Brandon-Southshore	35*	15	399	348	485	606
Southshore Limited	47	85	291	258	254	253
Citrus Park-Carrollwood	50	45	566	477	451	501
New Tampa-Pasco	51	45	933	1,062	1,113	1,152
Oldsmar-Town 'n' Country	59*	47	1,261	1,372	1,422	1,531
Clearwater Express	200	97	452	405	412	411
PSTA 100X	100X***	207	1,632	1,720	2,316	2,391
PSTA 300X	300X***	149	602	598	705	720
MetroRapid - Hillsborough Ave		2,045	602	694	718	772
Northwest Limited Express (R)	61	42	746	695	700	721
Sub Total		3,325	14,748	13,842	16,577	17,254
HART 405: MetroRapid: Downtown to Brandon						
HART 404: MetroRapid: East-West						
HART 403: MetroRapid: Downtown to Tampa Airport			957	889	1,005	1,007
HART 402: MetroRapid: Dale Mabry/Himes Ave.						
HART 411: Route 2 - Nebraska Avenue (UATC to Downtown)						
HART 410: Route 5 - 40th St (Cross Creek to Downtown)			957	889	1,005	1,007
Sub Total			957	889	1,005	1,007
Grand Total			15,706	14,731	17,582	18,261

*Terminated by HART on July 10, 2011; ridership reflects average weekday boardings from 10/10 - 02/11.
 **Reflects the existing express route stop APC boarding data collected in 11/2011.
 ***Reflects PSTA 100X and 300X average weekday boardings for FY 2011
 (R) Also part of this alternative.

Table D - 5: BTL Network #2 Transit Ridership Results (Source: AECOM)

Bus Toll Lane Network Alternative 2 Existing Ridership Summary

Carrier	Existing Express Route #	Average Weekday Boardings**
New Tampa-Westshore		N/A
Brandon to Westshore		N/A
Northwest County to USF		N/A
Northwest County to Westshore		N/A
USF to Westshore		N/A
North Brandon to MacDill		N/A
Lutz Express	20	68
Dover - Brandon Express	22	60
Fishhawk-Riverview-MacDill	24	115
Bradon-MacDill	25	148
Fishhawk-South Brandon	27	123
East County	28	34
Brandon-Southshore	35*	15
Southshore Limited	47	85
Citrus Park-Carrollwood	50	45
New Tampa-Pasco	51	45
Oldsmar-Town 'n' Country-Alt1	59*	47
Oldsmar-Town 'n' Country-Alt2	59*	47
Northwest Limited Express	61	42
Clearwater Express	200	97
PSTA 100X	100X***	207
PSTA 300X	300X***	149
MetroRapid - Hillsborough Ave		2,045
MetroRapid - Dale Mabry Hwy		1,804
Dale Mabry Hwy Express		
Sub Total		5,176
HART 405: MetroRapid: Downtown to Brandon		
HART 404: MetroRapid: East-West		
HART 403: MetroRapid: Downtown to Tampa Airport		
HART 402: MetroRapid: Dale Mabry/Himes Ave.		
HART 411: Route 2 - Nebraska Avenue (UATC to Downtown)		
HART 410: Route 5 - 40th St (Cross Creek to Downtown)		
Sub Total		
Grand Total		

Estimated Model Peak Ridership (2-way)

	2015	2025	2035	2045
132	107	105	114	
8	4	4	4	
77	114	84	93	
82	68	69	72	
223	251	241	229	
53	66	100	103	
876	686	606	566	
1,228	1,028	1,242	1,262	
361	130	133	326	
710	225	636	594	
891	760	1,004	1,000	
431	443	382	358	
270	292	317	284	
314	264	279	281	
400	552	559	648	
724	300	908	1,009	
288	346	352	370	
296	323	328	343	
518	480	479	475	
47	44	43	43	
801	815	1,040	1,062	
344	352	402	408	
188	235	241	262	
432	565	610	682	
752	742	999	1,110	
9,795	9,052	10,281	10,488	
621	593	678	679	
621	593	678	679	
10,416	9,645	10,959	11,167	

Estimated Model Off-Peak Ridership (2-way)

	2015	2025	2035	2045
225	224	321	291	
127	143	156	165	
120	206	149	169	
137	151	158	166	
481	860	443	457	
171	149	171	195	
915	1,051	948	987	
557	583	744	803	
179	133	173	185	
351	296	401	423	
534	557	731	756	
212	254	291	291	
225	237	277	338	
26	30	32	41	
373	500	512	806	
192	186	259	250	
523	599	629	656	
733	799	833	883	
304	297	310	311	
177	175	192	195	
877	970	1,312	1,379	
296	285	335	344	
335	410	441	478	
534	736	767	829	
734	915	1,000	1,075	
8,547	9,956	10,605	11,198	
451	440	451	460	
451	440	451	460	
8,998	10,396	11,056	11,658	

Bus Toll Lane Network Alternative 2 Existing Ridership Summary

Carrier	Existing Express Route #	Average Weekday Boardings**
New Tampa-Westshore		N/A
Brandon to Westshore		N/A
Northwest County to USF		N/A
Northwest County to Westshore		N/A
USF to Westshore		N/A
North Brandon to MacDill		N/A
Lutz Express	20	68
Dover - Brandon Express	22	60
Fishhawk-Riverview-MacDill	24	115
Bradon-MacDill	25	148
Fishhawk-South Brandon	27	123
East County	28	34
Brandon-Southshore	35*	15
Southshore Limited	47	85
Citrus Park-Carrollwood	50	45
New Tampa-Pasco	51	45
Oldsmar-Town 'n' Country-Alt1	59*	47
Oldsmar-Town 'n' Country-Alt2	59*	47
Northwest Limited Express	61	42
Clearwater Express	200	97
PSTA 100X	100X***	207
PSTA 300X	300X***	149
MetroRapid - Hillsborough Ave		2,045
MetroRapid - Dale Mabry Hwy		1,804
Dale Mabry Hwy Express		
Sub Total		5,176
HART 405: MetroRapid: Downtown to Brandon		
HART 404: MetroRapid: East-West		
HART 403: MetroRapid: Downtown to Tampa Airport		
HART 402: MetroRapid: Dale Mabry/Himes Ave.		
HART 411: Route 2 - Nebraska Avenue (UATC to Downtown)		
HART 410: Route 5 - 40th St (Cross Creek to Downtown)		
Sub Total		
Grand Total		

Estimated Model Daily Ridership (2-way)

	2015	2025	2035	2045
357	331	426	405	
135	149	160	169	
197	322	233	262	
219	219	227	238	
704	1,111	584	586	
174	215	279	298	
1,791	1,737	3,554	1,553	
1,789	1,611	3,980	2,065	
533	263	506	511	
1,061	124	1,037	1,017	
1,427	1,317	1,715	1,756	
643	697	673	649	
504	529	594	622	
340	294	311	322	
863	1,052	1,091	1,254	
916	1,086	1,167	1,253	
811	845	881	1,032	
1,029	1,122	1,161	1,226	
822	777	789	786	
234	219	235	238	
1,678	1,785	2,381	2,441	
640	637	737	752	
323	625	682	740	
966	1,301	1,377	1,511	
1,488	1,657	2,002	2,185	
18,342	18,908	20,886	21,688	
1,072	1,033	1,129	1,139	
1,072	1,033	1,129	1,139	
19,414	19,941	22,015	22,825	

*Terminated by HART on July 10, 2011; ridership reflects average weekday boardings from 10/10 - 02/11.

**Reflects the existing express route stop APC boarding data collected in 11/2011.

***Reflects PSTA 100X and 300X average weekday boardings for FY 2011

(R) Also part of this alternative

Estimated Annual Revenues

The annual toll and transit BTL revenues were estimated by using the set of factors shown in Table D-7 where a 2.5 percent inflation rate per year was assumed. The model year dollars (2010 dollars) were converted to the future year dollars using this inflation rate.

Table D -7: BTL Revenue Conversion Factors (Source: AECOM)

BTL Revenue Factors				
Inflation Rate	2.50%	52 weeks x (5+2x0.5)	Forecast Years	Model-Year \$ to Future-Year \$ Conversion Factor
Initial Model Year	2010		2015	1.1314
Daily-to-Annual VMT Conversion	312		2025	1.4483
Daily-to-Annual Ridership Conversion	310		2035	1.8539
BTL Model Year Express Bus Fare	\$1.00		2045	2.3732

Annual BTL VMT was obtained by using a factor of 312 (one weekend = one weekday) derived from existing demand on the Selmon Expressway.

Annual Transit Ridership was estimated using a factor of 310 assuming partial usage on weekends.

Modeling Conclusions

The BTL networks were successfully modeled and the corresponding toll and transit revenues were estimated at a planning level. The BTL variable toll rates are typically highest in the AM peak period followed by mid-day and PM peak period. The evening time period showed minimal usage of the BTL links. The BTL toll rate setting requirement is seen to be gradually increasing with increasing demand in the future years and approaches a very high value in 2045.

Purely in terms of toll revenue, BTL Network #1 performs the best, followed by BTL Network #3 and BTL Network #2, in that order. Similarly, in terms of transit revenue, BTL Network #3 performs the best, followed by BTL Network #2 and BTL Network #1, in that order.

The modeling also suggests that scenarios with a mix of arterial and freeway facilities are more difficult to stabilize and manage. It was also found that the critical bottleneck links were typically on BTL Network entry and exit ramps. In a number of locations single lane slip ramps limited the utilization of the BTL freeway lanes. A more thorough examination of these as well as all design and operational elements would be performed prior to project formulation and decision making (likely during NEPA studies).

The final annual toll and transit revenues used for input to the financial feasibility model are shown in Table D-8. As described in the table, the BTL concept appears to provide an attractive public transit option with excellent level of service while also delivering a valuable mix of traffic capacity and service to a large volume of willing toll payers.

Table D -8: Estimated Annual BTL Revenues (Source: AECOM)

		Inflation Rate	2.50%				Year	Model Year 5 to Future Year 5 Conversion Factor	
		Model Year	2010				2015	1.1314	
		Daily to Annual VMT Conversion	312	52 weeks x (5 + 2 x 0.5) weekdays			2025	1.4483	
		Daily to Annual Riders Conversion	310				2035	1.8539	
		BTL Model Year Fare	\$1.00				2045	2.3732	
Future Year Dollars									
Highway Revenues									
BTL1									
Year	MIN Annual VMT (vehicle-miles)	AVG Annual VMT (vehicle-miles)	MAX Annual VMT (vehicle-miles)	MIN Weighted Average Toll Rate (\$/mi)	AVG Weighted Average Toll Rate (\$/mi)	MAX Weighted Average Toll Rate (\$/mi)	MIN Gross Revenue (\$)	AVG Gross Revenue (\$)	MAX Gross Revenue (\$)
2015	101,819,960	103,093,514	104,367,069	\$ 0.34	\$ 0.37	\$ 0.41	\$ 34,402,817	\$ 38,478,512	\$ 42,554,206
2025	148,592,482	149,244,147	149,895,812	\$ 0.42	\$ 0.45	\$ 0.49	\$ 61,825,716	\$ 67,524,789	\$ 73,223,861
2035	191,980,701	194,375,562	196,770,422	\$ 0.64	\$ 0.69	\$ 0.74	\$ 122,954,387	\$ 133,900,168	\$ 144,845,949
2045	194,776,609	197,938,097	201,099,584	\$ 1.05	\$ 1.14	\$ 1.23	\$ 204,807,071	\$ 226,378,444	\$ 247,949,818
BTL2									
Year	MIN Annual VMT (vehicle-miles)	AVG Annual VMT (vehicle-miles)	MAX Annual VMT (vehicle-miles)	MIN Weighted Average Toll Rate (\$/mi)	AVG Weighted Average Toll Rate (\$/mi)	MAX Weighted Average Toll Rate (\$/mi)	MIN Gross Revenue (\$)	AVG Gross Revenue (\$)	MAX Gross Revenue (\$)
2015	72,062,096	72,313,924	72,565,752	\$ 0.30	\$ 0.33	\$ 0.35	\$ 21,493,778	\$ 23,551,752	\$ 25,609,726
2025	102,910,132	106,699,127	110,488,122	\$ 0.33	\$ 0.36	\$ 0.38	\$ 34,251,414	\$ 38,339,513	\$ 42,427,613
2035	125,402,315	125,956,151	126,509,988	\$ 0.53	\$ 0.57	\$ 0.61	\$ 65,838,337	\$ 71,772,730	\$ 77,707,124
2045	146,269,100	147,906,833	149,544,566	\$ 0.77	\$ 0.84	\$ 0.91	\$ 113,064,845	\$ 124,315,145	\$ 135,565,445
BTL3									
Year	MIN Annual VMT (vehicle-miles)	AVG Annual VMT (vehicle-miles)	MAX Annual VMT (vehicle-miles)	MIN Weighted Average Toll Rate (\$/mi)	AVG Weighted Average Toll Rate (\$/mi)	MAX Weighted Average Toll Rate (\$/mi)	MIN Gross Revenue (\$)	AVG Gross Revenue (\$)	MAX Gross Revenue (\$)
2015	58,051,676	58,092,462	58,133,249	\$ 0.39	\$ 0.42	\$ 0.46	\$ 22,689,890	\$ 24,689,078	\$ 26,688,266
2025	90,103,638	91,917,798	93,731,959	\$ 0.46	\$ 0.50	\$ 0.53	\$ 41,196,894	\$ 45,647,857	\$ 50,098,810
2035	109,589,778	110,739,737	111,889,696	\$ 0.68	\$ 0.75	\$ 0.82	\$ 74,343,992	\$ 83,131,531	\$ 91,919,070
2045	139,504,555	140,464,046	141,423,536	\$ 0.96	\$ 1.06	\$ 1.16	\$ 134,029,006	\$ 148,879,385	\$ 163,729,763
Transit Revenues									
BTL1									
Year	MIN Annual Riders	AVG Annual Riders	MAX Annual Riders	MIN Weighted Average Fare (\$/rider)	AVG Weighted Average Fare (\$/rider)	MAX Weighted Average Fare (\$/rider)	MIN Gross Revenue (\$)	AVG Gross Revenue (\$)	MAX Gross Revenue (\$)
2015		4,868,860			\$ 1.13			\$ 5,508,668	
2025		5,159,640			\$ 1.45			\$ 7,472,697	
2035		5,450,420			\$ 1.85			\$ 10,104,774	
2045		5,660,910			\$ 2.37			\$ 13,434,501	
BTL2									
Year	MIN Annual Riders	AVG Annual Riders	MAX Annual Riders	MIN Weighted Average Fare (\$/rider)	AVG Weighted Average Fare (\$/rider)	MAX Weighted Average Fare (\$/rider)	MIN Gross Revenue (\$)	AVG Gross Revenue (\$)	MAX Gross Revenue (\$)
2015		6,018,340			\$ 1.13			\$ 6,809,199	
2025		6,421,495			\$ 1.45			\$ 9,300,239	
2035		6,824,650			\$ 1.85			\$ 12,652,520	
2045		7,075,750			\$ 2.37			\$ 16,792,207	
BTL3									
Year	MIN Annual Riders	AVG Annual Riders	MAX Annual Riders	MIN Weighted Average Fare (\$/rider)	AVG Weighted Average Fare (\$/rider)	MAX Weighted Average Fare (\$/rider)	MIN Gross Revenue (\$)	AVG Gross Revenue (\$)	MAX Gross Revenue (\$)
2015		7,245,940			\$ 1.13			\$ 8,198,116	
2025		7,456,585			\$ 1.45			\$ 10,799,358	
2035		7,667,230			\$ 1.85			\$ 14,214,616	
2045		7,926,390			\$ 2.37			\$ 18,810,950	

Note: The weighted averaged toll rates are computed by taking a ratio of the annualized VMT and annualized revenue.

BTL Roadway Capital and Operating Cost Estimates

Capital costs for the roadway component of each BTL Network roadway were developed using standard planning methodologies.

Capital Cost Estimating Methodology

General Approach

The methodology used to develop the cost estimates (and unit costs) for the Bus Toll Lane projects were based on the “top-down” method. For this method, an order of magnitude cost is determined, usually derived from data from similar projects. This cost is used directly or divided by some measure, (such as route foot) and applied as unit cost. Alternatively, the “bottom-up” approach could be used for the unit costs, where the cost of major work elements is determined by totaling the cost of their components parts. In order to use this approach, sufficient engineering design and calculation is required to produce the quantities of the facility. The unit cost developed, combined with the calculated quantities of the major category of work determines the cost. The “top-down” approach was used for this feasibility study because the required detail for the “bottom-up” approach was not yet developed. The “top-down” approach for this feasibility level of analysis was determined sufficiently accurate.

Cost Data

Unit cost data were developed using several resources and are comparable to those seen in the Tampa Bay region for similar type of construction. The cost data would continue to be refined as more information becomes available in design development phases of the project. The first task in developing the cost data was the preparation of a list of project types included in the various alternative networks. The cost of these project types have been estimated using various cost references and historical FDOT cost data.

Unit costs were developed for the following units: per centerline mile, per square foot, per lane (foot for standard or extended special lane type), and/or lump sum. Unit costs included in the estimates are derived from multiple sources. These sources are as follows:

- FDOT (D-7) LRE System of historical costs in District 7 (2011) per Centerline Mile
- FDOT (D-5) LRE System of historical costs in District 5 (2007) per Centerline Mile
- FDOT Basis of Estimating and List of Master Pay-Items (2011)
- Tampa Hillsborough Expressway Authority (THEA) – Gandy Connector SEIR/PD&E Study (2010)
- TCRP REPORT 90 – Bus Rapid Transit, Volume 1; Case Studies in BRT (2003)
- TCRP SYNTHESIS 83 - Bus and Rail Preferential Treatment in Mixed Traffic

Capital Cost Categories

The methodology used in developing the capital cost estimates is consistent among all alternative networks. The capital cost components are grouped into four categories as follows: (1) Lanes, (2) ITS/Systems/Signage/Barriers, (3) Ramps and (4) Other.

- **Lanes** – The lanes are identified by facility type, either Interstate/Freeway (guideway) or Urban Arterial (virtual guideway). The lane facility type was further defined by the “Project Type”. Project types for Interstate/Freeway guideway facilities included: Lane – Bus Toll Lane (BTL) reversible, Elevated one lane in each direction (2-lanes total), Elevated two lanes in each direction (4-lanes total). Project types for urban facilities included: Add one arterial lane each direction, Elevated lane in each direction (2-lanes total), Elevated two-lanes in each direction (4-lanes total), Queue Jump (one-lane in each direction), Left Turn Queue Jump (one-lane), and Curb Bus Lane.
- **ITS/Systems/Signage/Barriers** – These are identified by facility type, either Interstate/Freeway or Urban Arterial, and further defined by the “Project Type”. Project types included: Turn Prohibition, New Signal with Traffic Signal Priority (TSP), Transit Signal Priority, and Reversible Gates and Communication.
- **Ramps** – Ramps are identified by facility type, either Interstate/Freeway or Urban Arterial, and further defined by the “Project Type”. Project types included: Ramps: Slip Ramps/Exit Ramps/Frontage Egress, Relocate Slip Ramp, Close Slip Ramp (includes ramp and/or bridge removal), Reconfigure Frontage road to Close Slip Ramp, Direct Connect Ramp, and One Lane Reversible Direct Connect Ramp.
- **Other** –The projects identified as Interstate/Freeway as defined in the current Transportation Improvement Program (TIP) as being in the network, but the capital costs are not included in the network cost estimate.

Estimating Procedure

The estimating procedure utilized a unit cost look-up table that included all possible project types for the alternative networks. Contingencies of specific unit costs were passed through from the cost reference source, but no additional contingency assumptions were added to the individual project or network cost. The steps for estimating cost for each network project were as follows:

- Identification of the facility (e.g., Veterans Express – (Interstate/Freeway))
- Identification of the project type (e.g., 2 lane BTL, reversible)
- Identification of projects limits and calculation of distance (e.g. From: “Gunn” To: Dale Mabry Hwy Exit; distance = 4.70 miles; or identification of lane type of “standard” or “extended” to assume distance)
- Identification of number of lanes, if applicable (e.g., 2 lanes)
- Retrieve unit cost from look-up table
- Calculation of project cost
- Summation of all network’s project cost to estimate alternative network cost

Roadway Construction Cost Assumptions

The following tables identify the base and sources for the capital cost assumptions for the BTL network roadway options.

Table D-9 presents the unit cost assumptions for the major component of the construction elements for the BTR networks.

