General Findings of the New River Rail Crossing

By The Lochner/LBA Partnership

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Lochner
225 West Washington Street, 12th Floor
Chicago, IL 60606
t: (312) 372 7346
www.hwlochner.com

London Bridge Associates Limited
Suites 49-52, The Hop Exchange, 24 Southwark Street, London SE1 1TY
t: +44 (0)20 8399 8614 e: welcome@lba.london
www.lba.london

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New River Crossing

CONTENTS

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1. EXECUTIVE SUMMARY

1.1. The Florida Department of Transportation (FDOT), in conjunction with Broward County, have recently proposed four alternative construction options for a new rail crossing of the New River in the City of Fort Lauderdale, Florida (City). The Lochner/LBA study was requested by the City of Fort Lauderdale leadership to provide a high-level review of the proposed tunnel alternative as produced in the recent FDOT study and associated public outreach programs along with other feasible tunnelling options, to determine the overall viability of constructing a tunnel option in lieu of alternative bridge options.

The City prefers the construction of a tunnel facility, supporting Brightline and other possible (freight) rail transportation infrastructure. to continue the City's Vision Plan and growth agenda surrounding the development of a world-class residential, commercial and oceanfront destination community. City leadership is concerned about the consequences of bridge construction which will likely be seen as a "divide" to the community. This study assesses the more significant technical and environmental issues, challenges, and benefits, based on publicly available information, and shares observations of the current cost estimate for the bored tunnel alternative.

Exhibits 1, 2 and 3 – Photos of Existing Bascule Bridge over New River

1.2. This report identifies the necessary protocol for the City to gain a clearer understanding of the engineering and environmental challenges. By promoting a tunnel solution, the City wishes to explore the greater social benefits and economic growth opportunities that such a solution might bring to improve the urban realm and to promote the strategic, sustainable, and economic growth of Fort Lauderdale. Note that much additional study and other evaluations (geotechnical investigation, utility documentation, topographical surveying, etc.) are required to confirm the construction viability and cost opinion for such a facility.

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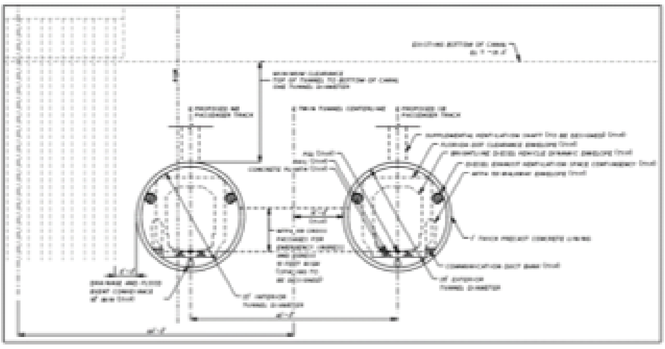
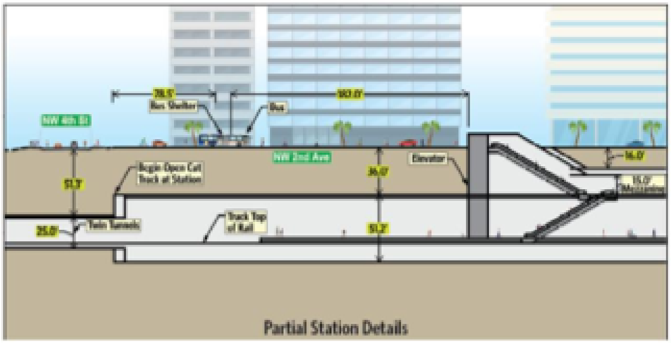
1.3. This report highlights that, based on publicly available information and limited site reconnaissance, construction of a tunnel, like the existing Henry E. Kinney Tunnel located to the east of the project site, is physically viable. While more detailed property surveys are required to provide confirmation, it appears that current construction techniques will allow certain tunnelling options to be built within the existing railroad right-of-way, simplifying construction phasing of a tunnel alternative. In addition, other alternatives to the proposed double twin bored tunnel in the FDOT study (see below), can likely be constructed with a cost reduction on the order of 15 to 20%, and a reduction in construction schedule of approximately one year. These alternative tunnel options utilize cofferdam-type methods of construction as opposed to using a tunnel boring machine (TBM), thereby significantly reducing construction cost and schedule. That stated, a side-by-side comparison of a tunnel construction compared to a bridge will not likely provide a cheaper alternative based on initial construction costs. However, depending on the extents/scope/length of either facility, additional roadway/intersection costs would be associated with any bridge option to maintain city-wide traffic patterns and public access. That, combined with evaluating long term life cycle costs, could allow the tunnel option to be comparable.





