Miami-Dade Transportation Planning Organization

TPO WO-VII-38 **EMERGING TUNNELING TECHNOLOGIES** FEASIBILITY STUDY

February 2022

EXECUTIVE SUMMARY

Table of Contents

List of Tables

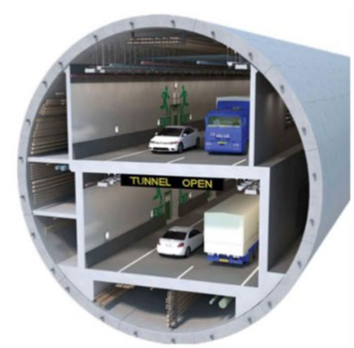
List of Figures

Executive Summary

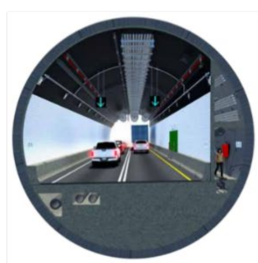
This study evaluated emerging tunnel technology to assess the implementation of transit tunnel corridors in Miami-Dade County. The tunnels are intended to accommodate public transportation via electric multi-passenger transit vehicles for the advancement of mobility options in Miami-Dade County. The tunnels are proposed for use by transit vehicles to accommodate a range of up to 60 passengers per vehicle. In general terms, the methods that are used today to construct tunnels can be broadly categorized as:

- Sequential excavation method by conventional means (SEM, drill, and blast etc.)
- Excavation by Tunnel Boring Machine (TBM)
- Cut-and-cover
- Pipe jacking
- Jacked box tunneling

Among all methods, tunnel construction by TBM is often the preferred tunneling method for its ability to cause the least amount (if any) of surface disruption. See examples below of tunnels with varying dimensions.

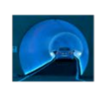


SR-99
Alaskan Way Viaduct
(57 ')



Parallel Thimble
Shoal Tunnel
(42')

Zurich Airport
Skymetro
(20.5')



Las Vegas Convention
Center Loop
(14')

This study utilized a tiered analysis using the process illustrated in below. The study documents the results of the Tier 1 and Tier 2 levels analysis and identified the next steps to be addressed in Tier 3.

Tier	Description
Tier 1 Initial Transit Tunnel Corridors	• **Base Network -** Long Range Transportation Plan (LRTP), Transportation Improvement Program (TIP), Previous Studies, Other Corridors • **Criteria -** Coverage – service to population and employment hubs, Connection to existing transit systems, Environmental Justice – service to potentially underserved communities, Efficiency – provide most direct route between areas
Tier 2 Potential Transit Tunnel Corridors	• **Base Network -** 25 Corridors from Tier 1 Level Analysis • **Criteria** – Cost (Estimated Capital Cost), Land-Use (Transit Supportive Land Use, Community Redevelopment Areas, Access to Major Activity Centers), Mobility (Projected Daily Traffic Volume, Projected Ridership, Connects to SMART Plan Corridor, Connects to Existing/Proposed Rail Stations), Technical (Interface with Underground Utilities, Crosses Under Water, Constructability (Routing and MOT))
Tier 3 Transit Tunnel Corridor Development	• **Base Network -** 8 Corridors from Tier 2 Level Analysis • **Next Steps -** Partner Coordination, Vehicle Identification and Specification/Envelope, Tunnel Sizing from Space-Proofing Analysis for Specific Vehicle Envelope, Fire and Life Safety Design Criteria, Subterranean Rights, Land-Use Policies to Support Transit, Transit Service Plan (alignment, stations, frequency, service span), Ridership Estimates, Operating and Maintenance Plan, Capital Cost Estimate, Environmental Permitting, Public Involvement, Financial Plan, Inter-agency Agreements

The Tier 1 level screening analysis resulted in the identification of two Strategic Miami Area Rapid Transit (SMART) Plan corridors and six Long Range Transportation Plan (LRTP) priority corridors for potential tunnel application as demonstrated below.

Table 1: Potential Transit Tunnel Corridors

Corridor Number	Tier 1 Potential Transit Tunnel Corridors		Tier 2 Potential Transit Tunnel Corridors
	Description	Length (miles)	
1	Aventura Brightline Station to Sunny Isles	2.4	
2	Golden Glades to Sunny Isles	6	
3	Opa-locka to Miami Lakes	4.6	
4	Metrorail Transfer Station to Collins Avenue	8.8	
5	Miami Central to PortMiami	1.3	LRTP Priority Corridor
6	Brickell Avenue to FTX Arena	1.2	
7	FTX Arena to Design District	2.5	LRTP Priority Corridor
8	Miami Central to Design District	2.8	LRTP Priority Corridor
9	Design District/ Magic City Loop	4.4	
10	Miami Intermodal Center to Wynwood	4.1	
11	Overtown Connector	1	LRTP Priority Corridor
12	Miami Intermodal Center to Miami Central	4.9	
13	Magic City Casino to Douglas Road	3.2	LRTP Priority Corridor
14	Gables Connector	4.1	
15	Douglas Road Metrorail Station to Coconut Grove	1.1	
16	Douglas Road Metrorail Station to Coral Gables City Hall	1.6	
17	Ludlum Corridor	10.9	LRTP Priority Corridor
18	Flagler Corridor	7	SMART Plan Corridor
19	Downtown Doral to Miami International Airport	6.5	
20	Downtown Doral to East-West NW 87 Street Station	1.9	
21	Dolphin Terminal to East-West NW 107 Avenue Station	1.6	
22	East-West NW 107 Avenue Station to Florida International University	2.4	
23	South Miami Metrorail Station to Tropical Park	4.4	
24	University Metrorail Station to University of Miami	2.5	
25	Kendall Corridor - Dadeland South Metrorail Station to Baptist West	9.3	SMART Plan Corridor