Table D - 9: BTL Unit Cost Assumptions Source: (Source: American Consulting Engineers)

Bus Toll Lanes Study - Initial Cost Estimates

Facility Type	Project Type	Cost (per mile, sq. ft., lane, or lump-sum)	Distance / Notes	Cost Assumptions / Notes
LANES				
Interstate/ Freeway	Lane - BTL reversible	\$1,700,591	Rural Arterial Cost Type - Per centerline mile	All lane costs assume no required R/W acquisition cost Cost from FDOT (D7) LRE Systems - Add 1 Through Lane on Inside (To Existing) with 5' Paved Shoulders
Interstate/ Freeway	Elevated one lane in each direction (2-lanes total)	\$37,620,000	Per Mile (converted from 57' cross-section @ \$125/sf)	Cost from FDOT (D7) LRE Systems - 2011 Bridge Cost Per Square Foot - FDOT District 7 Low Level; Assume 57 foot typical section width per Gandy design. Shoulder width same as urban arterial.
Interstate/ Freeway	Elevated two lanes in each direction (4-lanes total)	\$53,460,000	Per Mile (converted from 57' cross-section @ \$125/sf)	Cost from FDOT (D7) LRE Systems - 2011 Bridge Cost Per Square Foot - FDOT District 7 Low Level; Assume 81 foot typical section width per Gandy design plus two 12 foot lanes.
Urban Arterial	Add one arterial lane each direction	\$1,643,383	Inside of Existing	Cost from FDOT (D7) LRE Systems - Add 1 Through Lane on Inside (To Existing) with 5' Sidewalk, and Curb & Gutter
Urban Arterial	Elevated lane in each direction (2-lanes total)	\$37,620,000	Per mile (converted from sq. ft. unit cost)	Cost from FDOT (D7) LRE Systems - 2011 Bridge Cost Per Square Foot - FDOT District 7 Low Level; Assume 57 foot typical section width per Gandy design. Shoulder width same as Interstate/Freeway.
Urban Arterial	Elevated two-lanes in each direction (4-lanes total)	\$58,080,000	Per mile (converted from sq. ft. unit cost)	Cost from FDOT (D7) LRE Systems - 2011 Bridge Cost Per Square Foot - FDOT District 7 Low Level; Assume 88 foot typical section width per Gandy design plus two 12 foot lanes (4-lanes total).
Urban Arterial	Queue Jump (one-lane in each direction)	\$34,105,600	Standard = 2,600 feet	\$88/Sq Ft + 25% Contingency = \$110/Sq Ft; \$110* 300, 960 sqft = \$33,105,600 + \$500K road work on each end = \$34,105,600 (Source THEA) 57 foot typical section.
Urban Arterial	Left Turn Queue Jump (one-lane)	\$60,000	Standard = 150 feet	Queue Jump Costs must include Reversible Gates and Communications; Cost from FDOT (D7) LRE Systems - Assume for each standard queue jump lane (one each direction) 50 % of Add 300' Exclusive Left Turn Lane
Urban Arterial	Curb Bus Lane	\$1,000,000	Per mile	Source: TCRP REPORT 90 - Bus Rapid Transit, Volume 1: Case Studies in BRT (2003)
ITS / SYSTEMS / SIGNAGE/BARRIERS				
Urban Arterial	Turn Prohibition	\$2,000	LS	Sources: New York City Truck Route Management & Community Impact reduction Study (March 2007); TCRP SYNTHESIS 83 - Bus and Rail Preferential Treatments in Mixed Traffic; Cost ranges from \$300 to \$2,000.
Urban Arterial	New Signal With TSP	\$348,500	LS	Cost from FDOT (D7) LRE Systems: Intersection Traffic Signalization (Mast Arm Assembly for 6-Lane Roadway Intersecting 6-Lane Roadway
Urban Arterial	Transit Signal Priority	\$25,000	LS	Source: TCRP SYNTHESIS 83 - Bus and Rail Preferential Treatments in Mixed Traffic
Interstate/ Freeway	Reversible Gates and Communication	\$250,000	LS	Source - THEA
RAMPS				
Interstate/ Freeway	Ramps: Slip Ramps/Exit Ramps/Frontage Egress	\$1,876,832	Per centerline mile	Source: FDOT LRE District Five Centerline Mile Cost (March 2007) - Single Lane Ramp
Interstate/ Freeway	Relocate Slip Ramp	\$1,876,832	Per centerline mile	Source: FDOT LRE District Five Centerline Mile Cost (March 2007) - Single Lane Ramp; Assume 0.5 miles (1-75 projects)
Interstate/ Freeway	Close Slip Ramp	\$211,482	Per mile (converted from sq. yd. (removal) and per acre (clear/grubbing) unit cost)	FDOT Basis of Estimate (BOE) 2011 & Listing of Master Pay-Items; Assume 0.5 miles (1-75 projects); Items include: Removal of Concrete Pavement and Clear & Grubbing (push button contract)
Urban Arterial	Reconfigure Frontage road to Close Slip Ramp	\$1,643,383	Inside of Existing	Cost from FDOT (D7) LRE Systems - Add 1 Through Lane on Inside (To Existing) with 5' Sidewalk, and Curb & Gutter
Interstate/ Freeway	Direct Connect Ramp	\$2,501,634	Per centerline mile	Source: FDOT LRE District Five Centerline Mile Cost (March 2007) - Two Lane Ramp
Interstate/ Freeway	One Lane Reversible Direct Connect Ramp	\$1,876,832	Per centerline mile	Use same cost as slip ramp. Source: FDOT LRE District Five Centerline Mile Cost (March 2007) - Single Lane Ramp

Table D-10 identifies the square footage costs and sources for the structures cost estimating for each BTL network.

Table D - 10: Structures Cost Assumptions (Source: American Consulting Engineers)

2-Lane Structure

Length (Ft)	Width Lane/ 2-Way*	Square Foot (Sq. Ft)	Unit Cost /Sq. Ft (\$)	Cost/Mile (\$)	Notes
5,280	57	300,960	\$88	\$26,484,480	2009 Costs - Gandy Connector Bridge PD&E Study
5,280	57	300,960	\$110	\$34,105,600	\$88 + 25% Cont. = \$110/sqft + \$500K for road work on each end (Q-Jump)
5,280	57	300,960	\$125	\$37,620,000	2011 Bridge Cost Per Square Foot - FDOT District 7 Low Level
5,280	57	300,960	\$140	\$42,134,400	2011 Bridge Cost Per Square Foot - FDOT District 7 Mid Level
5,280	57	300,960	\$145	\$43,639,200	2009 FDOT Structures Design Guidelines (Average of \$130 & \$160)
5,280	57	300,960	\$1	\$300,960	

4-Lane Structure

Length (Ft)	Width Lane/ 2-Way*	Square Foot (Sq. Ft)	Unit Cost /Sq. Ft (\$)	Cost/Mile (\$)	Notes
5,280	88	464,640	\$88	\$40,888,320	2009 Costs - Gandy Connector Bridge PD&E Study
5,280	88	464,640	\$110	\$52,110,400	\$88 + 25% Cont. = \$110/sqft + \$500K for road work on each end (Q-Jump)
5,280	88	464,640	\$125	\$58,080,000	2011 Bridge Cost Per Square Foot - FDOT District 7 Low Level
5,280	88	464,640	\$140	\$65,049,600	2011 Bridge Cost Per Square Foot - FDOT District 7 Mid Level
5,280	88	464,640	\$145	\$67,372,800	2009 FDOT Structures Design Guidelines (Average of \$130 & \$160)
5,280	88	464,640	\$1	\$464,640	

* Barrier separated

Table D-11 depicts the basis for estimates of removal of construction debris, concrete, steel and general clearing and grubbing for the planning cost estimates for the BTL networks:

Table D - 11: Materials Removal Cost Assumptions (Source: American Consulting Engineers)

Removal Concrete-Sq. yard cost

Length (Ft)	Width Lane + shldrs.	Square Foot (Sq. Ft)	Square Yard (Sq. Yd.)	Unit Cost /Sq. Yd. (\$)	Cost/Mile (\$)	Notes
5,280	20	105,600	11,733	\$16.60	\$194,773	FDOT Basis of Estimate (BOE) 2011 & Listing of Master Pay-Items

Clear & Grubbing-per acre costs

Length (Ft)	Width Lane + shldrs.	Square Foot (Sq. Ft)	Acres	Unit Cost /Acre (\$)	Cost/Mile (\$)	Notes
5,280	20	105,600	2	\$6,892.50	\$16,709	FDOT Basis of Estimate (BOE) 2011 & Listing of Master Pay-Items

Total per mile (\$) = \$211,482

Capital Costs by BTL Network

The following table presents a summary of the construction cost by corridor for each BTL network. Tables D-12 through D-14 then present the supporting details of the construction cost for each BTL network.

Table D - 12: Capital Cost for BTL Network #1 (Source: American Consulting Engineers)

BUS TOLL LANE NETWORK 1										
Other Networks	Facility	Type	From	To	Distance (mi)	Notes	Distance (mi)	Number of Lanes	Unit Costs	Total Cost
Veterans Expressways							Sub Total	12.50		\$73,824,629
	Veterans	2 Lane RTT reversible	East	FL 500 (Dale Mabry Hwy) East	4.70		4.70	2	1,750,541	\$7,989,581
	Veterans	2 Lane RTT reversible	North of Hillsborough	West	3.04		3.04	2	1,750,541	\$5,311,634
	Veterans	2 Lane RTT reversible	Reversible Structure	Owen Anderson Road Plaza	0.56	4-Lane 1,000-ft. Structure = \$47.62/M ² . 2-Lane = \$32.46/M ² . 4-lane/2-lane = \$45.54/M ² /lane	0.56	2		\$26,598,000
	Veterans	2 Lane RTT reversible	North of Courtney Campbell	North of Hillsborough	1.80		1.80	2	1,750,541	\$3,121,120
	Veterans - Northern End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
	Veterans - Southern End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
Interchange from Veterans to I-275							Sub Total	0.00		\$0
2.0	Veterans	Improvements as shown in ITR	I-275	North of Courtney Campbell	0.00	<i>Do not include cost</i>		0		\$0
2.0	I-275	Improvements as shown in ITR	Veterans	West Avenue	1.00	<i>Do not include cost</i>		0		\$0
Hillsborough Avenue							Sub Total	2.75		\$98,146,400
2	Hillsborough Avenue	Queue Lane	at Shelton Road	Standard	ACL - Queue Lane Costs must include Reversible Gates & Communications	0.50	2	34,125,600	\$17,052,800	
2	Hillsborough Avenue	Turn Platforms	at Walsh Road	Standard			1	0,000	\$7,000	
2	Hillsborough Avenue	Queue Lane	at Hanley Road	Standard		0.50	2	34,125,600	\$17,052,800	
2	Hillsborough Avenue	Queue Lane	George Road	Overpass Road - (Underpass)	1.05	Assume overpass cost - (Underpass)	1.25	2	37,620,000	\$47,025,000
2	Hillsborough Avenue	Queue Lane	at Anderson Road	Standard		0.50	2	34,125,600	\$17,052,800	
Bayway Street Transit Access							Sub Total	0.00		\$78,142,420
2.0	Bayway Street	Add one external lane each direction	Alford Interchange	West of Woodlawn	0.00	No toll	0.00	2	1,643,583	\$3,287,166
2.0	Bayway Street	Two Lane Lane each direction (divided)	West of Woodlawn	West of Woodlawn	2.25	Cost does take into account 2 lanes (one each direction)	2.25	2	37,620,000	\$75,240,000
I-275 East-West Section							Sub Total	3.16		\$50,622,100
2.0	I-275	3.975 Lanes Each Direction Exit Ramps to Down Lane (Should)	Hwy 66/67	Arday Street	2.40	Range 1 = 0.32 mi. and Range 2 = 0.40 mi = 0.72 mi (Should)	2.40	8	1,750,541	\$14,004,328
2.0	I-275	Arday Street	Overpass	Overpass	0.76		0.76	1	37,620,000	\$13,146,320
I-275/I-4 Interchange							Sub Total	3.16		\$27,126,772
2.0	I-275/I-4	2 Lane RTT reversible	Arday Street	East of I-4 interchange	1.05	Assume it is elevated	1.05	2	37,620,000	\$76,002,000
2.0	I-275/I-4	Ramp	I-275 S	I-275 W	0.50	Assume 1-Lane	0.50	1	1,676,632	\$838,316
2.0	I-275/I-4	Ramp	I-275 S	I-4 E	0.50	Assume 1-Lane	0.50	1	1,676,632	\$838,316
2.0	I-275/I-4	Reversible Gates & Communication			\$250,000				250,000	\$250,000
I-4							Sub Total	12.20		\$47,348,400
2	I-4 - Western End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
2	I-4 - Eastern End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
2	I-4	2 Lane RTT reversible	East of I-4 interchange	Slip Ramps East of Selmon Connector	2.00		2.00	2	1,750,541	\$3,501,082
2	I-4	Slip Ramps	East of Selmon Connector	East of Selmon Connector	0.75	Per FHWA "A Guide for Hot Lane Development" (1,000 ft. = 0.75 miles)	0.75	1	1,676,632	\$1,187,624
2	I-4	Selmon Connector	Selmon Expressway	East	1.00	<i>Do not include in costs</i>		0		\$0
2	I-4	2 Lane RTT reversible	Selmon Connector	Slip Ramps West of I-75	0.30		0.30	3	1,750,541	\$5,251,623
2	I-4	Slip Ramps	West of I-75	West of I-75	0.75	Per FHWA "A Guide for Hot Lane Development" (1,000 ft. = 0.75 miles)	0.75	1	1,676,632	\$1,187,624
2	I-75 - Taylor End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
I-75/I-4 Interchange							Sub Total	1.00		\$4,511,200
2	I-4/I-75	2 Lane RTT reversible	Transition I-4	Transition I-75	1.00		0.50	2	1,750,541	\$8,752,706
I-75 North of I-4							Sub Total	11.35		\$35,886,654
2	I-75	Slip Ramps	North of I-4 interchange	Ramp from New Tampa Blvd	0.75	Per FHWA "A Guide for Hot Lane Development" (1,000 ft. = 0.75 miles)	0.75	1	1,676,632	\$1,187,624
2	I-75	2 Lane RTT reversible	North of I-4 interchange	North of I-4 interchange	0.55		0.55	2	1,750,541	\$3,121,120
2	I-75	Slip Ramps	South of Bruce B Downs	South of Bruce B Downs	0.75	Per FHWA "A Guide for Hot Lane Development" (1,000 ft. = 0.75 miles)	0.75	1	1,676,632	\$1,187,624
2	I-75	Reversible Gates & Communication			\$250,000				250,000	\$250,000
Northern Terminus of I-75 BTL Lanes							Sub Total	0.50		\$21,089,881
2	I-75	Direct Connect Ramp	New Tampa Blvd	I-75	0.00		0.00	1	2,501,624	\$2,501,624
2	Bruce B Downs Blvd	Queue Lane	at New Tampa Road	Standard		0.50	2	34,125,600	\$17,052,800	
2	New Tampa Blvd	At one external lane each direction	Bruce B Downs	I-75	1.00		0.50	2	1,643,583	\$8,217,915
2	I-75	Reversible Gates & Communication			\$250,000				250,000	\$250,000
Selmon/I-75 Interchange							Sub Total	4.70		\$7,491,629
2	I-75	Slip Ramps	Slip Ramps from Southbound Frontage to Median BTL Lanes		0.00		0.00	1	1,676,632	\$1,676,632
2	I-75	Relocate Slip Ramps I-75 GP to SR 60			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Close Slip Ramps I-75 GP to SR 60			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Relocate Slip Ramps I-75 GP to SR 60			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Close Slip Ramps I-75 GP to Selmon			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Slip Ramps from Northbound BTL Lanes to Frontage Road			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Close Slip Ramps SR 60 to I-75 GP lanes			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Reconfigure SR Frontage Road to Close Slip Ramps			1.00	Assume distance = 1.00 miles	1.00	2	1,643,583	\$3,287,166
2	I-75	Add Slip Ramps from SR Frontage Road to I-75 SR GP lanes			0.50	Per I-75, assume distance = 0.50 miles	0.50	1	1,676,632	\$838,316
2	I-75	Reversible Gates & Communication			\$250,000				250,000	\$250,000
I-75 South of Selmon Interchange							Sub Total	10.20		\$30,426,779
2	I-75	2 Lane RTT reversible	North of Big Bend Road	South of Selmon	0.70		0.70	2	1,750,541	\$3,121,120
2	I-75	Slip Ramps	North of Selmon Drive	North of Selmon Drive	0.75	Per FHWA "A Guide for Hot Lane Development" (1,000 ft. = 0.75 miles)	0.75	2	1,676,632	\$2,514,968
2	I-75	Slip Ramps	North of Big Bend Road	North of Big Bend Road	0.75	Per FHWA "A Guide for Hot Lane Development" (1,000 ft. = 0.75 miles)	0.75	2	1,676,632	\$2,514,968
2	I-75	Reversible Gates & Communication			\$250,000				250,000	\$250,000
2	I-75	Queue Ramps								\$0
Miles							64.55	Total Network 1 Cost		\$530,382,313.92

Table D - 13: Capital Cost for BTL Network #2 (Source: American Consulting Engineers)

BUS TOLL LANE NETWORK 2

Other Network	Facility	Type	From	To	Distance (mi)	Notes	Distance (mi)	Number of Lanes	Unit Costs	Total Cost
Dale Mabry Hwy							Sub Total	3.98		\$125,796,897
	Dale Mabry Hwy	Left Turn Queue Jump	at Northdale Blvd		0.30			1	1,000,000	\$300,000
	Dale Mabry Hwy	Queue Jump	at Reams		Standard		0.50	2	\$4,325,000	\$17,052,000
	Dale Mabry Hwy	Queue Jump	at Fletcher		1.00	Extended		2	\$4,325,000	\$34,242,000
	Dale Mabry Hwy	Queue Jump	at Booth		1.17	Extended		2	\$4,325,000	\$48,019,740
	Dale Mabry Hwy	Queue Jump	at Waters		0.50	Standard		2	\$4,325,000	\$17,052,000
	Dale Mabry Hwy	Queue Jump	at High		0.50	Standard		2	\$4,325,000	\$17,052,000
	Dale Mabry Hwy	Transit Signal Priority	at Martin Luther King					2	25,000	\$50,000
	Dale Mabry Hwy	No Queue Jump	at Columbus Drive						0	\$0
Hillsborough Avenue							Sub Total	2.75		\$64,385,400
1	Hillsborough Avenue	Queue Jump	at Sheldon Road		Standard	ALL Queue Jump Costs must include Reversible Gates & Communications	0.50	2	\$4,205,800	\$17,052,000
1	Hillsborough Avenue	Turn Prohibition	at Wells Road		Standard		Standard	1	2,000	\$2,000
1	Hillsborough Avenue	Queue Jump	at Handy Road		Standard		0.50	2	\$4,205,800	\$17,052,000
1	Hillsborough Avenue	Queue Jump	George Road	Heaver Road	1.25	Assume overhead costs - (Underpass)	1.25	2	47,025,200	\$47,025,200
1	Hillsborough Avenue	Queue Jump	at Anderson Road		Standard		0.50	2	\$4,205,800	\$17,052,000
Dale Mabry Terminus							Sub Total	1.95		\$72,631,000
	Dale Mabry Hwy	Deviated One Lane in Each Direction	Dale Mabry south of Columbus Connecting to I-275 connector		0.85	Unit cost takes into account 2 lanes (one each direction)	0.85	1	\$7,620,500	\$41,977,000
	I-275 connector	Deviated Two lanes in each direction	to I-275 via New Alignment, Hines, & New Alignment		0.70	Unit cost takes into account 2 lanes (two each direction)	0.70	1	\$8,080,000	\$40,656,000
Service Street Transit Access							Sub Total	2.29		\$78,362,428
1.8	Service Street	Add one arterial lane each direction	Airport interchange	West of Westshore	0.95	No toll	0.95	2	1,843,389	\$8,122,426
1.3 modified	Blue Scout	Two Lane (one each direction) Deviated	West of Westshore	to I-275 connector Ramping	1.25	Unit cost takes into account 2 lanes (one each direction)	1.25	2	\$7,620,500	\$75,240,900
Interchange from Veterans to I-275							Sub Total	3.95		\$0
1.3	Veterans	Improvements as shown in TIP	I-275	North of Courtney Campbell	3.00	Do not include Cost	2.00		0	\$0
1.3	I-275	Improvements as shown in TIP	Veterans	Hines Avenue	1.95	Do not include Cost	1.95		0	\$0
I-275 East-West Section							Sub Total	8.30		\$56,822,500
1.3	I-275	3 BTL Lanes Each Direction	Hines Ave	Ashley Street	2.40		2.40	6	1,700,591	\$24,488,110
1.3	I-275	Exit Ramps to Downtown (Deviated)	Ashley Street	One way Pair	0.70	Ramp1 = 0.30 mi. and Ramp2 = 0.40 mi = 0.70 mi. (Deviated)	0.70	1	\$7,620,000	\$26,134,000
I-275/I-4							Sub Total	2.19		\$63,156,110
1.3	I-275/I-4	2 Lane BTL reversible	Ashley Street	East of I-4 Interchange	1.05	Assume elevated	1.05	2	\$7,620,000	\$7,620,000
1.3	I-275/I-4	Ramp	I-275 S	I-275 W	0.50	1-Lane Ramp	0.50	1	1,876,832	\$938,416
1.3	I-275/I-4	Ramp	I-275 S	I-4 E	0.60	1-Lane Ramp	0.60	1	1,876,832	\$1,126,099
1.3	I-275/I-4	Reversible Gates & Communication			\$250,000				250,000	\$250,000
I-4							Sub Total	11.30		\$42,648,900
1	I-4 - Western End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
1	I-4 - Eastern End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
1	I-4	2 Lane BTL reversible	East of I-4 Interchange	Slip Ramps East of Selmon Connector	2.10		2.10	2	1,700,591	\$7,342,482
1	I-4	Slip Ramps	East of Selmon Connector		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	1	1,876,832	\$1,407,624
1	I-4	Service Connector	Selmon Expressway	I-4	1.80	Do not include in costs	1.80		0	\$0
1	I-4	3 Lane BTL reversible	Slip Ramps East of Selmon Connector	Slip Ramps West of I-75	6.80		6.80	3	1,700,591	\$32,141,120
1	I-4	Slip Ramps	West of I-75		0.75	Per FHWA "A Guide for Hot Lane Development"	0.75	1	1,876,832	\$1,407,624
1	I-275 - Eastern End	Reversible Gates & Communication			\$250,000				250,000	\$250,000
I-75/I-4 Interchange							Sub Total	1.35		\$4,681,396
1	I-4/I-75	2 Lane BTL reversible	Transition I-4	Transition I-75	1.35		1.35	2	1,700,591	\$4,681,396
I-75 North of I-4							Sub Total	11.15		\$35,686,454
1	I-75	Slip Ramps	North of I-4 Interchange		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	1	1,876,832	\$1,407,624
1	I-75	2 Lane BTL reversible	North of I-4 Interchange Blvd	Ramp from New Tampa Blvd	9.65		9.65	2	1,700,591	\$32,821,406
1	I-75	Slip Ramps	South of Bruce B Downs		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	1	1,876,832	\$1,407,624
1	I-75	Reversible Gates & Communication			\$250,000				250,000	\$250,000
Northern Terminus of I-75 BTL Lanes							Sub Total	1.47		\$31,521,838
1.75	I-75	One Lane Reversible Direct Connect Ramp	Bruce B Downs	I-75	0.80	1-Lane Reversible	0.80	1	1,876,832	\$1,505,466
	Bruce B Downs	New Signal With TSP	at Richwood Place Dr						348,500	\$348,500
	Bruce B Downs	Queue Jump	at New Tampa Blvd		Extended		0.87	1	\$4,325,000	\$29,671,872
10 Queue Jumps							Miles	45.05	Total Network 2 Cost =	\$21,959,238

Table D - 14: Capital Cost for BTL Network #3 (Source: American Consulting Engineers)