Exhibits 4, 5 and 6 – Twin Bored Tunnel Option Identified in FDOT Study

It is the opinion of the LL team that alternate tunnel options could reduce costs by 15 to 20% from the twin bored option. All the alternates should be carried forward into a detailed comparison analysis of costs and impacts so the optimum solution can be selected. A purpose and need statement that includes community cohesion, rail operations, and visual impacts should be developed and be the basis for the alternative analysis.

In summary:

- Costs of the twin bored tunnel from previous studies are likely underestimated by 15 to 20%. Current high-level estimates for the twin bore tunnel should be closer to $2bn given inflationary pressures.
- Other tunnel options are viable that are 15-20% less than the twin bored option.

- Multiple tunnel options (described within this report) should be analysed in more detail in the Project Development (PD&E) process currently being coordinated between the City, Broward County, and FDOT.
- The Purpose and Need statement for the PD&E Study should include values the City holds for downtown/economic development. The possibility exists that some level of analysis and environmental documentation could be adjoined to ongoing Commuter Rail assessments being performed across Broward County.
- The next request for funding should be to fully fund the PD&E Study with inclusion of the aforementioned tunnel options.

2. INTRODUCTION

The City commissioned the Lochner/LBA partnership (LL) to undertake a high-level review of existing, publicly-available documentation relevant to tunnel options for a proposed future rail crossing of the New River. The location of the New River crossing is located on the east side of the existing rail crossing south of the Fort Lauderdale Brightline Station. The existing documentation in the public domain discusses four alternatives for crossing the river (a low, medium, and high-level bridge and a twin bored tunnel located under the east side of the existing north-south rail tracks). An online presentation given by FDOT and Broward County in 2021 summarizes the engineering and alignment concepts of these alternatives. The tunnel option from this presentation and previous analysis is shown in Exhibits 4, 5 and 6. For the purposes of this report, we have focused solely on additional feasible tunnel options for the City to consider.

LL met with the City (The Mayor, City Manager and his team) on September 15th, 2022 to present ideas on other tunnel options. These options included bored, open cut, and \`cut and cover\` methods of excavating and supporting the ground under the river and the adjacent north and south approaches to the New River Crossing. LL also met with Brightline (the regional passenger train operator) and the Fort Lauderdale Marine Industries Association on September 14th and 15th, respectively. The organizations were indifferent to the river crossing alternative (tunnel versus bridge), but both agreed that the current operations would not be sustainable under a “do-nothing” alternative.

3. SCOPE AND ASSUMPTIONS

The scope of this report is to review the feasibility and potential challenges of the tunnelling options for the New River Crossing. LL reviewed the costs associated with the current bored tunnel alternative. This cost is shown in the **FDOT Broward County Commuter Rail Study (Initial Draft Opinion of Probable Construction Cost Estimate v1.0 New River Crossing Tunnel Alternative) dated December 3rd, 2021.** The LL report provides comment on the key requirements and scope of any future tunnel feasibility study for a further detailed review. LL participated in an introductory meeting with the City to discuss additional tunnelling options and provided guidance for next steps. In addition, LL offered thoughts on the environmental and social benefits of a tunnel solution and summarized the additional aspects of the project that need to be addressed in the environmental approval and grant funding process.

The review included in this report is a \`high level\` assessment and is based on the views and experience of senior tunnelling and environmental planning specialists.

4. REVIEW OF THE TUNNEL ALTERNATIVE AND OTHER TUNNELLED OPTIONS

4.1. Introduction

LL reviewed six potential tunnel options of the New River which are discussed in this section. This includes the TBM option developed in the FDOT study, as well as five additional options identified by LL. The key benefits, issues, and challenges for each option are summarized in Appendix A ("Table of Challenges, Issues, and Benefits of the Tunnelling Options"). The following is commentary of the general feasibility of each option.