The tunnel system proposed and evaluated in this study is based on operation of a closed system of tunnels, open only to publicly operated or publicly contracted electric vehicles for transit purposes. The system would be accessible via stations located at street-level approximately one mile apart, with an open platform underground for vehicle distribution and transfer between transit routes. The underground platforms would also be used for fire and life safety emergency vehicles to access the tunnel and for evacuation purposes. In addition, and following the requirements of National Fire Prevention Association, a combination of emergency egress shafts and cross-passageways or connection between the two running tunnels will be provided between stations. The cross-passageways will facilitate access between the two tunnels and strategically placed at a maximum spacing that allows motorists/riders to escape to an exit in an acceptable time-frame. Other emergency egress shafts would be included in accordance with specific design criteria. The tunnels would also be equipped with exhaust/ventilation fans.

For the purposes of this study, small diameter tunnels and large diameter tunnels were reviewed for use by electric transit vehicles. The small diameter tunnel was based solely on the Las Vegas Convention Center (LVCC) Loop. The large diameter tunnel was develop based on accommodating an electric bus. Overall tunnel characteristics by typical sections were obtained from research and should be further verified through a space-proofing analysis based on specific vehicle envelope and applied to Miami-Dade County conditions.

The characteristics of small diameter tunnels and large diameter tunnels are summarized in Table 2, described in detail in the following text, with typical sections shown in Figure 1 and Figure 2.

Table 2: Overall Transit Tunnel Characteristics

Small Diameter Tunnel (LVCC)	Large Diameter Tunnel
Tunnel size 12-foot inside diameter	Tunnel size 24 to 27-foot inside diameter
Two side-by-side tunnels for two-way operation	Two side-by-side tunnels for two-way operation
Tunnel bottom approximately 40 feet below grade	Tunnel bottom approximately 52 to 55 feet below grade
Vehicles 4-passenger capacity	Vehicles 60-passenger capacity
At-grade stations with electric charging stations	Electric charging station at bus maintenance facility
Fire and safety, emergency egress, emergency vehicle access	Ventilation, fire and safety, emergency egress, emergency vehicle access

Small Diameter Tunnel (LVCC) - The smaller 12-foot inside diameter tunnel is provided as an example from The Boring Company, the tunnel boring company who constructed the Las Vegas Convention Center (LVCC) Loop. **This tunnel profile is provided as-is, as an example of an existing application and should be further evaluated for application in Miami-Dade County and for accordance with established roadway geometrics standards (i.e., AASHTO, APTA or NFPA).** The dimensions shown are approximate and inferred based on information publicly available. The dimensions indicated are approximate and not based on detailed segmental lining or finished tunnel dimensions for the LVCC Loop.

Large Diameter Tunnels - A 24-foot inside diameter single lane, electric bus tunnel is a rough possible layout considering the roadway geometrics guidelines of the American Public Transportation Association in addition to an AASHTO conformant alternative. Figure 2 is based on the American Public Transit Association (APTA) model for Bus Rapid Transit (BRT).

For both cases small and large diameter tunnels, a depth of 1.5 to 2 times the tunnel outer diameter, is indicated as typical minimum required which can vary from case to case.

The study concludes by identifying next steps for implementing transit tunnel corridors profiled in this report. The recommended next steps include extensive coordination with TPO Committees and partner agencies, identification of the specific vehicles that will use the tunnel, space-proofing analysis to determine the appropriate tunnel size to accommodate the identified vehicle, development of life and safety design criteria, development of engineering concept, development of design criteria including fire and life safety requirements and development of an extensive public input strategy.

The finished LVCC Loop tunnel is shown in Figure 3. Small diameter Earth Pressure Balance Machines (EPB) used to construct the LVCC Loop tunnels are seen in Figure 4 and Figure 5.

In conclusion, Emerging Tunneling Technologies show potential to increase speed and reliability by providing dedicated and unobstructed exclusive lanes for transit only vehicles.