BUS TOLL LANE NETWORK 3

Other Network	Facility	Type	From	To	Distance (mi)	Notes	Distance (mi)	Number of Lanes	Unit Costs	Total Cost
>275/4 Interchange							Sub Total	3.15		\$61,334,515
1,2	1-275/4	2 lane BT, reversible	Ashley Street	East of I-4 Interchange	1.05	Assume elevated	1.05	2	\$7,620,000	\$79,002,000
1,2	1-275/4	Ramp	1-275 S	>275 W	0.50	Assume 1-Lane Ramp	0.50	1	1,876,832	\$98,416
1,2	1-275/4	Ramp	1-275 S	>4 E	0.60	Assume 1-Lane Ramp	0.60	1	1,876,832	\$1,126,099
1,2	1-275/4	Reversible Gates & Communication			\$250,000			250,000		\$250,000
>275							Sub Total	18.36		\$524,277,496
	1-275	Slip Ramps	1-275 BTL Lanes	>275 N/S	0.75	Per FHWA "A Guide for Hot Lane Development"	0.75	1	1,876,832	\$1,407,624
	1-275	Ramps/One Way Pair (Reversible)	1-275 BTL Lanes	N Florida/Tampa one way lane	2.30	Elevated	2.30	2	\$7,620,000	\$82,764,000
	1-275	3 Lane Reversible BT	Ramp to N Florida/Tampa one way pair	Waggonville Avenue	5.35	Elevated	5.35	3	\$7,620,000	\$155,487,500
	1-275	Slip Ramps	Waggonville Avenue		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	1	1,876,832	\$1,407,624
	1-275	3 Lane Reversible BT	Waggonville Avenue	North of Beams Avenue	3.20	Elevated	3.20	2	\$7,620,000	\$120,384,000
	1-275	Slip Ramps	North of Beams Avenue		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	1	1,876,832	\$1,407,624
	1-275	1 Lane Reversible BT	North of Beams Avenue	North of Power Line ROW	3.15	Elevated	3.15	1	\$7,620,000	\$58,251,500
	1-275	Reversible Gates & Communication			\$250,000			250,000		\$250,000
	1-275	NEED SLIP RAMP FROM NEW TOLL LANES			0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	1	1,876,832	\$1,407,624
>275 Northern Terminus							Sub Total	9.67		\$58,839,863
	New Alignment	3 lanes in each direction	North Terminus of 1-275 BTL Lanes	Overpass from New Tampa Blvd	2.70	4-Lanes - Total	2.70	4	1,700,581	\$18,364,363
	New Overpass	2 lanes in each direction	New Tampa Blvd	New Alignment	0.25	4-Lanes - Total	0.25	4	1,700,581	\$1,700,581
	New Tampa Blvd	All one arterial lane each direction	Bruce & Downs	>75	1.85	2-Lanes - Total	1.85	2	1,643,383	\$6,080,517
	Bruce & Downs	Queue lanes			In Curve	Elevated	0.87	2	\$4,235,600	\$28,671,872
Salmora/75 Interchange							Sub Total	4.70		\$7,663,819
	1	Slip Ramps from South Bound Frontage to Median BT Lanes			0.20		0.20	1	1,876,832	\$175,946
	1	Relocate Slip Ramp 1-75 GP to SR 301			0.50	For 1-75, assume distance = 0.50 miles	0.50	1	\$876,832	\$938,434
	1	Close Slip Ramp 1-75 GP to SR 301			Demolition	For 1-75, assume distance = 0.50 miles	0.50	1	211,482	\$105,741
	1	Relocate Slip Ramp 1-75 GP to Selmon			0.50	For 1-75, assume distance = 0.50 miles	0.50	1	\$876,832	\$938,434
	1	Close Slip Ramp 1-75 GP to Selmon			Demolition	For 1-75, assume distance = 0.50 miles	0.50	1	211,482	\$105,741
	1	Slip Ramp from North Bound BT Lanes to			0.50	For 1-75, assume distance = 0.50 miles	0.50	1	\$876,832	\$938,434
	1	Frontage Road			Demolition	Old use cut off access from 301 to >75 North - Perhaps Slip Ramps north of	0.50	1	211,482	\$105,741
	1	Close Slip Ramp SR 301 to 1-75 GP lanes			1.00	Assume distance = 2.0 miles	1.00	1	\$943,383	\$1,086,766
	1	Reconfigure NB Frontage Road to Close Slip Ramp			0.50	For 1-75, assume distance = 0.50 miles	0.50	1	\$876,832	\$938,434
	1	Add Slip Ramp from SB Frontage Road to 1-75 SB GP lanes			0.50	For 1-75, assume distance = 0.50 miles	0.50	1	\$876,832	\$938,434
	1	Reversible Gates & Communication			\$250,000			250,000		\$250,000
1-75 South of Selmon Interchange							Sub Total	16.26		\$95,475,779
	1	2 lane BT, reversible	North of Big Bend Road	South of Selmon	6.70		6.70	2	1,700,581	\$29,580,283
	1	Slip Ramps	North of Gibsonton Drive		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	2	1,876,832	\$2,823,248
	1	Slip Ramps	North of Big Bend Road		0.75	Per FHWA "A Guide for Hot Lane Development" (4,000 ft. = 0.75 miles)	0.75	2	1,876,832	\$2,823,248
	1	Reversible Gates & Communication			\$250,000			250,000		\$250,000
Interchange from Veterans to 1-275							Sub Total	3.95		\$0
1,2	Veterans	Improvements as shown in TYP	1-275	North of Courtney Campbell	2.00	Do not include Cost	2.00	0	0	\$0
1,2	1-275	Improvements as shown in TYP	Veterans	Hess Avenue	1.95	Do not include Cost	1.95	0	0	\$0
>275 East-West Section							Sub Total	0.33		\$58,822,610
1,2	1-275	3 BT, Lanes Each Direction	Hibes Avenue	Ashley Street	2.40		2.40	6	1,700,581	\$24,488,510
1,2	1-275	Exit Ramps to Downtown	Ashley Street	One way Pair	0.95	Ramp1 = 0.45 mi. and Ramp2 = 0.50 mi = 0.95 mi.	0.95	1	\$7,620,000	\$26,334,000
>275/4 Interchange							Sub Total	3.15		\$61,334,515
1,2	1-275/4	2 lane BT, reversible	Ashley Street	East of I-4 Interchange	1.05	Determine if all is elevated	1.05	2	\$7,620,000	\$79,002,000
1,2	1-275/4	Ramp	1-275 S	>275 W	0.50	1-Lane Ramp	0.50	1	1,876,832	\$98,416
1,2	1-275/4	Ramp	1-275 S	>4 E	0.60	1-Lane Ramp	0.60	1	1,876,832	\$1,126,099
1,2	1-275/4	Reversible Gates & Communication			\$250,000			250,000		\$250,000
Sproule Street Transit Access							Sub Total	3.88		\$78,362,428
1,2	Sproule Street	Build one arterial lane each direction	Airport Interchange	West of Westshore	0.95	No toll 2-lanes	0.95	2	1,643,383	\$3,122,428
1,2 modified	Bay Street	Two Lane (one each direction) Elevated	West of Westshore	to 1-275 via Columbus & Hines	2.35	Unit cost takes into account 2 lanes (one each direction)	2.35	1	\$7,620,000	\$78,240,000
		1-Demol Ramp								
							Miles	52.37	Total Network 3 Cost =	\$915,366,626

Roadway Right-of-Way Cost Methodology and Assumptions

A conceptual right of way (ROW) cost estimate was performed based on the preliminary design information and alignments for the Phase 3 BTL network alternatives as shown on Figures D1 – D-27 (with the assumption that most of the mainline limited-access BTL facilities could be constructed within existing right-of-way). Historical market conditions and market influences and other historical data were analyzed to provide a reliable, supportable and defensible ROW cost estimate.

This estimate evaluated other factors and the knowledge and expertise from other disciplines in evaluating the overall cost costs associated with acquiring a parcel of real property typically through an eminent domain action. In addition to land and improvement values, conceptual estimates also usually include other costs such as: acquisition costs, legal fees, appraisal and other expert fees, cost of demolition, business damages, costs of relocation of displaced people, cost of relocation housing payments for displacees, costs of moving of people, affected businesses, and personal property.

This ROW cost estimate analyzed general right of way costs including estimates of land and improved cost (not value) and real estate severance damages to real estate for all property types located on each of the proposed alignments on a conceptual basis. The property types impacted range from residentially zoned vacant lots to commercially zoned improved properties as depicted on the study conceptual alignment maps. The evaluation also considered demolition costs, business damage costs, ancillary support, litigation, expert witness and consulting fees associated with acquiring fee simple and/or less than fee simple title for the purposes of alignment selection and/or funding and budget allocation in connection with the BTL study.

Study Locations

The study was conducted for three locations in Tampa, Florida that were identified as requiring additional ROW for the BTL networks.

- The first is located along Boy Scout Boulevard west to along Himes Avenue (Network 2, Boy Scout). This alternative may impact 69 total parcels (8 vacant, 42 residential, and 19 commercial) with a total of 148,104 square feet of right of way required. For networks 1 & 3, the alignment follows Boy Scout to Himes Avenue. Because the required improvement footprint is less than the available right of way, the project assumes that no additional right of way will be needed.
- The next area is located downtown and exits I-275 and connects with Ashley Street (Network 2, Ashley). This alternative may impact 23 total parcels (6 vacant, 4 residential, and 13 commercial) with a total of 105,336 square feet of right of way required.
- The final study area is I-275 exiting to Columbus Avenue and connecting to Florida Avenue and Tampa Street, just north of Downtown (Network 3, Columbus) with a total of 31,800 square feet of right of way required. This alternative may impact 94 total parcels (11 vacant, 27 residential, and 56 commercial).

Assumptions and Limiting Conditions

This ROW cost estimate was performed under the auspices of the Florida Department of Transportation's (FDOT) Guidance Document 2 (Right of Way Cost Estimates), and conducted in compliance with the Uniform Standards of Professional Appraisal Practice (USPAP) under the following general assumptions:

1. Level of Confidence: Pursuant to FDOT Guidance Document 2 (Right of Way Cost Estimates) and the subject assignment's scope of services, this right of way cost estimate has been designated a Poor level of confidence whose definition is outlined as follows: Poor level of confidence: R/W Maps are not available or are extremely preliminary. Other exhibits are of limited accuracy to depict the project. Parcels, proposed acquisitions and remainders are not identified. Potential relocation, property management, environmental and business damage concerns have not been identified. Market data are limited, but available.
2. This cost estimate is a conceptual level estimate only. Detailed study and inspection of individual parcels has not been performed. The project corridors are conceptual and the level of accuracy in the mapping is low.
3. Elevation has been considered and assumed that proposed acquisitions will not affect drainage or access to the affected parcels, except where noted.
4. It is specifically assumed that this is NOT a limited access right of way acquisition.
5. Where the corridor utilizes existing right of way and crosses a State County or City owned right of way or road, it is assumed that no additional right of way is to be acquired.
6. All of the property information was taken from the Hillsborough County Property Appraisers office.
7. All of the approximate total acquisition areas for each alternative was provided by the BTL study team engineers. These sizes are assumed to be correct.
8. Multipliers and factors used in the estimate are generally accepted and standard in the industry.
9. Right of way utility relocation costs and other agency costs were not included as a part of this cost estimate.
10. This cost estimate assumes no change in access such as driveway closings. Changes in access due to construction of medians located within the right of way are not compensable under Florida law.
11. This cost estimate assumes impacted parcels will not have a significant change in the availability of utilities or cost of service.

12. Apparent hazardous materials indicators were not studied and there is no knowledge of any environmental issues. Therefore, cost estimates do not include the impact or presence of any hazardous materials on the value of the affected parcels. In other words, parcels within the project area are considered clean.

The summary presented in Table D-15 includes all property types impacted which range from residentially zoned vacant tracts to commercially zoned improved properties.

Table D - 15: Summary of Right of Way Costs (Source: IAA)

Alternative	Total Right of Way Cost
Network 2, Boy Scout	\$14,474,500
Network 2, Ashley	\$6,459,300
Network 3, Columbus	\$13,783,500

BTL Network Roadway Capital Cost Summary

Capital Cost Summary Results for BTL Networks

A summary of the capital cost estimates for each BTL Network is included in Table D-16. The preliminary total cost estimate ranges from approximately \$530,300,000 to \$915,400,000, including preliminary engineering, design, Construction Engineering Inspection (CEI) and construction. Table D-17 divides the summary of capital costs into the various network component corridors.

**Table D - 16: Summary of Capital Cost Estimates for All BTL Networks
(a) In 2011 dollars (Source: American Consulting Engineers)**

Network #	Capital Cost Estimate (a)
1	\$530,300,000
2	\$622,000,000
3	\$915,400,000

Table D - 17: Summary of Capital Cost for Network Corridors
 (Source: American Consulting Engineers)

BUS TOLL LANE NETWORK 1

BTL	Facility	Distance (mi)	Total Cost
1	Veterans Expressway	Sub Total 12.10	\$73,824,619
1	Interchange from Veterans to I-275	Sub Total 0.00	\$0
1	Hillsborough Avenue	Sub Total 2.75	\$98,185,400
1	Spruce Street Transit Access	Sub Total 3.30	\$78,362,428
1	I-275 East-West Section	Sub Total 3.10	\$50,822,510
1	I-275/I-4 Interchange	Sub Total 2.15	\$81,316,515
1	I-4	Sub Total 11.20	\$42,848,900
1	I-75/I-4 Interchange	Sub Total 1.35	\$4,591,596
1	I-75 North of I-4	Sub Total 11.15	\$35,886,654
1	Northern Terminus of I-75 BTL Lanes	Sub Total 2.55	\$21,089,893
1	Selmon/I-75 Interchange	Sub Total 4.70	\$7,983,019
1	I-75 South of Selmon Interchange	Sub Total 10.20	\$35,470,779
		Miles 64.55	\$530,382,313.92

BUS TOLL LANE NETWORK 2

BTL	Facility	Distance (mi)	Total Cost
2	Dale Mabry Hwy	Sub Total 3.98	\$125,790,397
2	Hillsborough Avenue	Sub Total 2.75	\$98,185,400
2	Dale Mabry Terminus	Sub Total 1.55	\$72,633,000
2	Spruce Street Transit Access	Sub Total 2.20	\$78,362,428
2	Interchange from Veterans to I-275	Sub Total 3.95	\$0
2	I-275 East-West Section	Sub Total 3.10	\$50,822,510
2	I-275/I-4 Interchange	Sub Total 2.15	\$81,316,515
2	I-4	Sub Total 11.20	\$42,848,900
2	I-75/I-4 Interchange	Sub Total 1.35	\$4,591,596
2	I-75 North of I-4	Sub Total 11.15	\$35,886,654
2	Northern Terminus of I-75 BTL Lanes	Sub Total 1.67	\$31,521,838
		Miles 45.05	621,959,238

BUS TOLL LANE NETWORK 3

BTL	Facility	Distance (mi)	Total Cost
3	I-275/I-4 Interchange	Sub Total 2.15	\$81,316,515
3	I-275	Sub Total 16.90	\$524,277,496
3	I-275 Northern Terminus	Sub Total 5.67	\$55,819,363
3	Selmon/I-75 Interchange	Sub Total 4.70	\$7,983,019
3	I-75 South of Selmon Interchange	Sub Total 10.20	\$35,470,779
3	Interchange from Veterans to I-275	Sub Total 3.95	\$0
3	I-275 East-West Section	Sub Total 3.35	\$50,822,510
3	I-275/I-4 Interchange	Sub Total 2.15	\$81,316,515
3	Spruce Street Transit Access	Sub Total 3.30	\$78,362,428
		Miles 52.37	\$915,368,626

BTL Roadway Operating and Maintenance Costs

Operating and routine maintenance (O&M) costs as well as major rehabilitation and repair (R&R) costs are an important input into determining the overall financial feasibility of a transportation project.

These costs are normally predicted by departments of transportation based on historical costs incurred for roadway operations. Roadways funded by toll revenues have similar O&M and R&R costs with the addition of cost for toll collection and maintenance of toll facilities. The BTL concepts presented in this study also include costs for the support of the ITS necessary to operate the reversible lane systems for those BTL corridors employing reversible roadways.

For purposes of this study, extensive use was made of information available from THEA and their operation of the Selmon Expressway Reversible Express Lanes (REL). The Selmon REL projects provided operational and cost information from a facility that very closely mirrors the operation and physical configuration of the reversible guideways considered in the BTL Study. O&M and R&R costs from FDOT statewide and District VII databases were also used.

For planning studies, the components of both O&M and R&R costs are normally calculated on a per mile basis. For the BTL Study, the following assumptions and methods were used to estimate costs:

- All corridors were estimated based on centerline miles
- Per mile costs were estimated for routine maintenance
- Per mile costs were estimated for the milling and resurfacing component of R&R costs
- Costs for toll collection were based on a percentage of gross revenue
- Costs relating to reversible roadway operations were based on a fixed cost per year
- All costs, with the exception of toll collection costs were inflated based on a 2.5% per annum inflation rate. (NOTE: Toll collection costs are not inflated on a per annum basis because toll rates are being inflated at the 2.5% per annum rate and costs are a percentage of gross revenue, thus the inflation factor is already included.
- In calculating the length for facilities where queue jumps are present, only the length of the queue jump, including the length of the approach on both sides of the queue jump were included. A length of 1/2 mile was assumed for a standard queue jump, and an average length of 1 mile was assumed for queue jumps in locations requiring extra length.

Routine Maintenance

The cost for routine maintenance, which encompasses all routine activities, such as restriping, sign maintenance and repair, routine barrier repair, and costs due to accident cleanup was assumed to be \$16,700 per centerline mile. This is based on costs incurred on the Selmon Reversible Express Lanes. Because of the barrier separated nature of virtually all of the BTL guideways, routine landscaping and associated activities such as grass cutting would not be required for these facilities.

Toll Collection

Toll collection was assumed to be undertaken with an all-electronic toll collection (AETC) system. Toll collection costs were calculated as 8.5% of gross toll revenues. This cost compares with the current costs incurred for the Selmon Expressway AETC open road tolling facility and also compares well with other national averages for AETC. Figure D-34 indicates the current estimate of toll collection cost for the Selmon Expressway.

THEA All-Electronic Toll Collection Cost Estimation Model

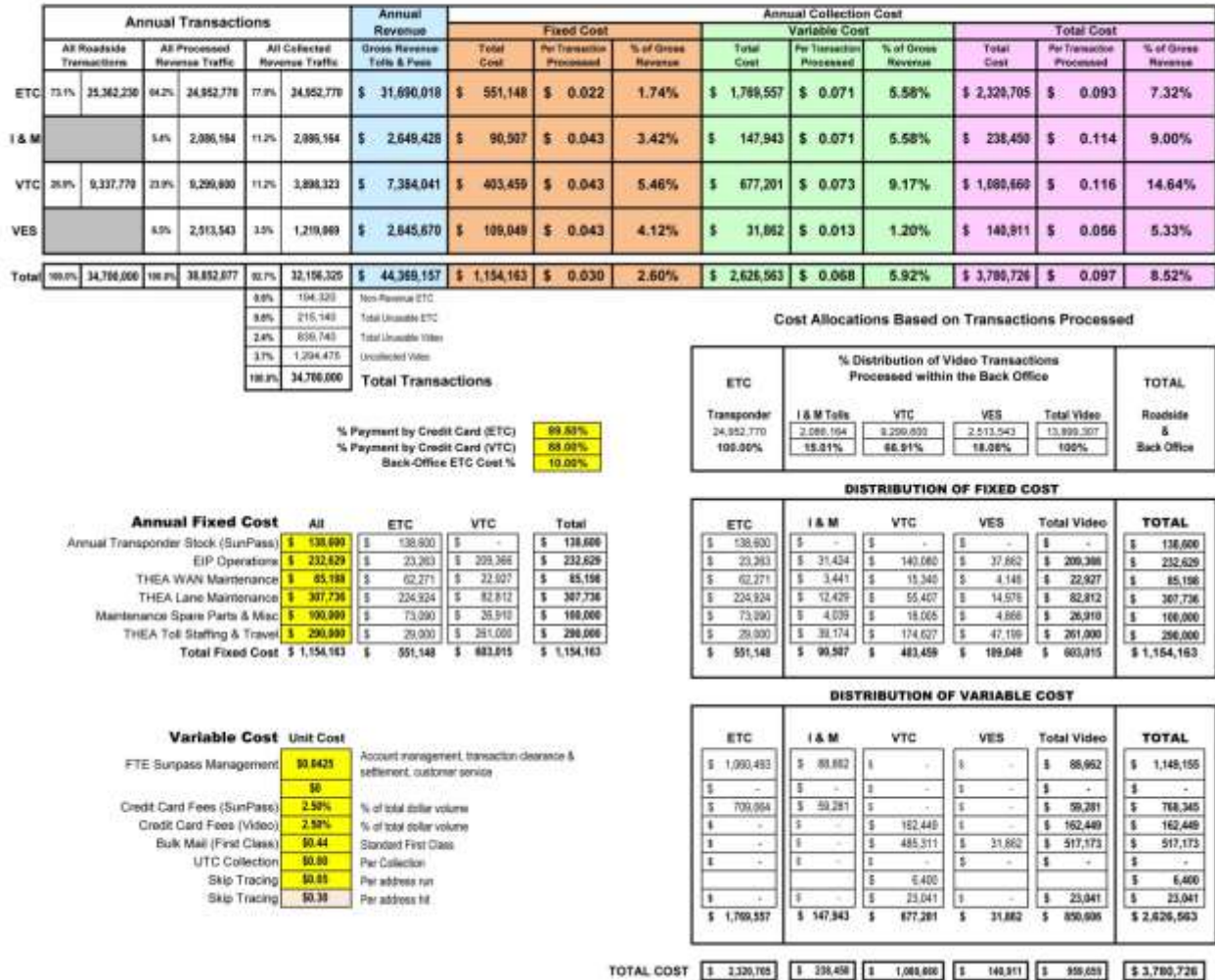


Figure D-314: THEA Toll Collection Costs for All-Electronic Tolls (Source: THEA)

Note: As mentioned earlier, the costs for BTL toll collection were not specifically inflated annually because annual increases are built in to the increased revenues that occur from higher traffic volumes and the assumed 2.5% annual rate increase.

Reversible Lane Operations

It was assumed that the cost of operating any of the BTL reversible guideways (to manage the daily changes of direction) would be an incremental addition to the existing REL management provided by the City of Tampa. This cost would essentially involve the addition of personnel to the on-going REL operations. A total cost of \$200,000 in 2012 was assumed to account for the additional cost of reversible lane operation. As these costs are subject to increasing labor or materials cost, this cost is inflated at 2.5% per year.

Final O&M Costs

For conversion into the financial feasibility template, O&M costs were combined into a single number. The following formula was used to produce the aggregate O&M costs:

$$(GR*(0.085))+((RMC)*1.025^{(EY-2012)})+(200000*1.025^{(EY-2012)})$$

Where:

GR = Gross Toll Revenue

RMC = Routine Maintenance Costs

(\$16,700 * length of improvements in the given network)

EY = Expenditure Year

(-2012 to inflate for the proper number of years)

The total length and associated O&M cost for each network is shown in Table D-18.