The most important influence on any tunnel option will be the prevailing ground conditions and the engineering properties of the soil and other geotechnical conditions. Based on geotechnical boring data in the vicinity of the proposed project obtained from the City, and from other public records, the ground adjacent to the existing rail crossing can be described generally as follows:

- Prevailing groundwater level adjacent to the river is approx. 5 feet below the ground surface
- From the ground level to 7 feet below the surface --- Soil conditions consist of fill material, sand, and fragments of limestone
- 7 feet to 18 feet below the surface --- Consists of a very soft layer of limestone with lenses of sand
- 18 feet to 50 feet below the surface --- The material consists of loose to dense sand
- 50 feet to 120 feet – Consists of soft, medium, to hard limestone with lenses/pockets of sand

These are similar soil conditions to those experienced during the successful construction of the Miami Port Road Tunnel constructed within the last decade.

4.2. Option 1 – Twin Bored Tunnel

This is the alternative cited in the FDOT Broward County public online presentation of the four primary alternative crossings (one tunnel option plus three bridge options) of the New River. This tunnel alternative uses a tunnel boring machine (TBM) that would probably progress from the southern tunnel portal cutting and be `turned around ` within the north portal cutting, with excavation and support provided to the other tunnel while the TBM progresses back towards the southern portal. This method of tunnelling would present the most robust (and likely most costly) method of construction by minimizing surface impacts and environmental intrusion. The Miami Port Road Tunnel (referenced above) was excavated through similar ground conditions using a similar method of tunnelling. This method requires that there is at least approximately one tunnel diameter (25-30 feet) of ground cover to the top of the tunnel below the riverbed. This requires the tunnel to be located deeper than other tunnel options (see below) and would result in a longer tunnel length. Also, the approach cuttings will be wider than other options as the tunnel portals will be at least 2 tunnel diameters wide plus the width of the separated twin tunnels. This alternative will also require the added capital and operational cost of tunnel ventilation and systems equipment. See Exhibits 4, 5 and 6 for a schematic of this option.

4.3. Options 2 & 5 – Single (larger) Tunnel

The single larger tunnel option would be formed using conventional excavation methods and would be supported using a roof and side wall of horizontally driven piles to form an outer structural `shell` with an inner circumferential shell of sprayed and cast-in-situ reinforced concrete. The length of tunnel could be shortened to the river crossing only with a possible short extension under the north and south banks of the river (see Exhibits 7 and 8). The remainder of the subsurface alignment could be constructed in open cutting (or `top down') construction, i.e., secant pile or diaphragm walls would be driven on either side of the subsurface alignment and then covered with an in-situ or precast concrete cover (See Exhibits 9). The excavation of the ground would then proceed within the enclosed structurally supported ground on the east side of the current railroad alignment. This method would minimize ground excavation and reduce the width of the open cut/top-down excavated tunnel approach cuttings. While detailed property and topographical surveys were not available, it is believed through reconnaissance/windshield surveys that this option could be constructed within the existing rights-of-way. There are existing roadways in the vicinity of the current rail alignment, and potentially, significant utility systems could cross under these facilities, which would need to be addressed in the next phase of planning or design.

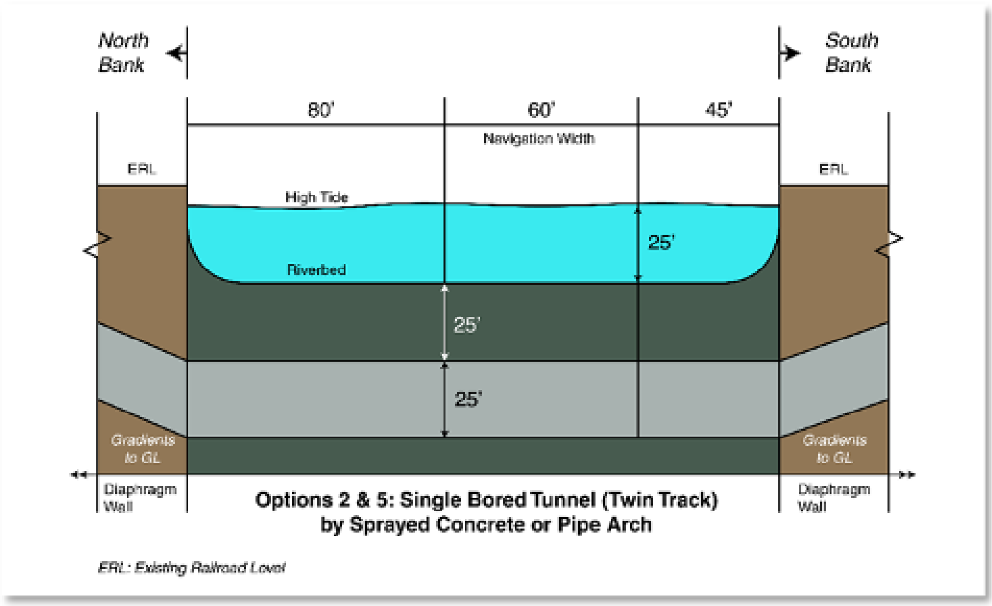


Exhibit 7 – Single (Larger) Tunnel (Profile View)