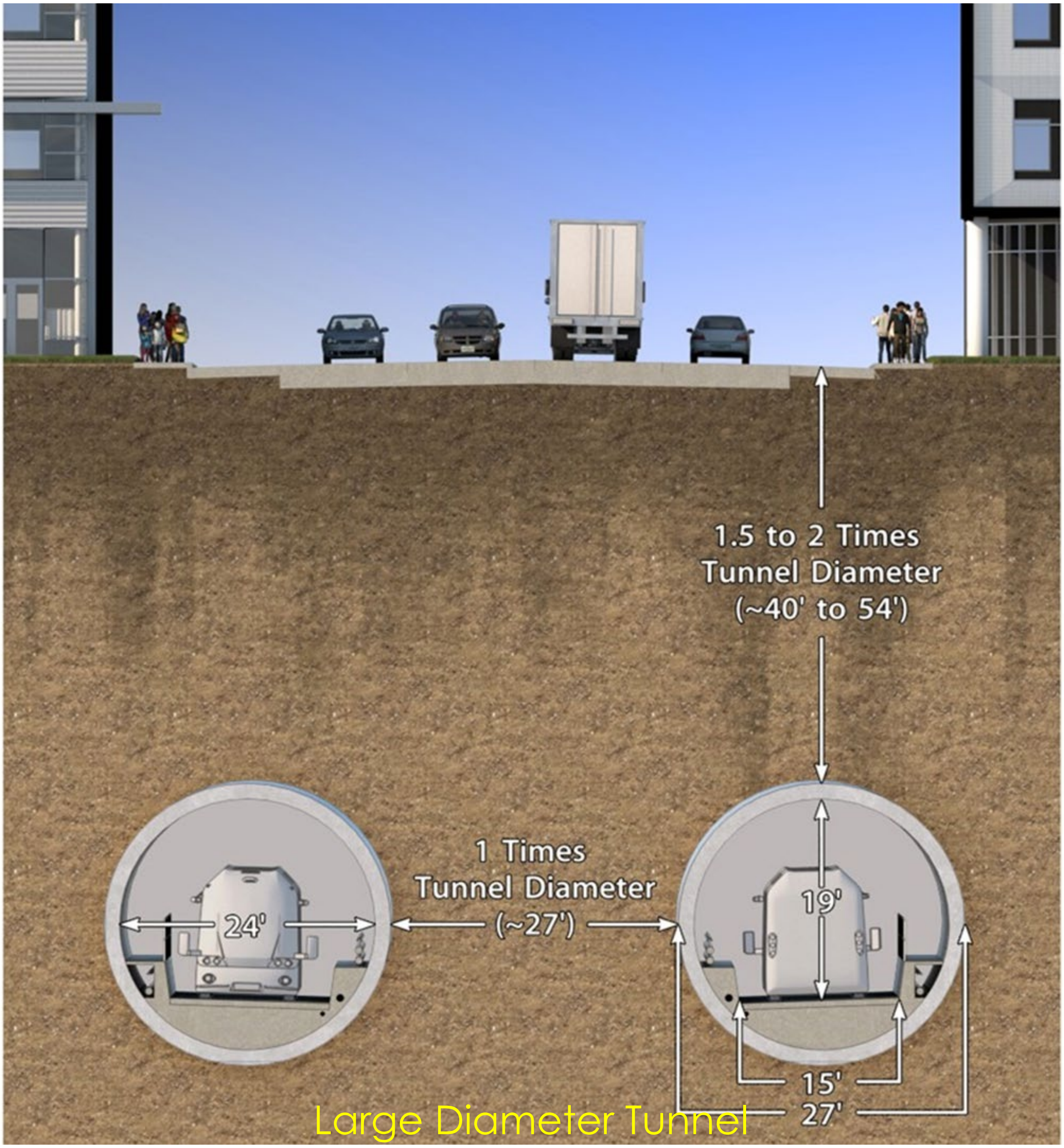
High level next steps include:

- Efficient Transportation Decision Making (ETDM) Planning Screening - Identify potential environmental issues on the selected corridors
- Concept Development – type of transit vehicle, life safety and emergency design criteria, process of construction under public and private properties
- Concept Layouts – roadway alignment, station footprints
- Transit Service – headway, hours of operation, number of vehicles required
- Partner Coordination – establishment of a Project Working Group, presentation at TPO Board and Committees, and briefings

Figure 1: Transit Tunnel Cross Section - Small Diameter Tunnel

Dimensions shown are approximate and inferred based on information publicly available. The dimensions indicated are approximate and not based on detailed segmental lining or finished tunnel dimensions for the LVCC Loop.

Figure 2: Transit Tunnel Cross Section - Large Diameter Tunnel



Based on roadway geometrics guidelines of the American Public Transportation Association in addition to an AASHTO conformant alternative

Figure 3: A Tesla automated electric vehicle inside the LVCC Loop (LVCC, 2021)

Figure 4: The EPB shield in one of the portal cut excavations (reviewjournal.com,2020)

Figure 5: The frontal shield of the EPB transportation to the LVCC portal site (TBC, 2019)

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