Table D - 18: Annual O&M Costs - Base Year 2012 (Source: Parsons Brinckerhoff)

	Network 1	Network 2	Network 3
Network Length (mi)	49.1	39.8	33.6
Routine Maintenance Cost 2012\$	\$819,970	\$664,660	\$561,120

Major Maintenance - Renewal and Rehabilitation (R&R)

R&R was also calculated on a per lane mile basis. Milling and resurfacing are based on FDOT District VII costs for facilities that closely replicate the types of facilities that would be developed for the BTL projects. It should be noted that urban arterials were used to determine costs for queue jumps.

Based on the costs examined, the cost for milling and resurfacing for a two lane facility is just over \$1 million per mile. Time between resurfacing was based on information available from FDOT central office. Resurfacing occurs in Florida every 14 to 17 years. For this study a resurface every 15 years was assumed. While the BTL network will carry a significant volume of traffic, heavy trucks are assumed to not be part of the vehicle mix (the current heavy truck percentage on the Selmon Expressway is between 2-3% and heavy trucks are not permitted on the THEA reversible lanes).

R&R of electronics and communications (toll collection and ITS controls for incident management and REL operations) on the BTL networks assumes a practical total replacement/upgrade of capital components over a ten year period. Annual R&R costs for each network are shown in Table D-19.

Table D - 19: Annual R&R Cost – Base Year 2012 (Source: Parsons Brinckerhoff)

	Network 1	Network 2	Network 3
Network Length (mi)	49.1	39.8	33.6
R&R Cost per annum 2012\$	\$3,681,102	\$3,028,275	\$2,455,668

As with O&M costs, R&R costs (all) were inflated at 2.5% per annum. Costs appearing in the financial feasibility template reflect the assumed 15 year cycle for resurfacing and the 10 year cycle for replacement and upgrading of electronics and communications equipment.

BTL Transit Capital and Operating Cost Estimates

Numerous assumptions were made to develop service characteristics and forecast costs for BTL transit services. Those assumptions are based on a variety of factors, including existing planning documents and reports, existing HART operating and capital costs, peer reviews of other similar services, travel demand model results, and professional judgment on the part of the project team. Transit cost assumptions can be grouped into operating cost assumptions and capital costs assumptions.

The assumptions and the resulting transit costs for each BTL network alternative are described in the following.

Operating Cost Assumptions

Operating cost assumptions consisted primarily of average speed calculations and development of an operating cost per revenue hour. Major assumptions are shown in Table D-20.

As shown in the table, different average speeds were developed for service operation on different facility types assuming that actual bus service on the BTL facilities would operate at the highest speed, 50 mph. A detailed review of the average speed calculations developed for this study is included in the Appendix. Operating cost per vehicle revenue hour is the industry standard variable used by most transit agencies to develop costs. For this study, HART’s fully-allocated operating cost per revenue hour of service was used for projecting operating costs for the BTL network alternatives.

Table D –20: Summary of Operating Cost Assumptions (Source: Parsons Brinckerhoff)

Description	Unit	Assumption/ 2012 Value	Source/Notes
Express Average Operating Speed*			
Highway (Limited-Access)	Miles per hour	50	<i>Bus Rapid Transit Practitioner's Guide 2007</i>
Arterial (Mixed-Traffic)	Miles per hour	23	HART 2012–2021 TDP (2011 average operating speed for HART express bus services on arterial segments with stop reduction adjustment)
Queue Jump Application	Per intersection	5–15%	<i>Bus Rapid Transit Practitioner's Guide 2007</i>
Arterial (Mixed-traffic with Queue Jump)	Miles per hour	26	Calculated based on 23 mph (mixed-traffic condition) and assumes 10% travel time reduction due to queue jump application
Arterial (Dedicated Bus Lanes)	Miles per hour	29	<i>Bus Rapid Transit Practitioner's Guide 2007</i> (0.5 min per mile reduction compared with mixed-traffic conditions)
BRT Average Operating Speed*			
Highway (Limited-Access)	Miles per hour	50	<i>Bus Rapid Transit Practitioner's Guide 2007</i>
Arterial (Mixed-Traffic)	Miles per hour	21	HART 2012–2021 TDP (2011 HART Route 36 [on Dale Mabry] and Route 34 [on Hillsborough Ave] average operating speeds with stop reduction adjustment)
Arterial (Dedicated Bus Lanes)	Miles per hour	25	<i>Bus Rapid Transit Practitioner's Guide 2007</i> (0.5 min per mile reduction compared with mixed-traffic conditions)
Transit Signal Priority (TSP) Applications	Per corridor	8–12%	<i>Bus Rapid Transit Practitioner's Guide 2007</i>
THEA Model Assumption	Miles per hour	24	Project team. Based on travel demand model results
Arterial (Dedicated Bus Lanes with TSP Applications)	Miles per hour	27	Calculated based on 25 mph (dedicated lanes condition) and assumes 8% travel time savings with TSP applications
Operating Cost per Revenue Hour		\$90.12	HART 2012–2021 TDP/Fixed-Route 2011 Value (fully allocated cost per revenue hour)
Operating Cost Inflation Rate		2.5%	HART 2012-2021 TDP
Park-and-Ride Lot Maintenance Cost	Per space per year	\$103	<i>FDOT State Park & Ride Guide (2012 Value)</i>

*Reflects cumulative operating speed gains.

Capital Cost Assumptions

Capital cost assumptions were drawn from several sources of information, including HART MetroRapid resource materials, the *FDOT Park-and-Ride Manual*, and CUTR’s *Bus Rapid Transit Practitioner’s Guide* (2007). Based on the information in those documents, capital cost assumptions were prepared for BTL stations and park-and-ride facilities, vehicles, and fare payment technology. Those cost assumptions are shown in Table D-21.

For the BTL study, it is assumed that a brand new vehicle fleet will be rolled out in the first year of BTL operation. A vehicle replacement schedule of 12 years was assumed consistent with Federal Transit Administration (FTA) guidelines for vehicles similar to those proposed to be used for the BTL premium express bus and BRT services.

Table D - 21: Summary of Capital Cost Assumptions (Source: Parsons Brinckerhoff)

Description	Component	Unit	Assumption/ 2012 Value	Source/Notes
Stations				
MetroRapid Type A Station	Construction & Engineering	Per station	\$137,000	HART MetroRapid
MetroRapid Type B Station	Construction & Engineering	Per station	\$143,000	HART MetroRapid
MetroRapid Type C Station	Construction & Engineering	Per station	\$153,000	HART MetroRapid
Park-and-Ride Surface Lot	Construction	Per space	\$9,000	<i>FDOT State Park & Ride Guide</i>
	Engineering & Design (including CEI)	Per total construction cost	22%	<i>FDOT State Park & Ride Guide</i>
Park-and-Ride Surface Lot	Maintenance	Cost per space	\$102	<i>FDOT State Park & Ride Guide</i>
Vehicles				
Diesel Hybrid Vehicle		Per vehicle	\$810,000	SCAT North/South BRT Alternatives Analysis
MCI Coach Bus Vehicle (Express Service)		Per vehicle	\$560,000	Pinellas Suncoast Transit Authority (PSTA)
CNG Vehicle (HART MetroRapid)		Per vehicle	\$460,000	HART
Off-board Fare Collection				
Magnetic Card Media		Per machine	\$73,000	<i>Bus Rapid Transit Practitioner's Guide 2007</i>
Smart Media		Per machine	\$79,000	<i>Bus Rapid Transit Practitioner's Guide 2007</i>
Inflation Rate				
Capital Cost Inflation			2.5%	HART 2012-2021 TDP

Transit Operating and Capital Cost by BTL Alternative

Using the cost assumptions in Tables D-21, operating and capital costs were projected for each BTL network alternative. Of the estimated capital costs, vehicles comprise the largest portion. Operating and capital cost details for each BTL network alternative are shown in Tables D-22 through D-27.

Table D -22: BTL Network #1 – Transit Operating Costs

(Source: Tindale Oliver and Associates)

Route Name	Route Length	Avg Speed (mph)	Off-Peak Freq (min)	Peak Srvc Span (hrs)	Off-Peak Srvc Span (hrs)	Annual Week Days	Peak Freq (min)	# of Peak Vehicles	Annual Operating Cost
Premium Express Service									
Apollo Beach/Gibsonton to MacDill	36.6	37	15.0	6.0	8.0	255	10	12	\$3,056,380
Brandon to Westshore	15.6	43	15.0	6.0	8.0	255	10	5	\$1,138,151
Northwest County to Westshore	10.4	33	15.0	6.0	6.0	255	10	4	\$873,647
Northwest Limited Express	14.2	37	15.0	6.0	8.0	255	10	5	\$1,183,217
North Brandon to MacDill	23.9	36	15.0	6.0	8.0	255	10	8	\$2,081,352
Lutz Express (Revised)	9.8	31	15.0	6.0	8.0	255	10	4	\$987,523
Dover-Brandon Express	18.2	34	15.0	6.0	8.0	255	10	7	\$1,677,269
Fishhawk-Riverview-MacDill	35.6	37	15.0	6.0	8.0	255	10	12	\$2,985,725
Brandon-MacDill	30.7	37	15.0	6.0	8.0	255	10	10	\$2,603,447
Fishhawk-South Brandon	23.5	32	15.0	6.0	8.0	255	10	9	\$2,304,152
East County	21.6	44	15.0	6.0	8.0	255	10	6	\$1,531,034
Brandon-Southshore	25.4	36	15.0	6.0	8.0	255	10	9	\$2,177,350
Southshore Limited	38.1	33	15.0	6.0	8.0	255	10	14	\$3,608,448
Citrus Park-Carrollwood	16.5	46	15.0	6.0	8.0	255	10	5	\$1,126,799
New Tampa-Pasco	34.6	36	15.0	6.0	8.0	255	10	12	\$3,023,103
Oldsmar-Town 'n' Country	17.5	32	15.0	6.0	8.0	255	10	7	\$1,688,858
Clearwater Express	20.6	30	15.0	6.0	8.0	255	10	9	\$2,176,754
PSTA 100X	23.7	33	15.0	6.0	8.0	255	10	9	\$2,248,799
PSTA 300X	19.8	36	15.0	6.0	8.0	255	10	7	\$1,727,038
Total								154	\$38,199,047
Bus Rapid Transit Service									
MetroRapid - Hillsborough Ave	5.7	23	10	6	10	255	10	3	\$1,068,512

Table D - 23: BTL Network #1– Transit Capital Costs
 (Source: Tindale Oliver and Associates)

Item	Subarea	Location	Status	Future # of Parking Spaces/Stops	Total Capital Cost
Park-and-Ride					
Eddie C. Moore Park	Pinellas County	2780 Drew St, Clearwater	Future	100	\$900,000
Ulmerton Rd	Pinellas County	Ulmerton Rd @ Starkey Rd	Existing	61	\$549,000
Gandy Blvd	Pinellas County	Gandy Blvd @ 16th St N	Future	100	\$900,000
Northwest Transfer Center	Airport/Northwest	8951 W. Waters Ave	Existing	94	\$846,000
Oldsmar	Oldsmar	SR 580 @ Tampa Rd	Existing	26	\$234,000
Citrus Park	Citrus Park	7502 Gunn Hwy	Existing	24	\$216,000
Van Dyke Rd	Cheval	Van Dyke Rd @ N Dale Mabry Hwy	Future	100	\$900,000
Pasco County Rd	Magnolia Place	W County Line Rd @ N Dale Mabry Hwy	Future	100	\$900,000
Wesley Chapel	Wesley Chapel	CR 56 @ Bruce B. Downs Blvd	Future	45	\$405,000
Pebble Creek	Wesley Chapel	Bruce B. Downs Blvd @ Cross Creek Blvd	Existing	100	\$900,000
Temple Terrace/New Tampa	Temple Terrace/New Tampa	I-75 @ Fletcher Ave	Future	100	\$900,000
Burnett Park	Seffner/Mango	11609 Clay Pit Rd	Future	100	\$900,000
Brandon/Riverview	Brandon/Riverview	Falkenburg Rd @ Causeway Blvd	Existing	50	\$450,000
Riverview Oaks	Riverview	US 301 @ Gibsonton Dr	Existing	36	\$324,000
DG Farms	Ruskin	4874 Sun Center Blvd	Future	150	\$1,350,000
Mt. Zion Assembly of God	Plant City	3005 Thonotosassa Rd	Future	100	\$900,000
Total Park-and-Ride Cost (Future)					\$8,055,000
Stations/Stops				# of Stations/Stops	Total Cost
Express Stop			New	1	\$137,000
BRT Station			New	8	\$1,224,000
Total Stations/Stops					\$1,361,000
Vehicles				# of Vehicles	Total Cost
Express Service				154	\$86,240,000
BRT Service				3	\$1,380,000
Total Capital Costs					\$98,123,000

Table D - 24: BTL Network #2 Transit Operating Costs

(Source: Tindale Oliver and Associates)

Route Name	Route Length	Avg Speed	Off-Peak Freq (min)	Peak Srvc Span (hr)	Off-Peak Srvc Span (hr)	# of Annual Week Days	Peak Freq (min)	# of Peak Vehicles	Annual Operating Cost
Premium Express Service									
New Tampa-Westshore	24.8	35	15.0	6.0	8.0	255	10	9	\$2,215,321
Brandon to Westshore	15.6	43	15.0	6.0	8.0	255	10	5	\$1,138,151
Northwest County to USF	12.3	26	15.0	6.0	8.0	255	10	6	\$1,502,986
Northwest County to Westshore	10.4	33	15.0	6.0	8.0	255	10	4	\$990,134
USF to Westshore	15.2	40	15.0	6.0	8.0	255	10	5	\$1,203,248
North Brandon to MacDill	23.9	36	15.0	6.0	8.0	255	10	8	\$2,081,352
Lutz Express	13.9	36	15.0	6.0	8.0	255	10	5	\$1,213,456
Dover-Brandon Express	18.2	34	15.0	6.0	8.0	255	10	7	\$1,677,269
Fishhawk-Riverview-MacDill	35.6	37	15.0	6.0	8.0	255	10	12	\$2,985,725
Brandon-MacDill	30.7	37	15.0	6.0	8.0	255	10	10	\$2,603,447
Fishhawk-South Brandon	23.5	32	15.0	6.0	8.0	255	10	9	\$2,304,152
East County	21.6	44	15.0	6.0	8.0	255	10	6	\$1,531,034
Brandon-Southshore	15.5	26	15.0	6.0	8.0	255	10	8	\$1,888,492
Southshore Limited	38.1	33	15.0	6.0	8.0	255	10	14	\$3,608,448
Citrus Park-Carrollwood	21.4	39	15.0	6.0	8.0	255	10	7	\$1,697,745
New Tampa-Pasco	37.8	37	15.0	6.0	8.0	255	10	13	\$3,196,566
Oldsmar-Town 'n' Country-Alt1*	16.8	29	15.0	6.0	8.0	255	10	7	\$1,793,285
Northwest Limited Express	14.2	31	15.0	6.0	8.0	255	10	6	\$1,450,326
Clearwater Express	20.6	30	15.0	6.0	8.0	255	10	9	\$2,176,754
PSTA 100X	23.7	33	15.0	6.0	8.0	255	10	9	\$2,248,799
PSTA 300X	19.8	36	15.0	6.0	8.0	255	10	7	\$1,727,038
Total								174	\$43,135,899
Bus Rapid Transit Service									
MetroRapid - Hillsborough Ave	5.7	23	15.0	6	10	255	10	3	\$862,252
MetroRapid - Dale Mabry Hwy	13.7	23	15.0	6	10	255	10	8	\$2,090,947
Total								11	\$2,953,199

Table D - 25: BTL Network #2 – Transit Capital Costs

(Source: Tindale Oliver and Associates)

Item	Subarea	Location	Status	Future # of Parking Spaces/Stops	Total Capital Cost
Park-and-Ride					
Eddie C Moore Park	Pinellas County	2780 Drew St, Clearwater	Future	100	\$900,000
Ulmerton Rd	Pinellas County	Ulmerton Rd @ Starkey Rd	Existing	61	\$549,000
Gandy Blvd	Pinellas County	Gandy Blvd @ 16th St N	Future	100	\$900,000
Northwest Transfer Center	Airport/Northwest	8951 W. Waters Ave	Existing	94	\$846,000
Oldsmar	Oldsmar	SR 580 @ Tampa Rd	Existing	26	\$234,000
Citrus Park	Citrus Park	7502 Gunn Hwy	Existing	24	\$216,000
Van Dyke Rd	Cheval	Van Dyke Rd @ N Dale Mabry Hwy	Future	100	\$900,000
Pasco County Rd	Magnolia Place	W County Line Rd @ N Dale Mabry Hwy	Future	100	\$900,000
First Baptist Church of Lutz	Lutz	18000 US 41, Lutz	Future	100	\$900,000
Wesley Chapel	Wesley Chapel	CR 56 @ Bruce B. Downs Blvd	Future	45	\$405,000
Pebble Creek	Wesley Chapel	Bruce B. Downs Blvd @ Cross Creek Blvd	Existing	100	\$900,000
University Area Transit Center	USF	Livingston Ave @ E 131st Ave	Existing	20	\$180,000
Temple Terrace/New Tampa	Temple Terrace/New Tampa	I-75 @ Fletcher Ave	Future	100	\$900,000
Burnett Park	Seffner/Mango	11609 Clay Pit Rd	Future	100	\$900,000
Brandon/Riverview	Brandon/Riverview	Falkenburg Rd @ Causeway Blvd	Existing	50	\$450,000
Riverview Oaks	Riverview	US 301 @ Gibsonton Dr	Existing	36	\$324,000
DG Farms	Ruskin	4874 Sun Center Blvd	Existing	150	\$1,350,000
Mt. Zion Assembly of God	Plant City	3005 Thonotosassa Rd	Future	100	\$900,000
Total Park-and-Ride Cost (Future)					\$7,605,000
				# of Stations/Stops	Total Cost
Express Stop			New	4	\$6,705,000
BRT Station			New	16	\$2,304,000
Total Stations/Stops					\$9,009,000
				# of Vehicles	Total Cost
Express Service				174	\$97,440,000
BRT Service				11	\$5,060,000
Total Capital Costs					\$119,114,000

Table D - 26: BTL Network Alternative 3 – Transit Operating Costs

(Source: Tindale Oliver and Associates)

Route Name	Route Length	Avg Speed	Off-Peak Freq (min)	Peak Srvc Span (hr)	Off-Peak Srvc Span (hr)	# of Annual Weekdays	Peak Freq (min)	# of Peak Vehicles	Annual Operating Cost
New Tampa-Westshore	24.5	40	15	6.0	8.0	255	10	8	\$1,923,673
Brandon to Westshore	15.6	43	15	6.0	8.0	255	10	5	\$1,138,151
Northwest County to USF	12.3	26	15	6.0	8.0	255	10	6	\$1,502,986
Northwest County to Westshore	10.4	33	15	6.0	8.0	255	10	4	\$990,134
USF to Westshore	15.2	40	15	6.0	8.0	255	10	5	\$1,203,248
North Brandon to MacDill	23.9	36	15	6.0	8.0	255	10	8	\$2,081,352
Lutz Express	16.0	34	15	6.0	8.0	255	10	6	\$1,457,777
Dover-Brandon Express	18.2	34	15	6.0	8.0	255	10	7	\$1,677,269
Fishhawk-Riverview-MacDill	35.6	37	15	6.0	8.0	255	10	12	\$2,985,725
Brandon-MacDill	30.7	37	15	6.0	8.0	255	10	10	\$2,603,447
Fishhawk-South Brandon	23.5	32	15	6.0	8.0	255	10	9	\$2,304,152
East County	26.8	43	15	6.0	8.0	255	10	8	\$1,934,354
Brandon-Southshore	20.7	33	15	6.0	8.0	255	10	8	\$1,948,735
Southshore Limited	38.1	33	15	6.0	8.0	255	10	14	\$3,608,448
Citrus Park-Carrollwood	15.2	31	15	6.0	8.0	255	10	6	\$1,523,899
New Tampa-Pasco	33.3	34	15	6.0	8.0	255	10	12	\$3,033,722
Oldsmar-Town 'n' Country*	17.5	32	15	6.0	8.0	255	10	7	\$1,724,206
Northwest Limited Express	14.2	31	15	6.0	8.0	255	10	6	\$1,450,326
Clearwater Express	20.6	30	15	6.0	8.0	255	10	9	\$2,176,754
PSTA 100X	23.7	33	15	6.0	8.0	255	10	9	\$2,248,799
PSTA 300X	19.8	36	15	6.0	8.0	255	10	7	\$1,727,038
Total								166	\$41,244,195

Table D - 27: BTL Network Alternative 3 – Transit Capital Costs

(Source: Tindale Oliver and Associates)

Item	Subarea	Location	Status	Future # of Parking Spaces/Stops	Total Capital Cost
Park-and-Ride					
Eddie C. Moore Park	Pinellas County	2780 Drew St, Clearwater	Future	100	\$900,000
Ulmerton Rd	Pinellas County	Ulmerton Rd @ Starkey Rd	Existing	61	\$549,000
Gandy Blvd	Pinellas County	Gandy Blvd @ 16th St N	Future	100	\$900,000
Northwest Transfer Center	Airport/Northwest	8951 W. Waters Ave	Existing	94	\$846,000
Oldsmar	Oldsmar	SR 580 @ Tampa Rd	Existing	26	\$234,000
Citrus Park	Citrus Park	7502 Gunn Hwy	Existing	24	\$216,000
Pasco County Rd	Magnolia Place	W County Line Rd @ N Dale Mabry Hwy	Future	100	\$900,000
First Baptist Church of Lutz	Lutz	18116 US 41, Lutz	Future	100	\$900,000
Wesley Chapel	Wesley Chapel	CR 56 @ Bruce B. Downs Blvd	Future	45	\$405,000
Pebble Creek	Wesley Chapel	Bruce B Downs Blvd @ Cross Creek Blvd	Future	100	\$900,000
Orange Grove	Carrollwood South	Busch Blvd & N Armenia Ave	Existing	52	\$468,000
University Area Transit Center	USF	Livingston Ave @ E 131st Ave	Existing	20	\$180,000
Burnett Park	Seffner/Mango	11609 Clay Pit Rd	Future	100	\$900,000
Brandon/Riverview	Brandon/Riverview	Falkenburg Rd @ Causeway Blvd	Existing	50	\$450,000
Riverview Oaks	Riverview	US 301 @ Gibsonton Dr	Existing	36	\$324,000
DG Farms	Ruskin	4874 Sun Center Blvd	Existing	150	\$1,350,000
Mt. Zion Assembly of God	Plant City	3005 Thonotosassa Rd	Future	100	\$900,000
Total Park-and-Ride Cost (Future)					\$6,705,000
Stations/Stops				# of Stations/Stops	Total Cost
Express Stop			New	1	\$137,000
Vehicles				# of Vehicles	Total Cost
Express Service				166	\$92,960,000
Total Capital Costs					\$99,802,000

Transit Cost Summary

A summary of costs, in 2012 dollars, is shown in Table D-28. Of the estimated capital costs, vehicles comprise the largest portion.