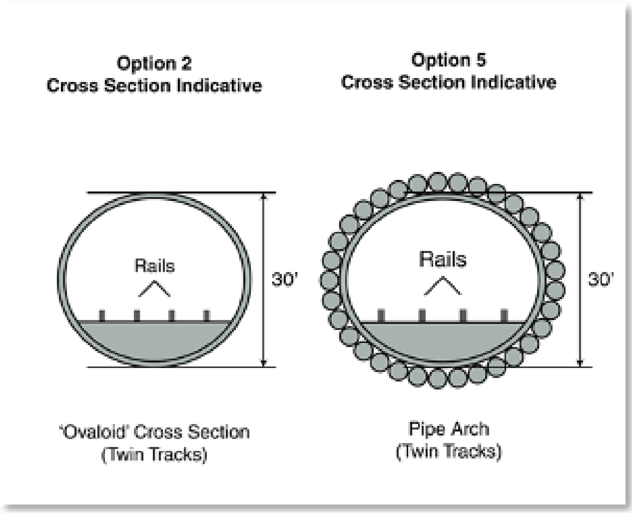


Exhibit 8 – Single (Larger) Tunnel (Cross Section View)

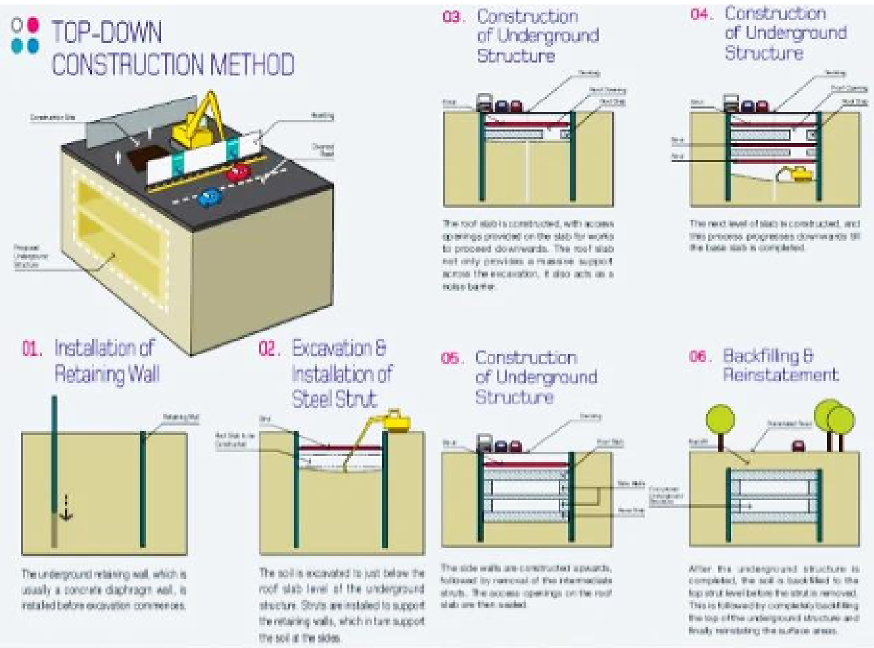


Exhibit 9 – Typical "Top-Down" Construction for River Approach Tunnels

In addition, a more detailed assessment of this method is required to better understand the topographic and groundwater conditions at the site. The next phase of work (or the study being procured by the (County/MPO) should evaluate these technical issues in more detail along with additional consideration of the vertical alignment of the tunnel approaches with respect to the surface roadways and utility crossings. If no significant constraints are found regarding these matters, then this option could significantly reduce the cost (approximately 15 to 20%) and schedule (reduction of approximately one year) of a tunnelled solution as compared to the twin-bore TBM option presented in the prior study.

4.4. Option 3 & 4 – Trench cutting across the river

As with Option 2, this method seeks to restrict the length of enclosed tunnelling to just under the river and use open, `top down` cuts for the north and south tunnel approaches. Using techniques employed in recently constructed Danish and Dutch tunnelled water crossings, a trench is sequentially progressed across the river by digging below the riverbed in a drained coffer dam (See Exhibit 10). This option needs to consider maintaining statutory navigational requirements during construction. Elements of this method of construction are regularly employed in Florida for the construction of coastal and river infrastructure. A cast-in-situ or precast ` tunnel box` unit is formed or lowered into the drained and enclosed coffer dam. The joints between the units would be sealed using robust, watertight synthetic gaskets. The riverbed geology would determine whether the temporary coffer dam could form an adequate seal with the underlying limestone formation (preliminary indications are that this is feasible).

The excavated/dredged trench that contains the concrete tunnel unit would need to be located at sufficient depth to enable 4 to 5 feet of cover to the top of the unit, so as be protected from river traffic. Also, means and methods would need to be explored to protect the existing rail bridge abutments. The tunnel unit is shown in Exhibit 11 and the profiles and cross section for these options is shown in Exhibits 12, 13, and 14 .

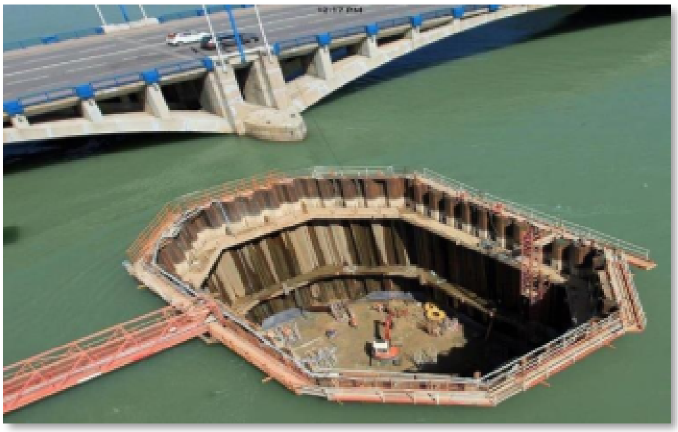


Exhibit 10 – Construction with Use of Coffer Dam

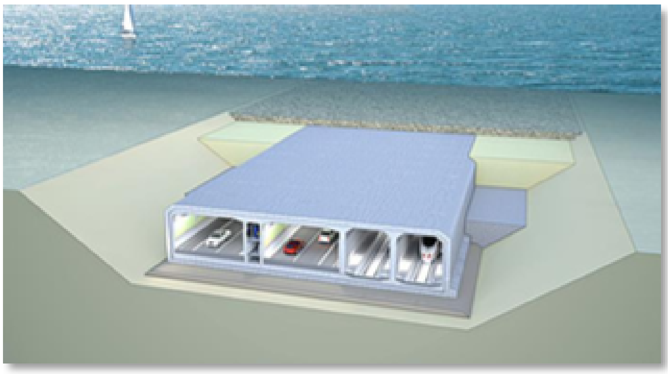


Exhibit 11 – Tunnel Unit Placed After Excavation

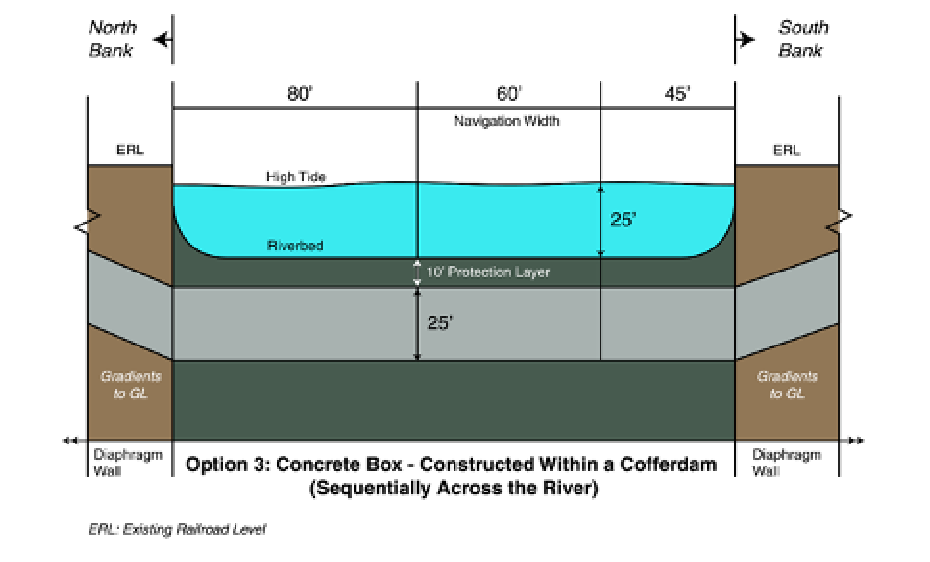


Exhibit 12 – Option 3 (Profile)