Table D - 28: Summary of BTL Network Alternative Operating and Capital Costs – 2012

(Source: Tindale Oliver and Associates)

Item	Annual Operating Costs (2012 Value)	Capital Costs (2012 Value)			
		Park-and-Ride Facility*	Station/Stop	Vehicle	Total
BTL Alternative 1					
Express Service	\$38,199,047	N/A	\$1,224,000	\$86,240,000	\$87,464,000
BRT Service	\$1,068,512	N/A	\$1,224,000	\$1,380,000	\$2,604,000
Total	\$39,267,560	\$8,055,000	\$2,448,000	\$87,620,000	\$98,123,000
BTL Alternative 2					
Express Service	\$43,135,899	N/A	\$6,705,000	\$97,440,000	\$104,145,000
BRT Service	\$2,953,199	N/A	\$2,304,000	\$5,060,000	\$7,364,000
Total	\$46,089,098	\$7,605,000	\$9,009,000	\$102,500,000	\$119,114,000
BTL Alternative 3					
Express Service	\$41,244,195	N/A	\$137,000	\$92,960,000	\$93,097,000
Total	\$41,244,195	\$6,705,000	\$137,000	\$92,960,000	\$99,802,000

*Park-and-ride facilities are not differentiated between express service and BRT and only a total cost was developed.

Section E

Financial Feasibility Analysis

1. Financial Analysis

The BTL concept provides support for public transportation by making transit agencies an equity partner with toll agencies in the development and operation of new price-managed express lanes in highly congested urban areas. It should be noted that a BTL is not a high occupancy toll (HOT) lane. No discounts or free passage are provided based on vehicle type or occupancy. Capacity is dedicated first to public transit, and then all of the remaining highway capacity is sold to automobile drivers who are willing to pay for free-flow service.

The approach for evaluating the multiple financial variables associated with constructing, operating and maintaining the three BTL networks involves a comparison of the revenue outputs produced from the transit ridership fare-box and toll traffic analysis with the overall capital investments, operating costs, annual maintenance costs and major maintenance costs (renewal and replacement) along with their timing by year to determine the financial sustainability of the candidate BTL networks.

Description of Analysis

The analysis included collection of input data, analysis of the data utilizing a financial feasibility model and a final report with descriptive graphics.

Data Collection Process

- Collect existing BTL inputs from the BTL Proof-of-Concept within a master data matrix
- Separate the public transportation data for each network into New Transit and Existing Transit.
 - New Transit: The capital cost and the cost of annual operations for all new BTL-dedicated express bus service is included in the financial feasibility evaluation for each of the BTL networks
 - Existing Transit: The operations cost of existing express bus and BRT services were identified but are not included in the BTL financial feasibility analysis because these services are part of the HART operations plans and were therefore assumed to be funded and operating with or without the BTL networks
- Adjustment for Transit Major Maintenance (MM) to include the cost of replacement busses over the operating term. Initial purchases of new busses before the operating term begins are included in the upfront capital costs.

Financial Feasibility Model and Scenario Analysis Process

- Uploaded BTL project data into a financial feasibility model and customized specific aspects of the model for the BTL project.
- Developed financing scenarios for each network using public funding sources.
- Applied credit spread and future market move to the current yield curve for bonding assumptions.

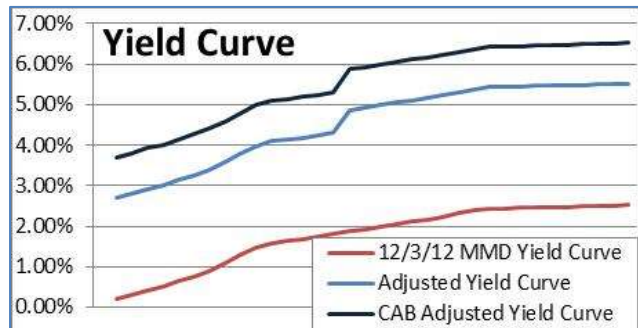


Figure E - 1: Yield Curve

- Assessed if the BTL project is financially feasible using the public funding and bonding sources assumed.

NOTE: The debt analysis utilized in this report represents a basic bond structure to illustrate financing capacity.

Municipal Market Data (MMD) yield curve: The MMD index is the industry's benchmark yield curve (interest rates) for AAA rated credits. Credits rated below AAA, such as a new toll project, have an additional credit spread added to reflect the increased risk and this report's analysis also includes a market move adder to conservatively account for the likelihood of higher rates in the future. An optimized financing could be structured utilizing additional debt products such as Capital Appreciation Bonds (CABs) or a federal TIFIA loan to aggressively tailor a project financing and produce additional upfront proceeds.

Capital Appreciation Bonds (CABs): A municipal security on which the investment return on an initial principal amount is reinvested at a stated compounded rate until maturity, at which time the investor receives a single payment (the "maturity value") representing both the initial principal amount and the total investment return. CABs typically are sold at a deeply discounted price and are distinct from traditional zero coupon bonds because the investment return is considered to be in the form of compounded interest rather than accreted original issue discount.

BTL Net Revenue Matrix, Projections and Dashboard

An input matrix was developed to drive projections of the multiple variables to a dashboard format for presenting the comparison of capital costs, the operating and maintenance costs and the major maintenance costs against the BTL new fare box revenue (tolls and transit ridership revenues) produced by the various BTL networks. The projections presents the net revenue return to THEA and HART based on the amount of capital invested in the project and is flexible enough to easily alter the partnership percentage. The dashboard also includes the ability for additional partners to participate in the project in both capital equity and operating roles.

The results are summarized in data tables (in spreadsheet format) that drive the dashboard in a manner that facilitates analyzing and presenting the investment requirements and resulting investment values for different levels of partnership in the BTL networks. The tables were populated through 30 full years of gross revenue.

Figures E-2 through E-4 on the following pages present the input matrix for each of the BTL Networks. An example of the dashboard is provided in the following section on Figure E-6.

LEGAL PAGE INSERTS– SPREADSHEET MATRIX OF BTL OUTPUTS

BTL #1 Input Matrix – 11” x 17”

Figure E - 2: BTL Network #1 Financial Feasibility Input Matrix (all amounts are in year of expenditures)

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BTL #2 Input Matrix – 11” x 17”

Figure E - 3: BTL Network #2 Financial Feasibility Input Matrix (all amounts are in year of expenditures)

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BTL #3 Input Matrix – 11” x 17”

Figure E - 4: BTL Network #3 Financial Feasibility Input Matrix (all amounts are in year of expenditures)

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2. Analysis Summary

The BTL analysis focused on three networks to develop a new premium bus network system to operate within a tolled corridor with guaranteed level of service (minimum mph). In each case, significant toll revenues are generated from tolling the passenger vehicles. However, the gross revenue forecasts have to be put in context of the upfront capital costs and ongoing operational costs. The study produced BTL network revenues based on a high, medium and low projections and the following analysis is based on the medium projections for each network.

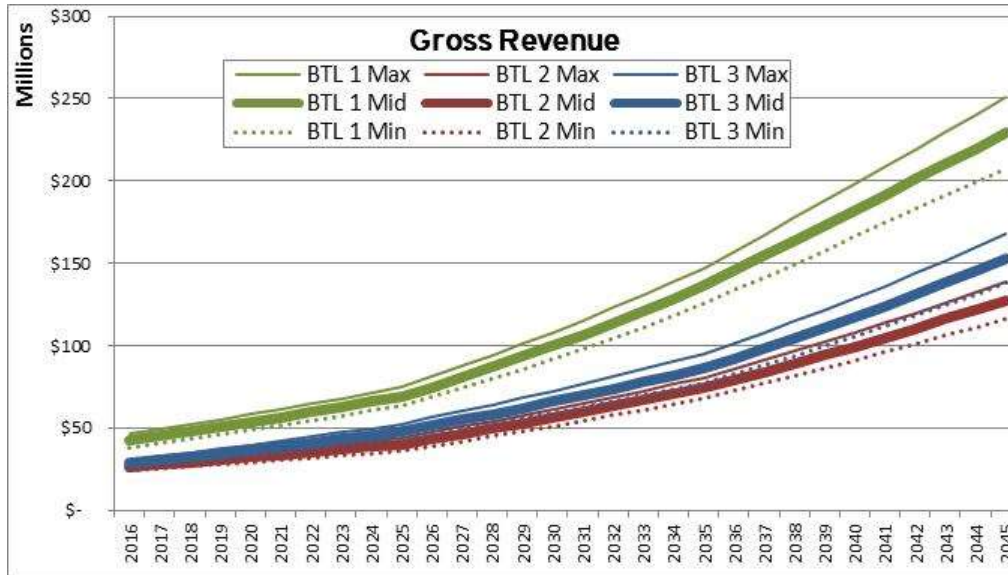


Figure E - 5: Summary Gross Revenues Graph (Source: HNTB)

	Gross Revenue (Toll and New Transit)	Toll O&M and MM	New Transit O&M and MM	Net Rev.: Toll Rev. less Toll O&M and MM	Present Value @ 5%	Total Net Rev.: Gross Rev. less Toll & New Transit O&M and MM	Present Value @ 5%	Comparator Index (Total Net Rev. /CapEx)	Comparator Index (PV @5% of Total Net Rev. /CapEx)
BTL 1									
High	3,765	589	535	3,118	1,096	2,642	898	4.5	1.5
Medium	3,464	545	535	2,861	1,005	2,385	807	4.0	1.4
Low	3,163	501	535	2,604	914	2,127	717	3.6	1.2
BTL 2									
High	2,111	401	585	1,642	582	1,124	366	1.6	0.5
Medium	1,940	371	585	1,502	531	984	316	1.4	0.4
Low	1,770	341	585	1,361	480	844	265	1.2	0.4
BTL 3									
High	2,495	393	567	2,018	712	1,535	511	1.5	0.5
Medium	2,274	361	567	1,830	646	1,347	445	1.3	0.4
Low	2,054	328	567	1,642	580	1,158	379	1.1	0.4

Table E - 1: Summary Results Table (30-yr term; \$millions) Source: HNTB

Unique Financial Model Used to Analyze the BTL Concept

To determine how well the BTL concept would stand up against traditional transit projects (both fixed rail and bus), the evaluation used a unique financial model to compare how the BTL fare box (transit rider revenue and equity share of toll revenue) would cover the following capital and operating costs:

(1) Facility OpEx

- Annual routine operations and maintenance of facilities
- Major maintenance (renewal and replacement) sinking fund

(2) Transit OpEx

- Annual routine operations and maintenance of rolling stock and facilities
- Major maintenance (periodic replacement of rolling stock)

(3) CapEx Financing

- Funding required for construction of roadway component
- Funding required for the additional rolling stock dedicated to BTL express service
- Funding required for BTL-specific transit facilities

The revenue and cost results for each of the BTL networks were analyzed within a financial model that was customized specifically for the BTL Proof-of-Concept Study. The model contains a dashboard with settings that permit adjustments to the revenue and cost inputs that go far beyond the high, medium and low ranges of the estimated revenues and costs produced within the study.

As shown on the example dashboard from the BTL Network #1 analysis, numerous elements that impact the investment and operations of a revenue generating project can be varied within the feasibility model, thus permitting a wide range of sensitivity analyses.

The adjustable elements within the model include:

- **Construction Assumptions:** amount of CapEx for the project (divided by percentage between the roadway and transit elements) and the potential sharing of the capital costs between project participants based on their equity investment
- **Operations Assumptions:** amount and distribution of revenue, transactions, toll/fare rates, operations & maintenance costs and major maintenance costs – and the division of the transit expenses between the new BTL-dedicated express bus service and any existing express bus and BRT services that may be included
- **Debt Assumptions:** interest rates, debt-coverage ratios, bond length, etc.

Model Dashboard Example

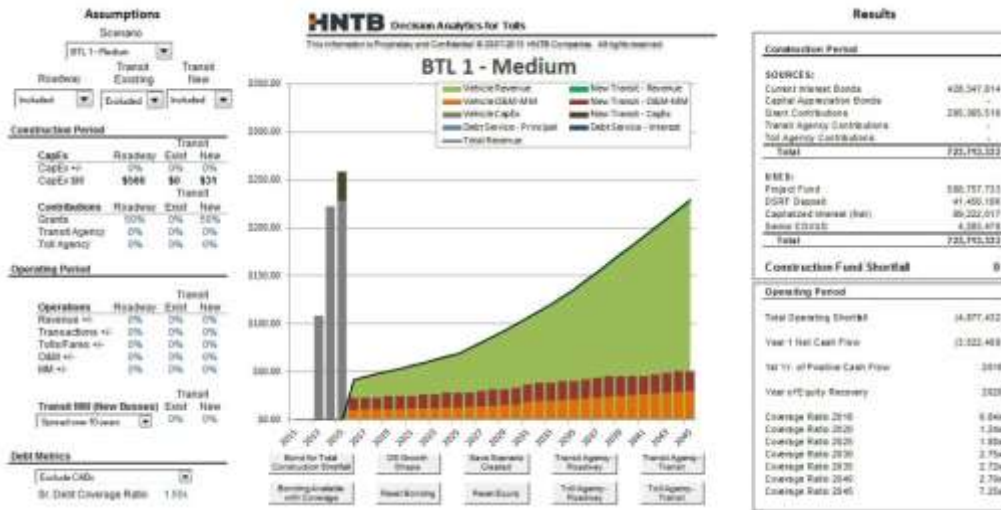


Figure E - 6: Example Dashboard from BTL Financial Analysis Model

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3. Illustrating the Transit and Tolls Partnership

The Bus Toll Lanes produce significant gross toll revenues that could enable transit to offer a new premium service under all the corridor scenarios tested. The analysis offers encouraging results for a new transportation paradigm that marries traditional transit and toll facility funding and financing.

Toll facilities typically require upfront funding support for the capital costs but normally do not require operational subsidies. The source of the upfront funding subsidy is typically hard to identify. Funding issues for new transit projects are nearly the opposite.

New transit projects are typically funded with federal grants or resources from local sources such as sales, real estate or fuel taxes. For transit, the difficulty is finding a sustainable revenue source to cover the ongoing operations and maintenance requirements since fare box revenues typically only cover approximately 20-30% of operations.

The following analysis explores the possibilities of utilizing the upfront funding sources available for transit as an equity investment to build a new Bus Toll Lanes network thus providing transit an ongoing operational subsidy from the revenues produced from the non-transit vehicles on the facility.

New toll facilities typically produce revenues sufficient to fund their operations and maintenance needs and have excess revenue capacity to fund a portion of their capital costs through toll revenue supported debt. However, start-up toll facilities typically are not able to fully fund their capital costs through debt and require some type of subsidy to provide the requisite gap funding. Financial markets also require “coverage” or cushion in case revenues are below the forecast. The higher relative sensitivity of price-managed lanes would likely require higher debt coverage cushions. That coverage provides most toll facilities with annual excess of cash after debt service and operations.

Transit projects typically apply for New Starts grants from the Federal Transit Authority to fund capital expenses such as the track work and rolling stock required for new projects. These grants usually require a percentage of matching funds that normally come from local resources. Grants also require the community to provide a feasible long-term funding plan to support the operations and maintenance of the project. The lack of a viable long-term funding plan will significantly decrease the ability to successfully obtain a grant or tax-based funding source for the upfront capital requirements.

In summary, the BTL concept incorporates transit capital funds to augment the toll financing potential, which should provide transit with a new source of sustainable revenues that can be used to pay for transit operations or fund other expansions of the local public transportation system.

Utilizing Bus Toll Lanes Network¹ as an example, the following outlines how tolling and transit can work together to create a project that neither likely could produce exclusively on their own. The following narrative and graphs demonstrate the stand-alone and combined funding efforts based on the revenue and cost forecasts produced by this exercise.

4. Case Studies of BTL Networks

BTL #1 Case Study Results

The analysis of the revenue and cost results for the study indicates that BTL #1 is the most viable project from an economic perspective. This conclusion is based on the total capital cost of the project and the net cash flows it generates.

To illustrate the potential of combining transit and tolls, the BTL #1 transit and tolls components are first presented separately as if they were stand-alone projects. Then, to illustrate the value of the transit-tolls partnership, the cash flows of the toll guideway and transit service are combined.

The basic assumptions for the BTL #1 case are as follows:

Table E-2: BTL #1 Basic Assumptions (Source: HNTB)

Component	Description
Network	BTL-1
Revenue Case	Medium forecast
Toll Facility Capital Cost	\$560 million; assumed funded externally (bonding, grants or taxes)
New Transit Capital Cost	\$31 million; assumed funded externally (bonding, grants or taxes)
Toll Facility O&M and MM	Included in cash flows and funded through toll revenues
New Transit O&M and MM	Layered onto cash flows per applicable scenario
Debt (as applicable)	Current Interest Bond @ 1.5x DSCR, WACC @ 5.46%
Interest Rates	MMD + 2.0% credit spread + market move (0.5% increasing to 1.0%)

**Weighted Average Cost of Capital represents the weighted average interest rate for the transaction*

Fare Box Cash Flows for BTL #1 as a New Transit Project

BTL#1 is first presented as if it were a new premium bus service being implemented without the infrastructure costs of a new guideway system. The revenues, capital costs and O&M costs are taken directly from the input matrix in Figure E-2.

As a transit project only, BTL #1's new transit annual revenues average about 10% of annual new transit operating costs. Even if the project's upfront capital costs are completely funded through grants or some other non-recourse financing, a significant operational subsidy is still required to operate the new transit network over the 30-year time frame (more than \$.5 Billion).

The following represent the characteristics of the transit financing and operations and the results of BTL#1 if the network was developed and operated as stand-alone express bus project.

BTL #1 Premium Bus Service

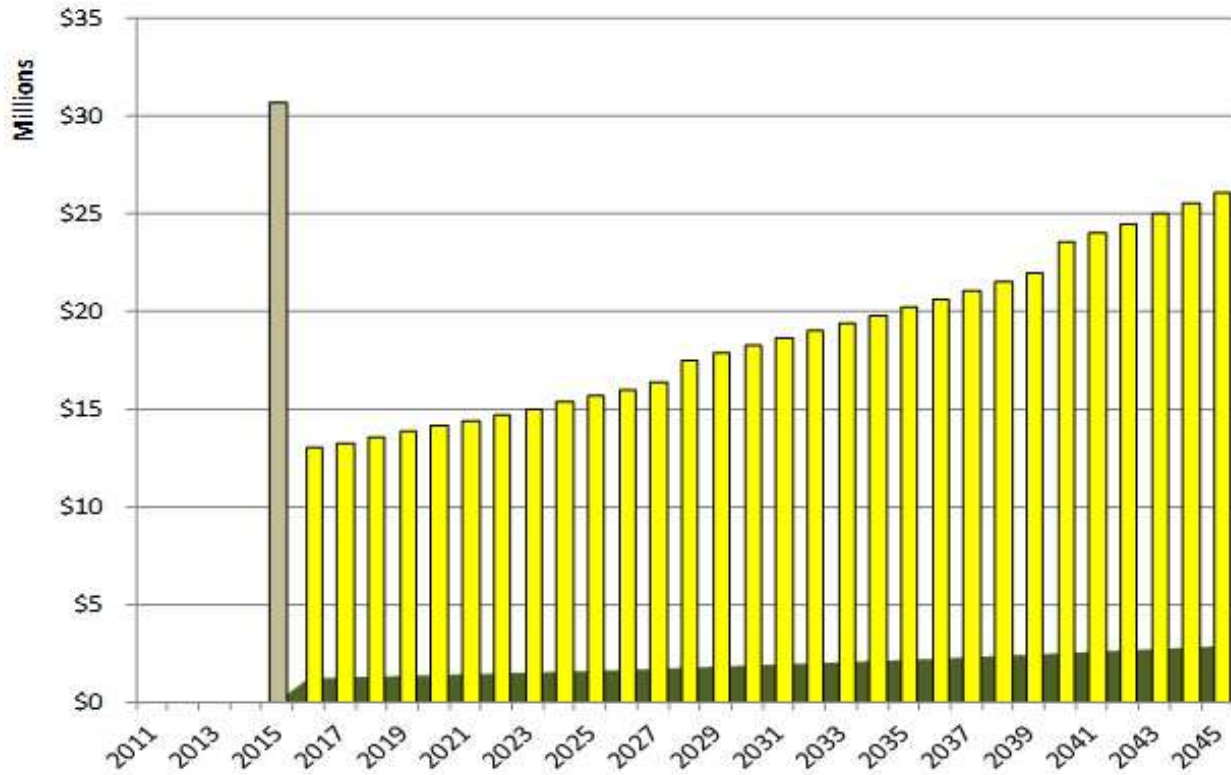


Figure E – 7: BTL#1 Premium Bus Service Capital Cost, Revenue and O&M Cost

Figure E-7 illustrates the up-front capital required for the new transit service (\$31 Million) and the subsidy requirements of the new transit service. A scale of \$0 - \$35 million is used to be able to visibly portray the transit financials. Total revenue of \$58 million over 30 years compared to the total O&M cost of \$559 Million results in a subsidy required to support the transit operations over the 30-year period of \$501 Million.

It should be noted that major maintenance costs to replace rolling stock and make periodic capital improvements for the dedicated bus service are incorporated every 12 years based on the experience of HART with similar equipment.

Dollars in Millions	New Premium Bus
Bus Capital Cost	\$31
Bus O&M Cost	\$559
Bus Revenue	\$58
Net Revenue	(\$501)
Transit Grant Financing	\$31
Unfunded Operating	(\$501)

Fixed Guideway Cash Flows with Debt for BTL #1 as a Toll Project

Toll projects typically produce positive net revenues and cash flow (gross revenue less annual operations and maintenance costs). If the BTL#1 guideway infrastructure was constructed as a 100% toll-funded project, it would produce substantial annual revenues with cumulative revenue at just over \$2.8 billion (after toll O&M). The following represent the characteristics of the toll financing and operations and the results of BTL#1 if the network fixed guideways were developed and operated as stand-alone price-managed toll projects.