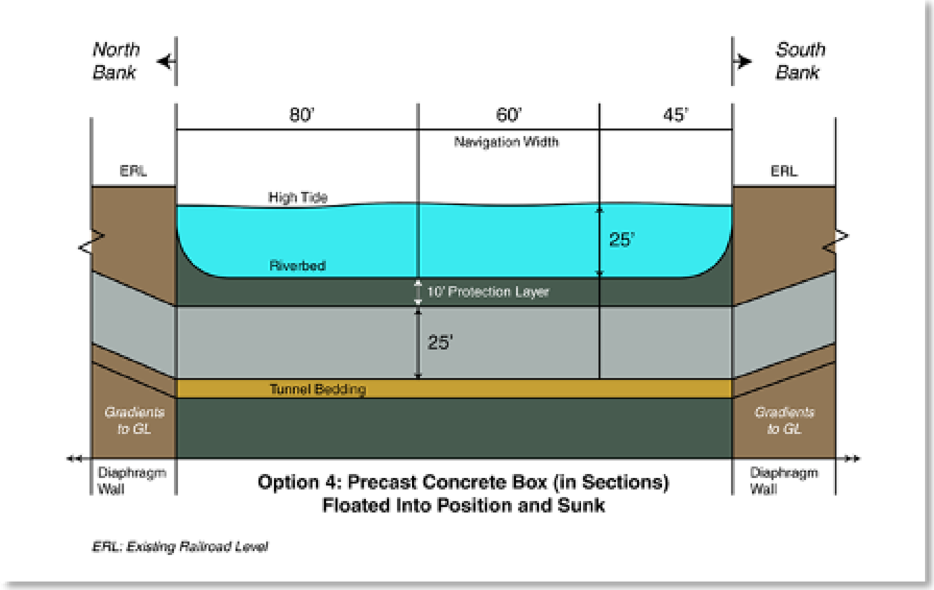


Exhibit 13 – Option 4 (Profile)

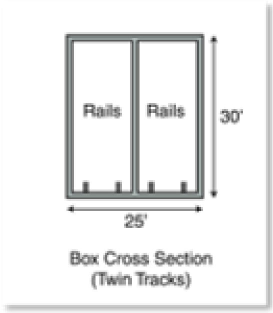


Exhibit 14 – Options 3 & 4 (Cross Section)

4.5. Option 6 – Two tunnels (one for passenger rail traffic and one for freight rail traffic)

Using the above methodologies, two appropriately sized tunnels could be constructed and potentially could remove the reliance of the existing rail bridge for passenger and freight traffic. However, for affordability this would mean that freight traffic would be restricted to a single bore tunnel, but the passenger traffic could use either tunnel. There would need to be a surface rail switch crossing on the north and southern tunnel approaches to facilitate a bidirectional operation in the larger tunnel. Most likely, a combination of Options 2 & 5 would serve this multipurpose rail traffic solution.

Commentary

In summary, a tunnel solution is feasible given the information reviewed to date and presented above. There are several potential options available that would require further detailed study to confirm technical feasibility, but of the publicly available information summarized to date, no fatal flaw to a tunnel option appears to exist.

In addition to the proposed twin-tunnel TBM option presented in earlier studies, a short subaqueous tunnel solution is possible thus allowing for shorter approach ramps, and likely lower costs, but this would depend on the impact of key utility and essential surface road crossings along the northern and southern approaches to the tunnel.

The shorter north and south approach ramps are likely to be accommodated within the east side of the existing rail tracks with limited disruption to current operations. In addition, the environmental impact on adjacent property and existing rail operations would likely be less than alternative bridge options. These impacts would need to be assessed in more detail during the next phase of planning/design.

Construction of the approach cuttings to the shorter river crossing options can be achieved using `top down` excavation and support methods, i.e., excavation can be undertaken within the enclosed space formed using vertically pre-driven secant pile side walls and a temporary steel surface canopy or a permanent structural concrete roof supported on the vertical piles. This construction method would mitigate any property and surface-related environmental impacts such as noise, visual impacts, and surface-related traffic impacts during construction. In addition, the impact of this alternative is likely to have added environmental benefits, discussed below.

The ground conditions and other social and environmental factors are the most significant influence on the feasibility of the above tunnelling options, especially considering possible bridge options. Rail operations and river navigation constraints are also important influences as are the potential major utilities that currently cross the existing railroad. These influences and constraints require further clarification and understanding as to their significance regarding the feasibility, challenges, and costs of each tunnelled option. These observations are based on the experience of senior tunnelling engineers/constructors (including other outside specialists contacted as a result of this study).

Refer to Appendix A for a summary of challenges, issues, and benefits of each tunnelled option discussed above.

5. COST ESTIMATE REVIEW

5.1. General comments on Estimate

LL has undertaken a high-level review of the tunnel cost estimate as presented in the report **FDOT Broward County Commuter Rail Study (Initial Draft Opinion of Probable Construction Cost Estimate v1.0 New River Crossing Tunnel Alternative) dated December 3rd, 2021**. We have estimated that general economic inflation has resulted in an increase in cost of at least 10% since this report was prepared. For example, the probable estimate for the twin bore tunnel option shown in the report is $1.8bn with a lower bound of $1.6bn and an upper bound of $2.6bn. Current high-level estimates for the twin bore tunnel should be closer to $2bn given inflationary pressures. Given the current escalation and variability of costs in the marketplace, the costs shown in this assessment are based on a comparison of the baseline established in the report. Final tunnel options costs will be dependent on more detailed engineering assessments at the proposed time of construction.

Forming a definitive view on the accuracy of this estimate would require detailed investigation of the sources of information used to compile the FDOT report. It would also require a detailed review of the methodology, geology, and other risk factors. Comments and observations of the estimate have been made based on the extensive previous experience of preparing cost estimates at a very preliminary stage of construction. LL does not profess to have an intimate knowledge of the scheme, or the validity of the data that was used in the initial cost estimates; thus, we have made reasonable judgements and assumptions of comparable costs to facilitate our review.

5.2. Observations

We noted the following points during our review:

- The assumptions were generally adequate for an early cost estimate of this nature

- The tabulated cost estimate was logical and thorough
- We believe that some of the contingencies and allowances may have been underestimated for an early-stage cost estimate particularly where there are uncertainties yet to be confirmed such as the geology along the alignment of the proposed bored tunnelling works
- The unit rates used in the estimate are almost certainly optimistic (low) and most likely do not reflect current levels of cost escalation and supply chain difficulties
- We also believe that some of the unit rates used in the cost estimate may not be appropriate when applied to the complexity of underground works
- We noted areas where quantities of materials had in our opinion been under or overestimated, e.g., the station support walls appear to be oversized and the depth of the support walls may not be adequate.
- Professional Fees are a significant portion of this cost estimate, and it is not clear what the scope of the professional fees includes, i.e., design, legal, planning, etc. More clarity is required to ensure a valid and realistic estimate.
- An additional tunnel option should be considered for analysis. This option would consist of a shorter, open cut type alignment which could offer savings of approximately 20%, resulting in an estimated present-day cost of $1.7bn.

5.3. What our Observations Indicate

The above examples, though not exhaustive, reflect the need for more specificity of key parameters that influence the costing for underground infrastructure, e.g., geology, geometry and alignment of the tunnel, ventilation and systems engineering requirements, etc. However, what is clear is that there is a need to ensure that more reliable and realistic cost estimates include:

- A more informed view of the base data and base assumptions
- A more thorough understanding of the underground construction methods and materials
- The input of experienced senior tunnel experts familiar with the delivery of underground construction
- The range of impact and influences on the environment, the urban realm and the public
- A more informed view of risks and how they are progressively managed and a more thorough appreciation of the use of contingencies when applied to key aspects of the delivery of tunnel projects
- Informed assumptions that significantly impact the schedule
- Unit rates that reflect the current impacts of supply chain disruption and escalation