- Toll facilities typically finance their upfront capital costs with debt (toll revenue bonds)
- Conditions of the financial markets, along with rating agencies and investors' perspectives, dictate the amount of debt that a given project can support
- Toll projects usually require an upfront public subsidy since an initial toll financing cannot fully fund capital costs
- Figure E-8 on the following page illustrates that toll revenue debt can help pay a portion of the upfront capital costs of the project and excess revenues exist after payment of debt service and annual toll operations and maintenance
- Given the forecasted revenue, cost of toll operations, maintenance and renewal, the net revenue would enable bond financing of just under 50% of the capital cost at a 1.5 coverage ratio.
- Even as a "toll facility" this project would require significant up-front contributions to fund capital costs.

Please note the scale of the representation has been changes to accommodate the larger amounts. The scale is now from \$0 - \$275 Million.

BTL #1 Price-Managed Fixed Guideway

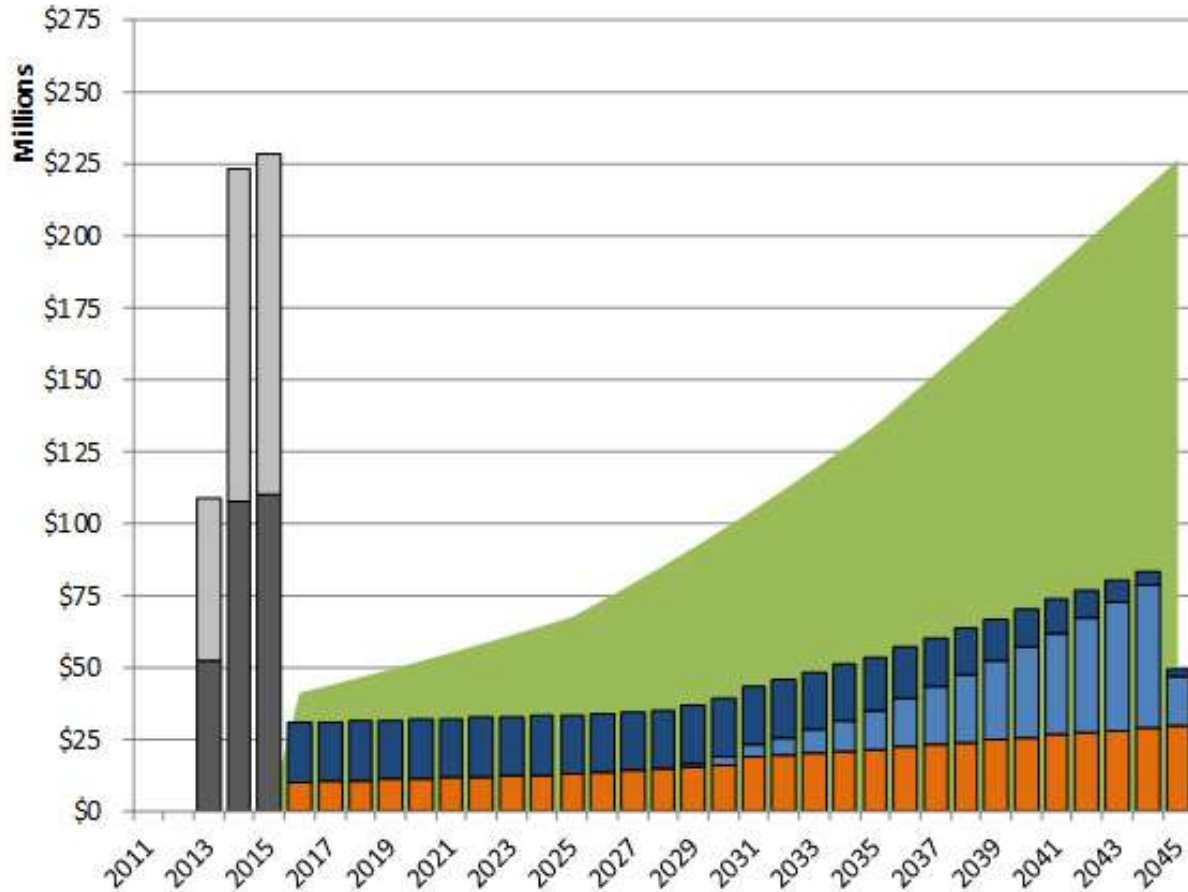


Figure E – 8: BTL #1 Price-Managed Fixed Guideway Capital Cost, Revenue and O&M Cost

Figure E-8 identifies the results of building and operating the fixed guideway as an exclusive toll project. Revenue (shown in green on the figure) over 30-years is in excess of \$3.4 Billion while O&M cost (in orange) is less than \$550 Million for the same time frame.

However, as noted, the \$2.8 Billion in excess operating revenue can only generate \$268 Million in revenue bond funding for the capital cost of the project – even though the cost of financing is less than \$900 Million (debt service shown in blue – dark blue for interest, light blue for principle repayment).

With total net revenue of more than \$2 Billion, the fixed guideway would require an up-front subsidy of \$292 Million from some other source to fund the total \$560 Million capital needs of the lanes.

Dollars in Millions	Fixed Guideway
Guideway Capital Cost	\$560
Toll Revenue	\$3,406
Guideway O&M Cost	\$545
Net Revenue	\$2,861
Toll Bond Financing	\$268
Cost of Finance	\$858
Net All Costs	\$2,003
Unfunded Capital	(\$292)

Combined Cash Flows for BTL #1 as a Transit-Tolls Partnership

As a combined transit-tolls project, BTL #1 achieves a level of financial performance that is superior to the results of the individual transit and price managed-lane projects contained within the BTL #1 network. The following represents the characteristics of the financing and operations of BTL #1 and the financial results if the network fixed guideways and transit service were developed and operated as a combined BTL transit-tolls partnership.

- The graphs assume the first call on the toll revenue is to cover 100% of toll operational costs.
- Net toll revenue would be able to fund less than 50% of the upfront capital costs in this scenario.
- Toll financing of \$268 Million could be viewed as a local match to other traditional transit funding sources.
- If the BTL project could fund its remaining upfront capital costs with traditional transit funding sources, toll revenues can support 100% of the ongoing operational costs of the new transit service.
- While there is an operational deficit in year one, toll revenues can support the tolling O&M as well as debt service and new transit O&M in the out years.
- Total combined gross revenue for this BTL is just under \$3.5 Billion through the year 2045 and cumulative revenue after toll and transit O&M and debt service for the 30-year time frame is just under \$1.5 billion.

Figure E-9 identifies the results of building and operating the fixed guideway as a combined transit-tolls project. Please note the scale of the graph is from \$0 - \$275 Million.

The total capital cost for the combined project is \$591 Million (guideway construction plus initial transit rolling stock and stations).

The combination of the toll revenue (shown in green) and the transit revenue (small dark line at the top of the toll revenue) over 30-years is in excess of \$3.4 Billion. The combined O&M cost for the guideway (in orange) and the transit (in yellow) for the same time frame is well over \$1 Billion. However, all O&M costs (including MM costs) for both the transit and guideway are easily covered by the combined transit and toll revenues with almost \$1.5 Billion in excess revenue over the 30 years available for expansion of transit activities within the BTL corridors or other public transportation uses.

BTL #1 Transit-Tolls Partnership Concept

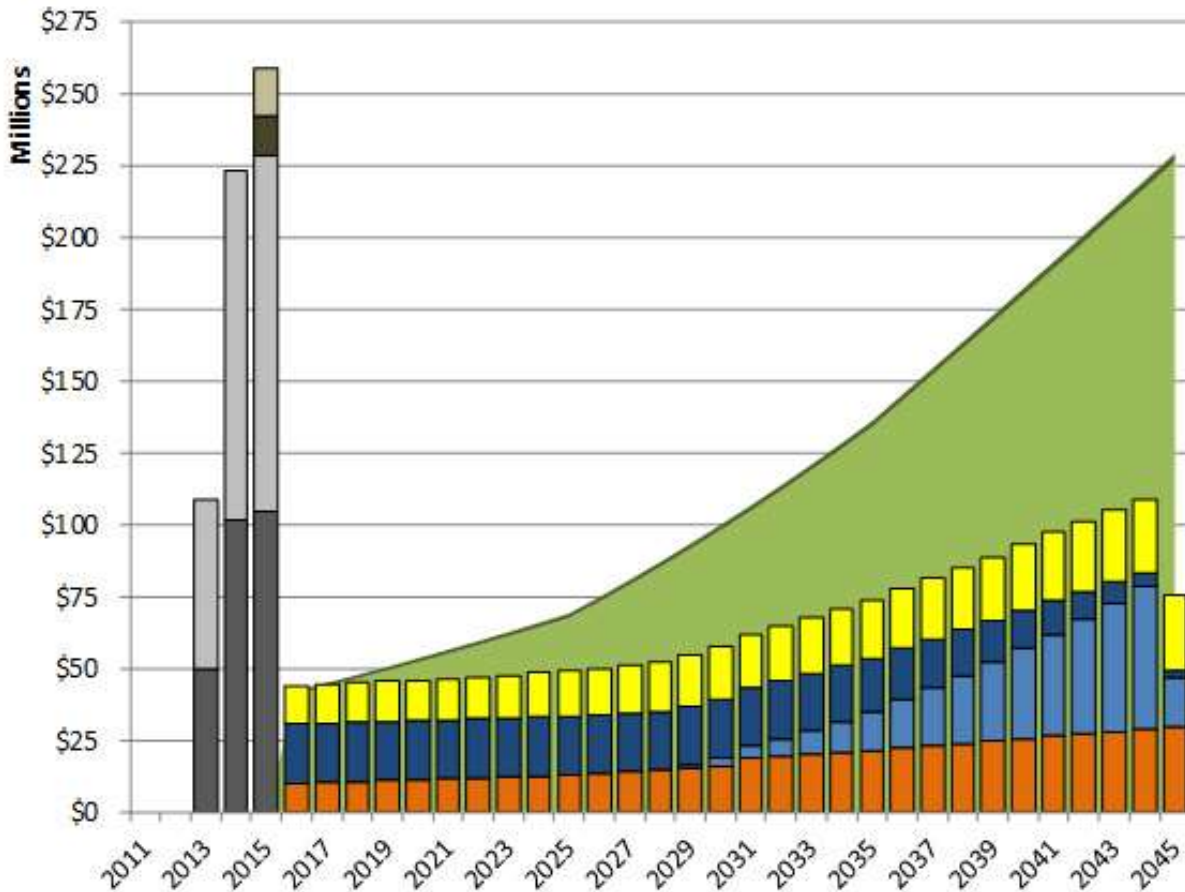


Figure E – 9: BTL Combined Concept – Guideway and Transit Capital Cost, Revenue and O&M Cost

As noted, the \$2.9 Billion net revenue in excess of guideway operating cost still only generates \$268 Million in revenue bond funding for the capital cost of the fixed guideway – even though the cost of financing is less than \$900 Million.

The total capital cost of the project would therefore require an up-front subsidy of \$323 Million from some other source to fund the total \$591 Million capital needs of the guideway and initial transit equipment. This could be in the form of transit grants or other local contributions. Under the transit-tolls partnership, the excess revenue (\$1.485 Billion over 30 years) above the cost of guideway and transit operations would then be divided among those who provided the actual capital investment of \$323 Million based on their percentage of investment.

Dollars in Millions	BTL Concept
Total Capital Cost	\$591
Revenue	\$3,464
Guideway O&M Cost	\$545
Net Revenue	\$2,919
Transit Grant Financing	\$323
Toll Bond Financing	\$268
Cost of Finance	\$875
Bus O&M Cost	\$559
Net All Costs	\$1,485

BTL #2 Case Study Results

While BTL # 2 does not perform as well as BTL #1 financially, the analysis of the revenue and cost results for the study indicates that it is still a very desirable project from an economic perspective. This conclusion is based on the total capital cost of the project and the net cash flows it generates.

As shown in Table E-3, the total capital cost is a major difference between BTL #2 and BTL #1 with BTL #2 considerably higher at \$719 Million.

The basic assumptions for the BTL #2 case are as follows:

Table E-3: BTL #2 Basic Assumptions

Component	Description
Network	BTL-2
Revenue Case	Medium forecast
Toll Facility Capital Cost	\$679 million; assumed funded externally (bonding, grants or taxes)
New Transit Capital Cost	\$40 million; assumed funded externally (bonding, grants or taxes)
Toll Facility O&M and MM	Included in cash flows and funded through toll revenues
New Transit O&M and MM	Layered onto cash flows per applicable scenario
Debt (as applicable)	Current Interest Bond @ 1.5x DSCR, WACC @ 5.46%
Interest Rates	MMD + 2.0% credit spread + market move (0.5% increasing to 1.0%)

**Weighted Average Cost of Capital represents the weighted average interest rate for the transaction*

Fare Box Cash Flows for BTL #2 as a New Transit Project

As shown in the previous case, BTL#2 is first presented as if it were a new premium bus service being implemented without the infrastructure costs of a new guideway system. The revenues, capital costs and O&M costs are taken directly from the input matrix in Figure E-3.

As a transit project only, BTL #2's new transit annual revenues average slightly more than 10% of annual new transit operating costs. Even if the project's upfront capital costs are completely funded through grants or some other non-recourse financing, a significant operational subsidy is still required to operate the new transit network over the 30-year time frame (slightly more than \$.5 Billion).

The following represent the characteristics of the transit financing and operations and the results of BTL#2 if the network was developed and operated as stand-alone express bus project.

BTL #2 Premium Bus Service

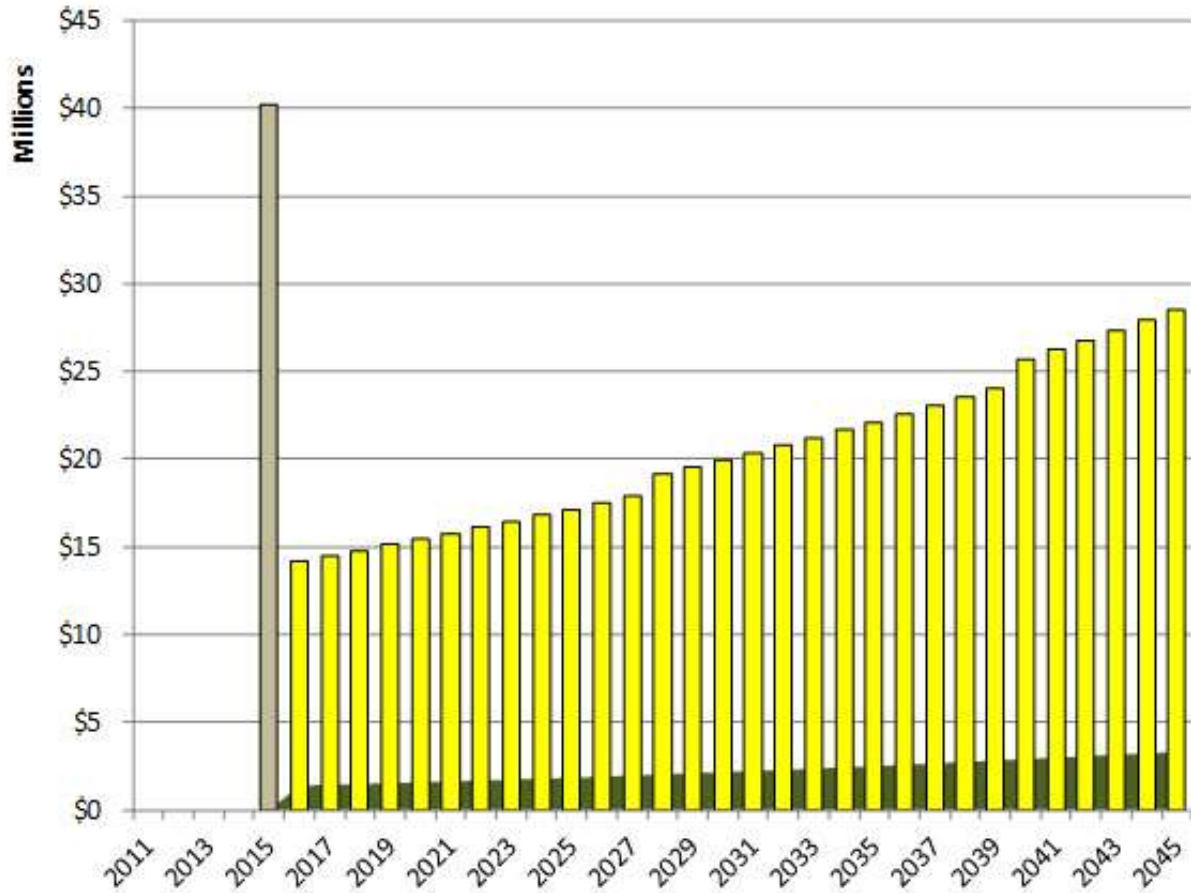


Figure E – 10: BTL#2 Premium Bus Service Capital Cost, Revenue and O&M Cost

Figure E-10 illustrates the up-front capital required for the new transit service (\$40 Million) and the subsidy requirements of the new transit service. A scale of \$0 - \$45 million is used to be able to visibly portray the transit financials. Total revenue of \$68 Million over 30 years compared to the total O&M cost of \$612 Million results in a subsidy required to support the transit operations over the 30-year period of \$545 Million.

Dollars in Millions	New Premium Bus
Bus Capital Cost	\$40
Bus O&M Cost	\$612
Bus Revenue	\$68
Net Revenue	(\$545)
Transit Grant Financing	\$40
Unfunded Operating	(\$545)

It should be noted that major maintenance costs to replace rolling stock and make periodic capital improvements for the dedicated bus service are incorporated every 12 years based on the experience of HART with similar equipment.

Fixed Guideway Cash Flows with Debt for BTL #2 as a Toll Project

Toll projects typically produce positive net revenues and cash flow (gross revenue less annual operations and maintenance costs). If the BTL#2 guideway infrastructure was constructed as a 100% toll-funded project, it would produce substantial annual revenues with cumulative revenue at just over \$1.5 billion (after toll O&M). The following represent the characteristics of the toll financing and operations and the results of BTL#2 if the network fixed guideways were developed and operated as stand-alone price-managed toll projects.

- Toll facilities typically finance their upfront capital costs with debt (toll revenue bonds)
- Conditions of the financial markets, along with rating agencies and investors' perspectives, dictate the amount of debt that a given project can support
- Toll projects usually require an upfront public subsidy since an initial toll financing cannot fully fund capital costs
- Figure E-11 illustrates that toll revenue debt can help pay a portion of the upfront capital costs of the project and excess revenues exist after payment of debt service and annual toll operations and maintenance
- Given the forecasted revenue, cost of toll operations, maintenance and renewal, the net revenue would enable bond financing of just over 22% of the capital cost at a 1.5 coverage ratio.
- Even as a "toll facility" this project would require significant up-front contributions to fund capital costs.

Please note the scale of the representation has been changes to accommodate the larger amounts. The scale is now from \$0 - \$275 Million.

BTL #2 Price-Managed Fixed Guideway

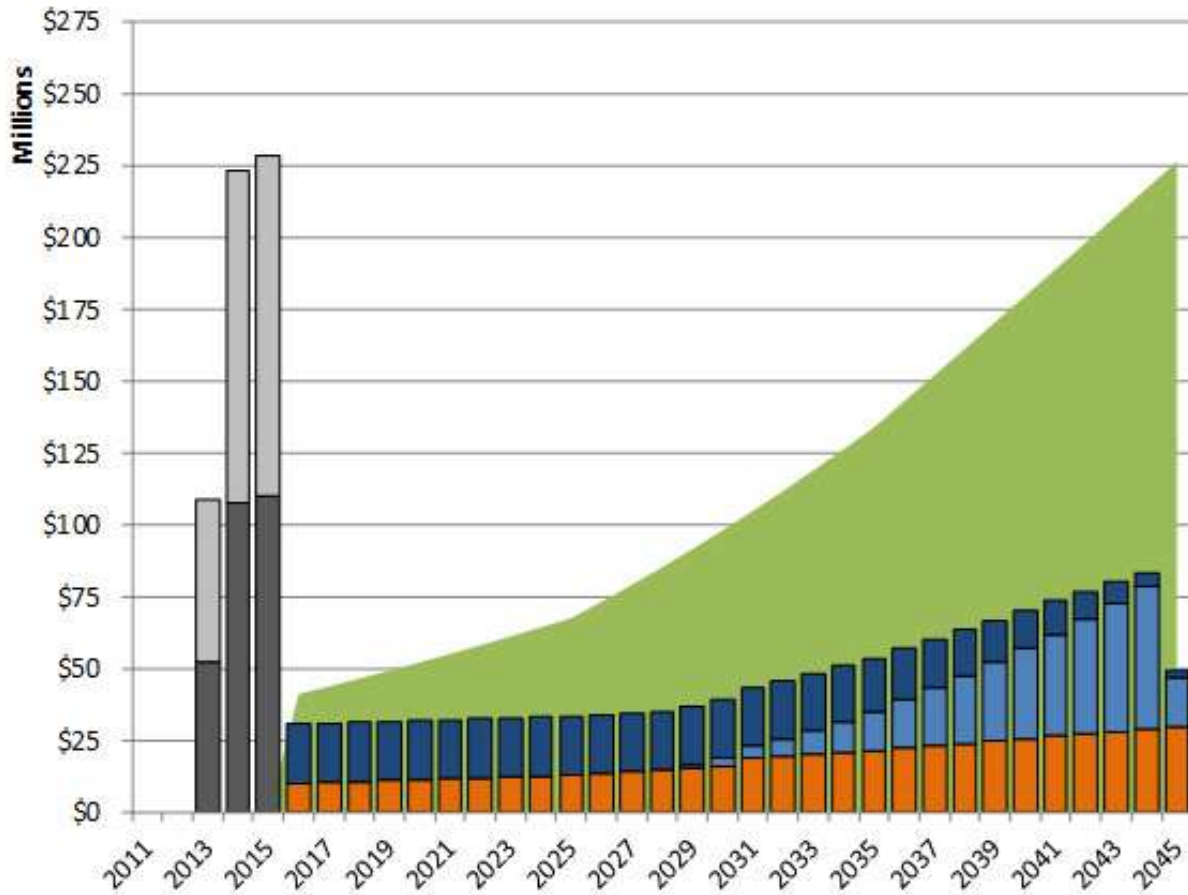


Figure E – 11: BTL #2 Price-Managed Fixed Guideway Capital Cost, Revenue and O&M Cost

Figure E-11 identifies the results of building and operating the fixed guideway as an exclusive toll project. Revenue (shown in green on the figure) over 30-years is in excess of \$1.8 Billion while O&M cost (in orange) is at \$371 Million for the same time frame. However, as noted, the \$1.5 Billion in excess operating revenue can only generate \$150 Million in revenue bond funding for the capital cost of the project – even though the cost of financing is only \$490 Million (debt service shown in blue – dark blue for interest, light blue for principle repayment).

With total net revenue of more than \$1 Billion, the fixed guideway would require an up-front subsidy of \$529 Million from some other source to fund the total \$679 Million capital needs of the lanes.

Dollars in Millions	Fixed Guideway
Guideway Capital Cost	\$679
Toll Revenue	\$1,872
Guideway O&M Cost	\$371
Net Revenue	\$1,501
Toll Bond Financing	\$150
Cost of Finance	\$490
Net All Costs	\$1,011
Unfunded Capital	(\$529)

Combined Cash Flows for BTL #2 as a Transit-Tolls Partnership

As a combined transit-tolls project, BTL #2 achieves a level of financial performance that is superior to the results of the individual transit and price managed-lane projects contained within the BTL #2 network. The following represents the characteristics of the financing and operations of BTL #2 and the financial results if the network fixed guideways and transit service were developed and operated as a combined BTL transit-tolls partnership.

- The graphs assume the first call on the toll revenue is to cover 100% of toll operational costs.
- Net toll revenue would be able to fund about 22% of the upfront capital costs in this scenario.
- Toll financing of \$150 Million could be viewed as a local match to other traditional transit fund sources.
- If the BTL project could fund its remaining upfront capital costs with traditional transit funding sources, toll revenues can support 100% of the ongoing operational costs of the new transit service.
- While there is an operational deficit up through year seven, toll revenues can support the tolling O&M as well as debt service and new transit O&M in the out years.
- Total combined gross revenue for this BTL is just under \$1.9 Billion through the year 2045 and cumulative revenue after toll and transit O&M and debt service for the 30-year time frame is just under \$0.5 billion.

Figure E-12 identifies the results of building and operating the fixed guideway as a combined transit-tolls project. Please note the scale of the graph is from \$0 - \$325 Million.

The total capital cost for the combined project is \$719 Million (guideway construction plus initial transit rolling stock and stations).

The combination of the toll revenue (shown in green) and the transit revenue (small dark line at the top of the toll revenue) over 30-years is in excess of \$1.9 Billion. The combined O&M cost for the guideway (in orange) and the transit (in yellow) for the same time frame is just under \$1 Billion. However, all O&M costs (including MM costs) for both the transit and guideway are still covered by the combined transit and toll revenues with almost \$0.5 Billion in excess revenue over the 30 years available for expansion of transit activities within the BTL corridors or other public transportation uses.

BTL #2 Transit-Tolls Partnership Concept

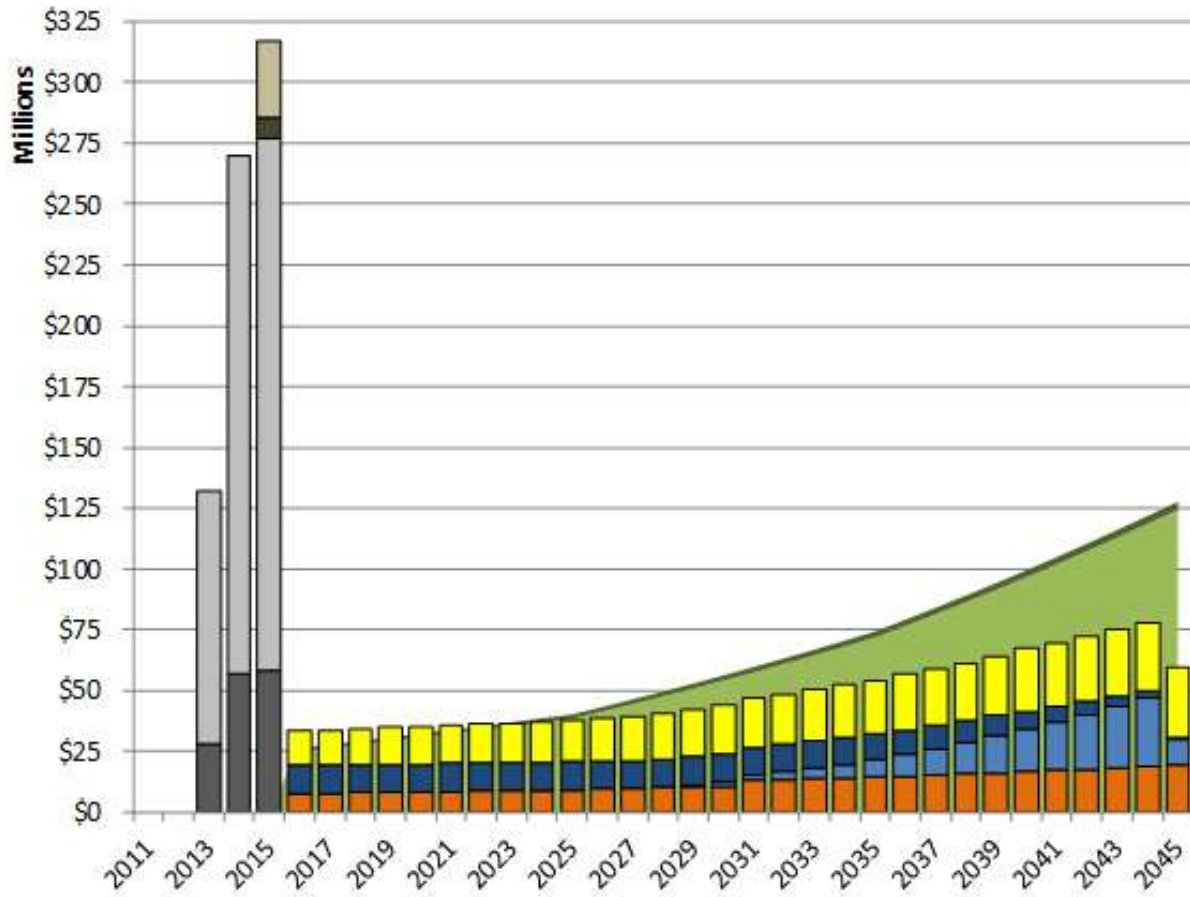


Figure E – 12: BTL #2 Combined Concept – Guideway and Transit Capital Cost, Revenue and O&M Cost

As noted, the \$1.5 Billion net operating revenue in excess of guideway operating costs still only generates \$150 Million in revenue bond funding for the capital cost of the fixed guideway – even though the cost of financing is only \$490 Million.

The total capital cost of the project would therefore require an up-front subsidy of \$569 Million from some other source to fund the total \$719 Million capital needs of the guideway and initial transit equipment. This could be in the form of transit grants or other local contributions.

Under the transit-tolls partnership, the excess revenue (\$467 Million over 30 years) above the cost of guideway and transit operations would then be divided among those who provided the actual capital investment of \$569 Million based on their percentage of investment.

Dollars in Millions	BTL Concept
Total Capital Cost	\$719
Revenue	\$1,940
Guideway O&M Cost	\$371
Net Revenue	\$1,569
Transit Grant Financing	\$569
Toll Bond Financing	\$150
Cost of Finance	\$490
Bus O&M Cost	\$612
Net All Costs	\$467

BTL #3 Case Study Results

While BTL #3 does not perform as well as BTL #1 financially, the analysis of the revenue and cost results for the study indicates that it is still a very desirable project from an economic perspective. This conclusion is based on the total capital cost of the project and the net cash flows it generates.

As shown in Table E-4, the total capital cost of BTL #3 is the highest of all the BTL networks at \$1.1 Billion.

The basic assumptions for the BTL #3 case are as follows:

Table E-4: BTL #3 Basic Assumptions (Source: HNTB)

Component	Description
Network	BTL-3
Revenue Case	Medium forecast
Toll Facility Capital Cost	\$981 million; assumed funded externally (bonding, grants or taxes)
New Transit Capital Cost	\$29 million; assumed funded externally (bonding, grants or taxes)
Toll Facility O&M and MM	Included in cash flows and funded through toll revenues
New Transit O&M and MM	Layered onto cash flows per applicable scenario
Debt (as applicable)	Current Interest Bond @ 1.5x DSCR, WACC @ 5.46%
Interest Rates	MMD + 2.0% credit spread + market move (0.5% increasing to 1.0%)

**Weighted Average Cost of Capital represents the weighted average interest rate for the transaction*

Fare Box Cash Flows for BTL #3 as a New Transit Project

As shown in the previous cases, BTL#3 is first presented as if it were a new premium bus service being implemented without the infrastructure costs of a new guideway system. The revenues, capital costs and O&M costs are taken directly from the input matrix in Figure E-4.

As a transit project only, BTL #3's new transit annual revenues average slightly more than 14% of annual new transit operating costs. Even if the project's upfront capital costs are completely funded through grants or some other non-recourse financing, a significant operational subsidy is still required to operate the new transit network over the 30-year time frame (slightly more than \$0.5 Billion).

The following represent the characteristics of the transit financing and operations and the results of BTL#3 if the network was developed and operated as stand-alone express bus project.

BTL #3 Premium Bus Service

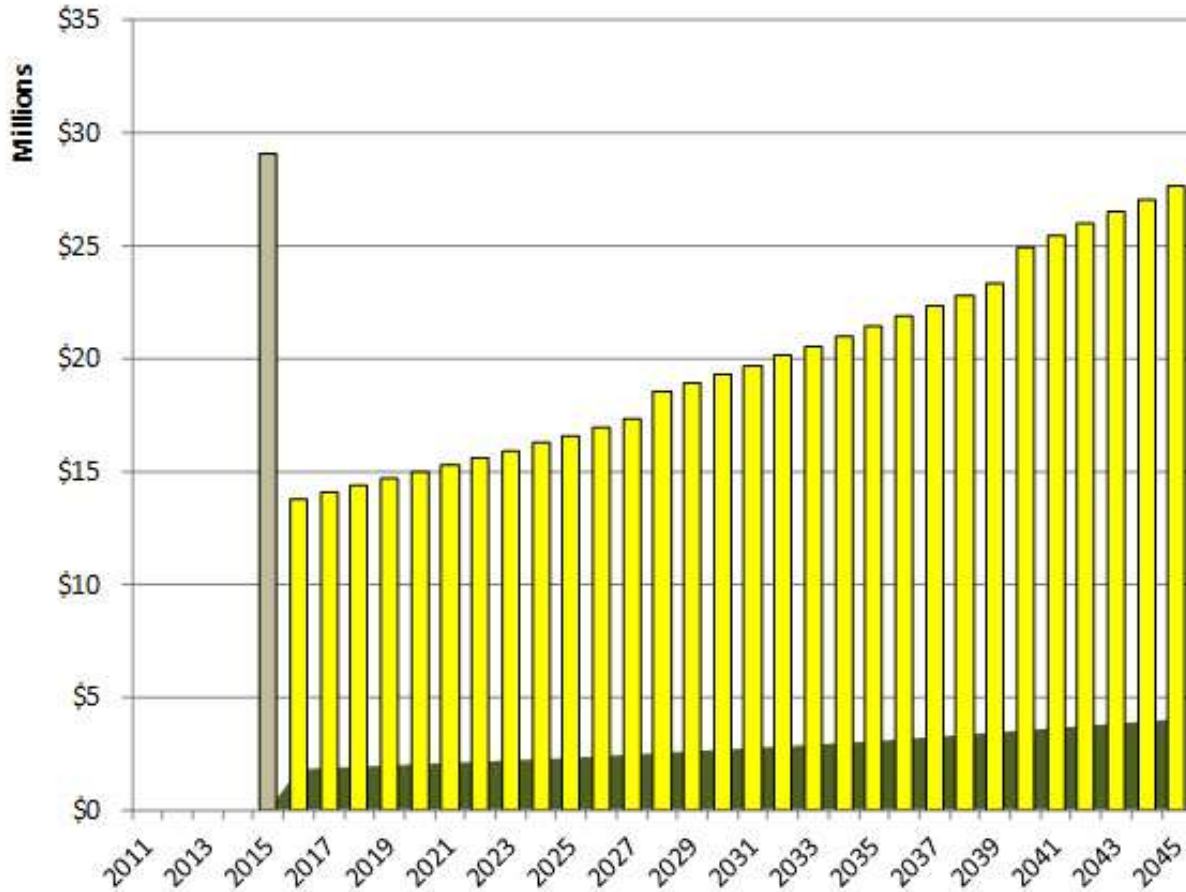


Figure E – 13: BTL#3 Premium Bus Service Capital Cost, Revenue and O&M Cost

Figure E-13 illustrates the up-front capital required for the new transit service (\$29 Million) and the subsidy requirements of the new transit service. A scale of \$0 - \$35 million is used to be able to visibly portray the transit financials. Total revenue of \$84 million over 30 years compared to the total O&M cost of \$593 Million results in a subsidy required to support the transit operations over the 30-year period of \$509 Million.

It should be noted that major maintenance costs to replace rolling stock and make periodic capital improvements for the dedicated bus service are incorporated every 12 years based on the experience of HART with similar equipment.

Dollars in Millions	New Premium Bus
Bus Capital Cost	\$29
Bus O&M Cost	\$593
Bus Revenue	\$84
Net Revenue	(\$509)
Transit Grant Financing	\$29
Unfunded Operating	(\$509)

Fixed Guideway Cash Flows with Debt for BTL #3 as a Toll Project

Toll projects typically produce positive net revenues and cash flow (gross revenue less annual operations and maintenance costs). If the BTL#3 guideway infrastructure was constructed as a 100% toll-funded project, it would produce substantial annual revenues with cumulative revenue at just over \$1.8 billion (after toll O&M). The following represent the characteristics of the toll financing and operations and the results of BTL#3 if the network fixed guideways were developed and operated as stand-alone price-managed toll projects.

- Toll facilities typically finance their upfront capital costs with debt (toll revenue bonds)
- Conditions of the financial markets, along with rating agencies and investors' perspectives, dictate the amount of debt that a given project can support
- Toll projects usually require an upfront public subsidy since an initial toll financing cannot fully fund capital costs
- Figure E-14 illustrates that toll revenue debt can help pay a portion of the upfront capital costs of the project and excess revenues exist after payment of debt service and annual toll operations and maintenance
- Given the forecasted revenue, cost of toll operations, maintenance and renewal, the net revenue would enable bond financing of just over 17% of the capital cost at a 1.5 coverage ratio.
- Even as a "toll facility" this project would require significant up-front contributions to fund capital costs.

Please note the scale of the representation has been changes to accommodate the larger amounts. The scale is now from \$0 - \$450 Million.

BTL #3 Price-Managed Fixed Guideway

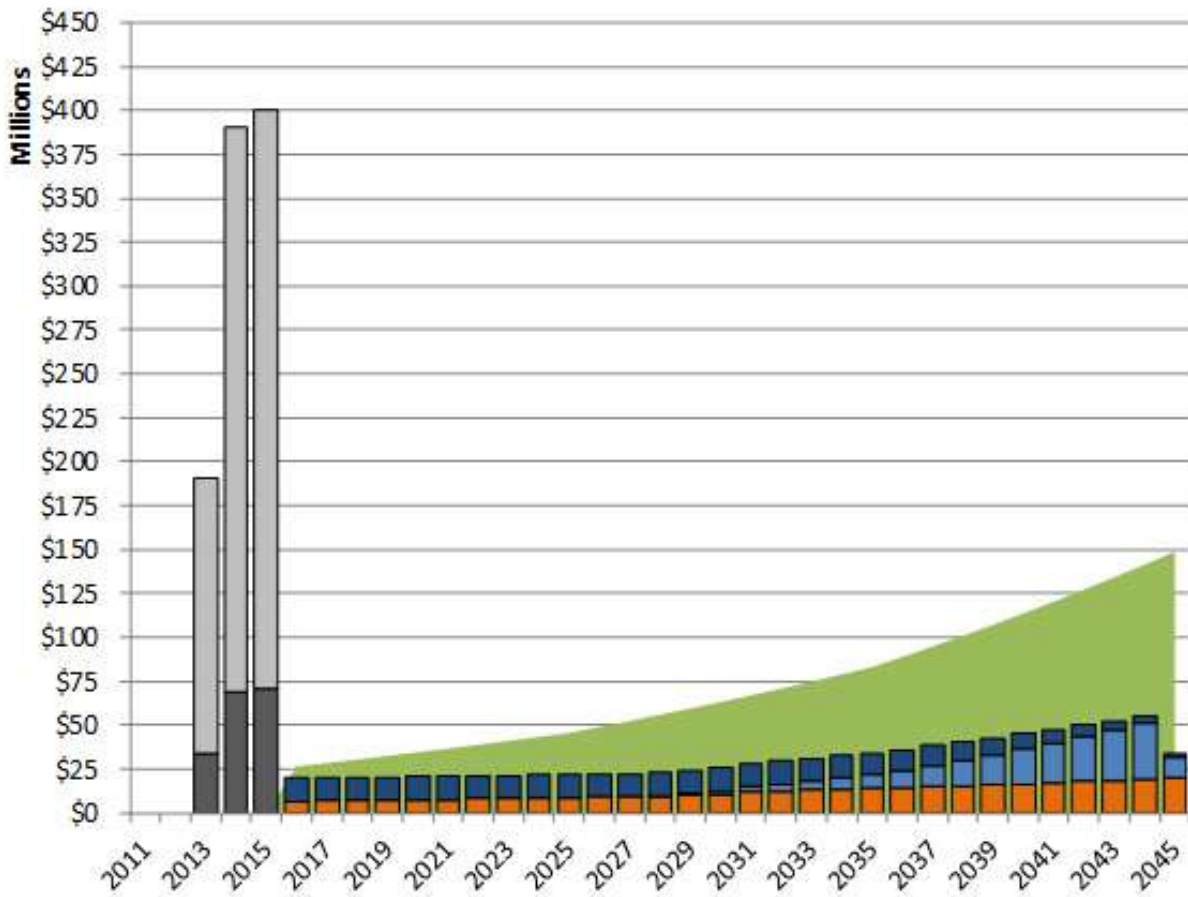


Figure E – 14: BTL #3 Price-Managed Fixed Guideway Capital Cost, Revenue and O&M Cost

Figure E-14 identifies the results of building and operating the fixed guideway as an exclusive toll project. Revenue (shown in green on the figure) over 30-years is almost \$2.2 Billion while O&M cost (in orange) is at \$361 Million for the same time frame. However, as noted, the \$1.8 Billion in excess operating revenue can only generate \$171 Million in revenue bond funding for the capital cost of the project – even though the cost of financing is only \$561 Million (debt service shown in blue – dark blue for interest, light blue for principle repayment).

With total net revenue of more than \$1.2 Billion, the fixed guideway would require an up-front subsidy of \$809 Million from some other source to fund the total \$981 Million capital needs of the lanes.

Dollars in Millions	Fixed Guideway
Guideway Capital Cost	\$981
Toll Revenue	\$2,191
Guideway O&M Cost	\$361
Net Revenue	\$1,830
Toll Bond Financing	\$171
Cost of Finance	\$561
Net All Costs	\$1,269
Unfunded Capital	(\$809)

Combined Cash Flows for BTL #3 as a Transit-Tolls Partnership

As a combined transit-tolls project, BTL #3 achieves a level of financial performance that is superior to the results of the individual transit and price managed-lane projects contained within the BTL #3 network. The following represents the characteristics of the financing and operations of BTL #3 and the financial results if the network fixed guideways and transit service were developed and operated as a combined BTL transit-tolls partnership.

- The graphs assume the first call on the toll revenue is to cover 100% of toll operational costs.
- Net toll revenue would be able to fund about 17% of the upfront capital costs in this scenario.
- Toll financing of \$172 Million could be viewed as a local match to other traditional transit fund sources.
- If the BTL project could fund its remaining upfront capital costs with traditional transit funding sources, toll revenues can support 100% of the ongoing operational costs of the new transit service.
- While there is an operational deficit through year four, toll revenues can support the tolling O&M as well as debt service and new transit O&M in the out years.
- Total combined gross revenue for this BTL is just under \$2.3 Billion through the year 2045 and cumulative revenue after toll and transit O&M and debt service for the 30-year time frame is just over \$750 Million.

Figure E-15 identifies the results of building and operating the fixed guideway as a combined transit-tolls project. Please note the scale of the graph is from \$0 - \$450 Million.

The total capital cost for the combined project is \$1.01 Billion (guideway construction plus initial transit rolling stock and stations).

The combination of the toll revenue (shown in green) and the transit revenue (small dark line at the top of the toll revenue) over 30-years is in excess of \$1.9 Billion. The combined O&M cost for the guideway (in orange) and the transit (in yellow) for the same time frame is just under \$1 Billion. However, all O&M costs (including MM costs) for both the transit and guideway are still covered by the combined transit and toll revenues with more than \$0.75 Billion in excess revenue over the 30 years available for expansion of transit activities within the BTL corridors or other public transportation uses.

BTL #3 Transit-Tolls Partnership Concept

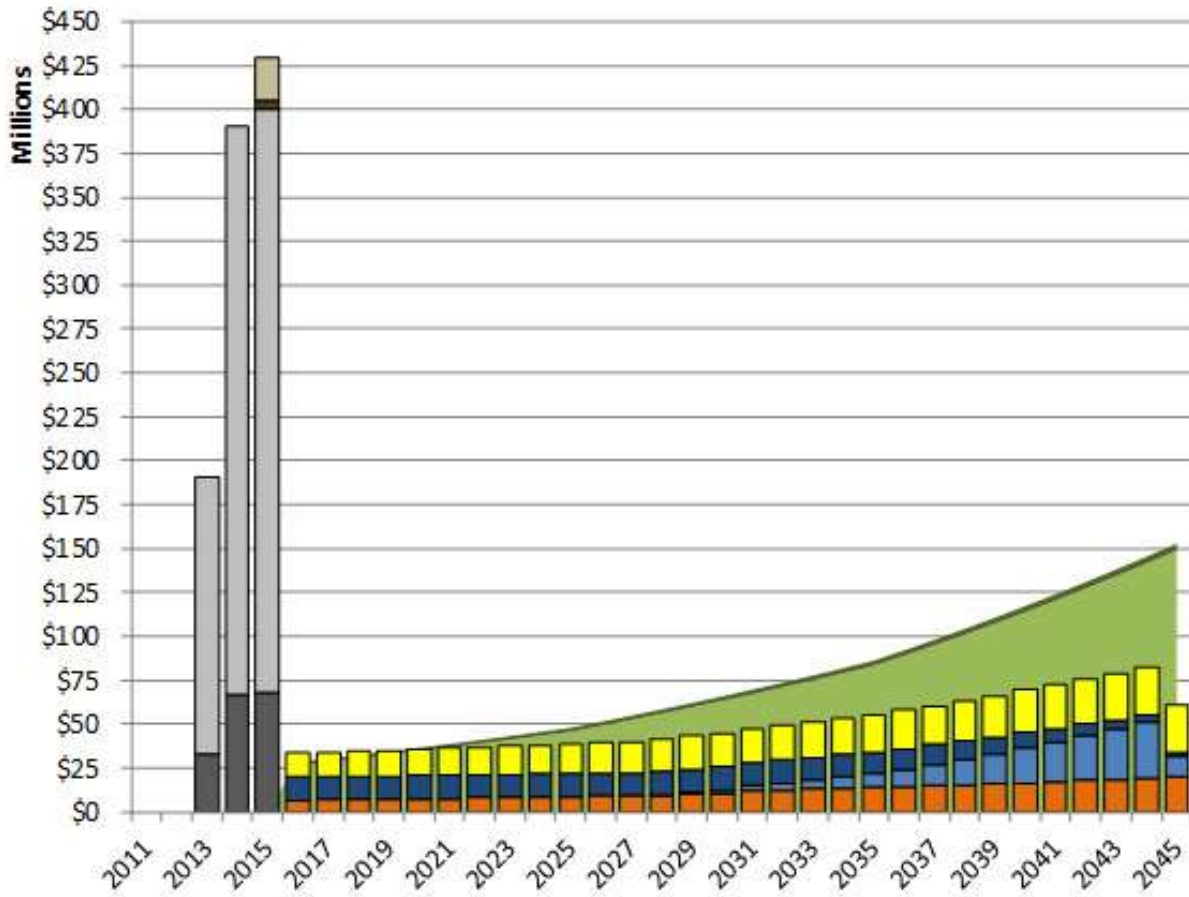


Figure E – 15: BTL #3 Combined Concept – Guideway and Transit Capital Cost, Revenue and O&M Cost

As noted, the \$1.9 Billion net operating revenue in excess of guideway operating costs still only generates \$172 Million in revenue bond funding for the capital cost of the fixed guideway – even though the cost of financing is only \$561 Million.

The total capital cost of the project would therefore require an up-front subsidy of \$838 Million from some other source to fund the total \$1.01 Billion capital needs of the guideway and initial transit equipment. This could be in the form of transit grants or other local contributions.

Under the transit-tolls partnership, the excess revenue (\$759 Million over 30 years) above the cost of guideway and transit operations would then be divided among those who provided the actual capital investment of \$838 Million based on their percentage of investment.

Dollars in Millions	BTL Concept
Total Capital Cost	\$1,010
Revenue	\$2,274
Guideway O&M Cost	\$361
Net Revenue	\$1,913
Transit Grant Financing	\$838
Toll Bond Financing	\$172
Cost of Finance	\$561
Bus O&M Cost	\$593
Net All Costs	\$759

Case Study Summary Observations

The summary financial evaluation of the BTL concept indicates a number of important results that are consistent in each of the BTL networks:

- When located within urban corridors with strong peak-hour traffic demand, the BTL price-management concept of “no free rides” returns enough revenue to pay for 100% of guideway and transit operating costs in each network
- Return on Transit Grant Investment (see Figure E-16): The net revenue returns on the capital investment required for each BTL are all positive, producing excess revenue that could be used to fund many different public transportation activities such as:
 - Expansion of the BTL dedicated express bus service to add additional frequency and routes
 - Further subsidizing of the public transportation fares on the BTL transit service
 - Subsidizing of other elements of the public transportation system
 - Expansion of other parts of the public transportation system
 - Recapitalization of the BTL debt to more favorable terms

BTL 1 - Return on Transit Grant Investment	
Transit Grant (Local, State, Federal)	\$323
Bus Operating Subsidy	\$501
+ Net System Revenue	\$1,485
\$1,986 / \$323 = 617%	

BTL 2 - Return on Transit Grant Investment	
Transit Grant (Local, State, Federal)	\$568
Bus Operating Subsidy	\$545
+ Net System Revenue	\$467
\$1,012 / \$568 = 178%	

BTL 3 - Return on Transit Grant Investment	
Transit Grant (Local, State, Federal)	\$838
Bus Operating Subsidy	\$510
+ Net System Revenue	\$759
\$1,269 / \$838 = 151%	

Figure E – 16: Financial Summary of Return on Transit Grant Investment

Section F

Policy Analysis

1. Transportation Policy Analysis

This evaluation and policy analysis was conducted by the Center for Urban Transportation Research (CUTR) at the University of South Florida. The evaluation and analysis efforts were divided into two primary elements:

Impacts of MAP-21: Since the start of the BTL Proof-of-Concept Study, the landscape for potential federal transit capital has transitioned somewhat by the passage of the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141 MAP-21). MAP-21 is important because one key to the feasibility of a BTL project or system is a transit agency's access to capital in order to create an equity position and share in the revenues. Transit agencies rely heavily on the federal funds administered by the Federal Transit Administration in the form of various capital grant programs which are formula driven and discretionary. Large federal transit grants for major capital investments in new transit capacity projects are distributed from congressionally authorized FTA funding sources newly defined in the most recent surface transportation law. These FTA capital funding sources are generally identified as either "New Starts" or "Small Starts" grants and the analysis includes a discussion of how a BTL project proposal would be viewed in the context of the Federal Transit Administration's (FTA) current evaluation of projects under their Section 5309 grant programs.

Suggested Statutory Modifications: What changes in the federal surface transportation authorization statute would be desired or necessary for the funding of Bus Toll Lanes with FTA New Starts or Small Starts capital funds to allow for the efficient implementation of Bus Toll Lanes.

Map-21

Based on the information available on MAP-21 at the time of this report, a BTL would now face less obstacles to compete for FTA Section 5309 funds as a Small Starts project than it would have at the beginning of the BTL assessment. If the project were to be estimated at less than \$250 million (expressed in year of expenditure dollars) and was not requiring more than a \$75 million federal funding commitment, it would seem to align with the eligibility criteria for a "Small Starts, Corridor-Based BRT Investment." That may not be true for new Starts grants.

MAP-21 was signed into law July 6, 2012 funding highway and transit projects and programs for Fiscal Years 2013 and 2014. Included in the new law are several changes that could affect the potential funding of a BTL project as envisioned in the THEA/HART Proof-of-Concept Study. For assessing the potential for successful implementation of BTL projects, the relevant portions of the law on transit funding are found under Section 5309 of the Act and the Definitions detailed in Section 5302.

Section 5302 as a result of MAP-21, now includes a definition of Bus Rapid Transit (BRT) for the purposes of eligibility for funding under the FTA programs for the “Urbanized Area Formula Program” and the “State of Good Repair Formula Program.”

The definition, cited below, applies to eligibility for transit capital New Starts or Small Starts funding.

“Chapter 53 of title 49, United States Code, as amended by MAP-21:

(2) BUS RAPID TRANSIT SYSTEM.—*The term ‘bus rapid transit system’ means a bus transit system—*

(A) in which the majority of each line operates in a separated right-of-way dedicated for public transportation use during peak periods; and

(B) that includes features that emulate the services provided by rail fixed guideway public transportation systems, including—

(i) defined stations;

(ii) traffic signal priority for public transportation vehicles;

(iii) short headway bidirectional services for a substantial part of weekdays and weekend days; and

(iv) any other features the Secretary may determine are necessary to produce high-quality public transportation services that emulate the services provided by rail fixed guideway public transportation systems.

The definition of “fixed guideway” was amended to remove HOV lanes although bus service associated with them remains eligible for certain funding. The new “Definitions Section” now reads as follows:

(7) FIXED GUIDEWAY.—*The term ‘fixed guideway’ means a public transportation facility—*

(A) using and occupying a separate right-of-way for the exclusive use of public transportation;

(B) using rail;

(C) using a fixed catenary system;

(D) for a passenger ferry system; or

(E) for a bus rapid transit system.

Perhaps the most significant change for BTL funding is found in the revised Section 5309 language on New and Small Starts and a new “Core Capacity Improvement” category of eligibility. For New Starts eligibility there seems to be little change in the new law as it relates to project funding accessibility for major discretionary dollars. The project development and screening processes have been streamlined for all 5309 investments.

Small Starts

MAP-21 lays out types of BRT projects for Section 5309 funding eligibility:

- **Fixed Guideway BRT Projects**, (as the previous language allowed) for those that operate on a separate, dedicated right-of-way and emulate rail service.
- The new **Core Capacity Improvement Projects** category could be explored for eligibility for conversion of HOVs, HOTs, BRTs and traditional bus lanes. These projects are defined as “having substantial corridor-based capital investment in an existing investment in an existing fixed guideway system that increases the capacity of a corridor by not less than 10%.”
- The **Small Starts Projects** definition has been broadened to include not only new fixed guideway capital projects but also “corridor-based BRT investments. A corridor-based BRT project is one that *“is requesting less than \$75 million in Section 5309 funds and has a total capital cost less than \$250 million.”*

A corridor- based BRT project is defined as a substantial investment in a defined corridor in which the majority does not operate in a separated right- of-way dedicated for transit use during peak periods, and includes features that emulate services provided by rail (defined stations, traffic signal priority, short bi-directional headways)” (Emphasis added – based on the interim guidance published by FTA).

Prior to the addition of corridor-based BRT investments, BRT projects could be eligible for Section 5309 funding even if the project included non-exclusive running way, but dedicated right of way needed to make up the majority of the project. This shift, while not as definitive as the sample legislative language outlined above, seems to unequivocally allow for consideration of a BTL under the Small Starts eligibility criteria.

There are other provisions of MAP-21 that seem conducive to the BTL concept that involve project financing. Eligibility for award of 5309 funds includes, state and local government entities including local transit agencies. The maximum federal share remains at 80 percent, although higher local match will be incentivized through the project assessment process.

Revenue bond proceeds may be used as local match if the revenues are derived from the transit project. This provision applies to three types of FTA funding including 5309. Debt service reserve deposits are eligible for reimbursement for these projects in Section 5323(e).

These financing provisions seem well suited for an equity sharing arrangement that would potentially involve bond proceeds based on projected revenue from non-transit traffic accessing the facilities. The general requirements for all 5309 projects are:

- The project must be part of an approved transportation plan as defined in 49USC
- The potential recipient has the requisite legal, and technical capacity
- The grantee retains control over the rolling stock and use of the facility
- The grantee demonstrates the financial capacity to maintain existing and new equipment and facilities

(4) EVALUATION OF BENEFITS AND FEDERAL INVESTMENT.—*In making a determination for a small start project under paragraph (3)(B), the Secretary shall analyze, evaluate, and consider the following evaluation criteria for the project (as compared to a no- action alternative): mobility improvements, environmental benefits, congestion relief, economic development effects associated with the project, policies and land use patterns that support public transportation and cost-effectiveness as measured by cost per rider.*

(5) EVALUATION OF LOCAL FINANCIAL COMMITMENT.—*For purposes of paragraph (3)(C), the Secretary shall require that each proposed local source of capital and operating financing is stable, reliable, and available within the proposed project timetable.*

(6) RATINGS.—*In carrying out paragraphs (4) and (5) for a small start project, the Secretary shall evaluate and rate the project on a 5-point scale (high, medium-high, medium, medium-low, or low) based on an evaluation of the benefits of the project as compared to the Federal assistance to be provided and the degree of local financial commitment, as required under this subsection. In rating the projects, the Secretary shall provide, in addition to the overall project rating, individual ratings for each of the criteria established by this subsection and shall give comparable, but not necessarily equal, numerical weight to the benefits that the project will bring to the community in calculating the overall project rating.*

The final rules on project eligibility and the selection criteria were published in January 2013 as was the draft policy guidance. The general evaluation criteria, statutorily defined, addresses:

- mobility improvements
- environmental benefits
- congestion relief
- economic development effects
- policies and land use patterns that support public transportation
- cost-effectiveness as measured by cost per rider
- local financial commitment

Some changes to how project evaluation will be conducted are noteworthy.

- **Cost Effectiveness for New Starts** projects will be based on the total annualized capital and operating cost per trip and for Small Starts the metric will be federal share invested per trip.
- **The Environmental Benefits Evaluation Techniques** have changed as well. Prior to the new rules the categorization of the metropolitan area was largely dependent on its air quality attainment status as determined by the Environmental Protection Agency. Now, specific benefits to the environment will be judged including VMT reduction, changes in specific pollutants, changes in energy use and greenhouse gas emissions and public health considerations including the project's impact on safety.
- **Under Economic Development**, the impact of a project's effect on affordable housing and on development patterns resulting in VMT reduction will be relevant and compared to the Cost Effectiveness measures mentioned above.

These provisions along with the favorable treatment of bond proceeds as local match and debt service reserve reimbursement potential all seem favorable to a BTL or BTL network as envisioned. It will be useful to have the technical study results to make a further evaluation of funding options.

New Starts

The focus of this assessment was to evaluate the competitiveness of a BTL project proposal under the current evaluation system employed by FTA for consideration of transit "New Starts" capital funding authorized under 49 USC 5309.

The evaluation noted that the evaluation criteria and scoring method for funding projects under the program is undergoing review for potential revision. However, the focus of the new rule consideration seems to be on streamlining the project approval process rather than introducing significant changes to the evaluation criteria. The following discussion is based on the previously published guidance for evaluation of fiscal year 2013 projects. For projects for fiscal years 2014 and 2015, a new law has been enacted.

From a review of the process, there are two parts to the evaluation system. The first is the "Project Justification" test, and the second relates to the local financial commitment.

The following table taken from the FTA document "*Capital Investment Program FY 2013 Annual Report Evaluation and Rating Process*" lists the measurements considered under the Project Justification element of the evaluation. The criteria are explicitly prescribed in the federal authorization law and have been consistent for the last two multi-year authorizations.

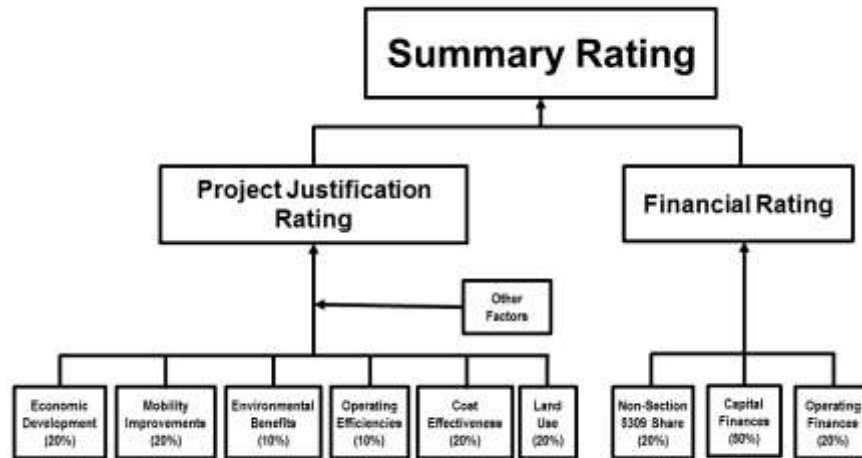
Criterion	Measures/Categories
Mobility Improvements (New Starts only)	<ul style="list-style-type: none"> • Number of Transit Trips • User Benefits per Passenger Mile • Number of Transit Dependents Using the Project • Transit Dependent User Benefits per Passenger Mile • Transit Dependents Benefits Compared to Share of Transit Dependents in the Region
Environmental Benefits (New Starts only)	<ul style="list-style-type: none"> • EPA Air Quality Designation
Operating Efficiencies (New Starts only)	<ul style="list-style-type: none"> • Incremental difference in system-wide operating cost per passenger mile between the build and the baseline alternatives
Cost Effectiveness (New Starts and Small Starts)	<ul style="list-style-type: none"> • Incremental Cost per Hour of Transportation System User Benefit between the baseline and build alternatives
Transit Supportive Land Use (New Starts and Small Starts)	<ul style="list-style-type: none"> • Existing Land Use
Economic Development Effects (New Starts and Small Starts)	<ul style="list-style-type: none"> • Transit Supportive Plans and Policies • Performance and Impacts of Policies

Source: *Capital Investment Program FY 2013 Annual Report Evaluation and Rating Process, U.S. Department of Transportation, Federal Transit Administration, 2012*

The other general area of evaluation for both New and Small Starts projects is that of local financial commitment and strength of the proposed project plan of finance. The “Small Starts”

program is authorized in Title 49 U.S.C. Section 5309(e) with a requested federal share of less than \$75 million with a total capital cost of under \$250 million. The following figure is also taken from the same FTA document and lists the financial rating criterion and the weights of each in the evaluation process.

Figure F - 1: New Starts Evaluation Process



Source: *Capital Investment Program FY 2013 Annual Report Evaluation and Rating Process, U.S. Department of Transportation, Federal Transit Administration, 2012*

For an FTA financed project to move from alternatives analysis to preliminary engineering or from preliminary engineering to final design, the evaluation must be performed on a proposed project and it must rate a threshold score of a “Medium” on a five point scale (High, Medium-High, Medium, Medium-Low and Low). The overall rating is derived from the average of the Project Justification and Financial ratings. Other factors may be considered in the rating according to Title 49 USC, including, “...other factors that the Secretary determines to be appropriate...”

It would appear that a BTL project would have no issue competing for New Starts capital using the current evaluation criteria, if that project could meet the definition for a fixed guideway and, therefore, be eligible for New Starts and Small Starts capital funds. However, the BTL Proof of Concept Study does not provide all of the detailed data required to attempt an evaluation of the BTL network (or corridors) under the FTA process.

Another observation has to do with the Financial Rating component of the evaluation. It would appear that if an equity sharing arrangement appears feasible, the project should rate very well on financial basis. In addition to the shared capital cost reducing the federal share, if the project returns an on-going stream of revenue for the transit agency, a BTL would not only rate high on the incremental cost per passenger mile, but could actually result in lower total cost per passenger mile for the overall transit system.

New Starts project justification evaluation places 20 percent of the weight of the rating on the category “Mobility” with three of the five measurements having to do with serving the population of transit disadvantaged. Based on some preliminary examination of the BTL network under study, it would appear that the premium transit service that could be provided would be targeted largely to “choice riders.” If this were the case, a BTL project may not rate very high in the area of mobility although this could be offset with impressive benefits per passenger mile and increases in transit ridership, and the significant reduction in transit fares provided by the revenue from toll payers for all riders including the disadvantaged.

Lastly, it appears that under the current evaluation system, it would appear that the Small Starts program may be more “friendly” towards a BTL funding request than a New Starts funding request. Because the “Mobility” measurement is not included, a project that is less than \$250 million in total capital cost and is requesting less than \$75 million in 5309 federal funding would not suffer if its main market was choice riders.

Recommended Statutory Modifications

The results of the investigation of legislative approaches to solving the issue of the apparent exclusion of Bus Toll Lanes from eligibility for New Starts and some limitations on Small Starts programs identified the definition of fixed guideway as a hurdle for the purposes of funding a BTL project as included in 49 USC 5302 which states:

FIXED GUIDEWAY — *“The term ‘fixed guideway’ means a public transportation facility ... (A) using and occupying a separate right-of-way for the exclusive use of public transportation ...”*

As the premise of a BTL is to sell off excess capacity of the transit facility to private vehicles at market rates, it is believed that the current interpretation of this approach would not meet the fixed guideway definition and eliminate a major potential capital funding source for transit agencies to construct a BTL project. One approach is to redefine fixed guideway to remove the limitation to the BTL concept and the second is to establish a pilot program in statute during the current transportation reauthorization to specifically allow some limited number of BTL projects. The suggested language on both approaches follows:

Redefinition of “Fixed Guideway” Language

A legislative language change to expand FTA New Starts eligibility to include Bus Toll Lanes would require a very simple amendment - after “a separate right of way for the,” delete “exclusive” and insert, “primary” therefore, the final definition reads:

FIXED GUIDEWAY — “The term ‘fixed guideway’ means a public transportation facility ... (A) using and occupying a separate right-of-way for the **primary** use of public transportation ...”

BTL Pilot Project Language

- (1) **Establishment.**- The Secretary of Transportation may establish and implement a pilot program to demonstrate the advantages and disadvantages of Bus Toll Lanes for certain new fixed guideway capital projects
- (2) **Definition.** – A Bus Toll Lane is a capital facility designed to facilitate high quality public transportation, financed in a manner that:
- gives the public transportation agency an equity position in the asset,
 - is financed partially by selling excess facility capacity to other vehicles through tolls and,
 - results in some revenue sharing arrangement with the public transportation agency.
- (3) **Limitation On The Number Of Facilities.** – The Secretary may permit up to 3 Bus Toll Lane projects for new fixed guideway capital projects
- (4) **Eligibility.**- To be eligible to participate in the Bus Toll Lane program, a recipient shall submit to the Secretary an application that contains, at a minimum, the following:
- (A) An identification of the new fixed guideway capital project that has not entered into a full funding grant agreement or project construction grant agreement with the Federal Transit Administration.
 - (B) A schedule and finance plan for the construction of and operation of the proposed project.
 - (C) An analysis of the costs, benefits, and efficiencies of the proposed Bus Toll Lane project.
- (5) **Selection Criteria.**—The Secretary may approve the application of a recipient under this subsection if the Secretary determines that—
- (A) the plan for the project is primarily beneficial and gives priority to urban bus transportation;
 - (B) the plan provides for the long-term funding of operations and maintenance of the facility and;
 - (C) the plan implementing the Bus Toll Lane project is justified.
- (6) **Program Term.**—The Secretary may approve an application of a recipient for a Bus Toll Lane project for fiscal years 2014 through 2019.
- (7) **Report To Congress.**—Not later than 2 years after the date of enactment of this Act, the Secretary shall transmit to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Banking, Housing, and Urban Affairs of the Senate, a report containing an assessment of the costs, benefits, and efficiencies of a Bus Toll Lane program for new fixed guideway capital projects.’’

Other Observations

First, regardless of the definitional issues and evaluation criteria in use by FTA, the results of the Proof-of-Concept Study indicate the BTL can produce solid public transit projects regardless of the innovative financing and revenue potential associated with the transit-tolls partnership. The public transportation benefits are obvious beyond the operating revenue stream and therefore should be acceptable to FTA.

Second, the transit benefits from the BTL appear to have a strong relationship to the proportion of the capital investment being sought from traditional transit sources. This, like most other issues raised in this report, can be assessed from the information on capital costs, ridership, operating costs and the feasibility analysis presented within the study.

It should be noted that under current FTA rules, a transit system using a catenary system can allow other traffic on the right of way and be eligible for federal New Starts capital. It could be argued that a BTL that used electric trolley buses would, under the current definition, be eligible. This may or may not be a practical solution, but it raises the point of consistency of the use of public transit right of way to the benefit of local public transportation.