5.4. Cost Estimate Compared to Other Similar Bore Tunnels

The UK Infrastructure Projects Authority cites that the cost of a tunnel is a function of the geology, the tunnel diameter and particularly the length of the tunnel. However, assessing simplified parametric costs over a range of relevant tunnel projects can be unreliable. Therefore, to compare the New River tunnel with the recently constructed Port of Miami Road Tunnel (reported to have cost $677 million per mile) is not a good basis for a realistic comparison. The Miami tunnel is 36 feet in diameter and 1.5 miles long. It had higher fixed costs because of the size and uniqueness of the Tunnel Boring Machine that was used, and the Miami Tunnel project is possibly more complex than the current New River tunnel alternative. Although the geology between the two projects are very similar, the surface locations are entirely different. The Miami Tunnel project is located in a semi-industrial contained environment, with few stakeholders to influence the surface interface. The urban realm location of the New River project presents a different set of influences regarding surface construction logistics, environmental requirements and the range of stakeholder interests. These factors will likely add more costs to the PD&E study and the permitting phase. This environment can also constrain the logistics of the contractor during construction, resulting in higher construction costs compared to the Port of Miami Tunnel project.

We used a range of cost data in our proprietary high-level costing model, which includes fixed and variable costs, and have adjusted for inflation, exchange rate, etc. Our preliminary review indicates that the cost should be 15 to 20% more than is currently reported.

5.5. The Cost of Other Tunnel Options

In Section 4 we described other methods of undergrounding the rail alignment under the New River. These methods have constraints and risks as described in Appendix B and should be addressed in the next steps. However, these methods could potentially reduce cost and schedule **resulting in 15 to 20% savings due to reduced geometry, adopting methods of construction familiar in Florida coastal and river engineering, reduced width of approach cuttings, etc**. Extending some of these methodologies to a longer tunnel alignment flanking the west side of the City CBD could result in cost and schedule benefits (and not least in associated social value and environmental benefits as described in Section 7). Further studies and the confirmation of basic data would be required to confirm this.

6. ENVIRONMENTAL REGULATIONS, PROCESS & FUNDING CONSIDERATIONS

6.1. Environmental Regulations

A potential funding source for the Broward Commuter Rail project includes federal funding inclusive of the Consolidated Rail Infrastructure and Safety Improvements (CRISI) Program and a number of other discretionary programs through the Bipartisan Infrastructure Law, in addition to regular funds allocated through standard federal allocation formulas distributed to the states. As such, any project seeking federal funding must eventually go through a formal process of alternative evaluations documenting environmental impacts to satisfy the National Environmental Policy Act (NEPA) requirements. The appropriate Federal Agency (FRA, FTA, or FHWA, for example) must approve the environmental document prior to design or design/build opportunities, if right-of-way is not an issue. NEPA is a procedural statute that requires Federal agencies to account for environmental impacts associated with the proposed action and its alternatives, when planning projects, issuing permits, or providing financial assistance. There are several laws that affect the analyses including: Americans with Disabilities Act (ADA), Executive Order 12898 on Environmental Justice, Title VI of the Civil Rights Act, the National Historic Preservation Act (NHPA), Farmland Protection Policy Act, Land and Water Conservation Fund Act, Railroad Noise Emissions Compliance Regulation, Section 4(f) of the US DOT Act of 1966, the Clean Air Act, Regulations for Emissions from Locomotives Program, Coastal Zone Management Act, Endangered Species Act, Marine Mammal Protection Act, Migratory Bird Treaty Act (MBTA), Wild and Scenic Rivers Act, the Clean Water Act, and the Safe Drinking Water Act.

Additionally, one of the primary goals of NEPA is to give the public meaningful opportunity to learn about and comment on a proposed action before decisions are made regarding that action.

6.2. The NEPA Process

The NEPA process defines the steps that must be taken to document consideration given to the significant environmental impacts of a proposed action. The documentation includes:

- **A purpose and need statement.** It is critical to establish the Purpose and Need (P/N) clearly at the outset. The P/N may include connecting communities, reducing delays due to bridge construction, aesthetic goal consistency with local plans, etc. Alternatives with higher costs may very well meet the P/N best and provide other value-based benefits.
- **Descriptions of all the "reasonable" alternatives that meet the purpose and need of the project.** A "No-Build" alternative must be carried throughout the NEPA process as it establishes a baseline for comparison with the other alternatives.
- **A narrative regarding the project environment.**
- **Evaluation of the impacts (direct and indirect) that each alternative has on the project environment as well as proposed mitigation of impacts.** NEPA requires the analysis to devote substantial treatment to each alternative considered in detail so that one may evaluate their comparative merits. Alternatives are thoroughly analysed with respect to the four categories of environment: social and economic, cultural, natural, and physical.

Elements of the four categories are provided in the table below.

Social and Economic	Cultural	Natural	Physical
Social	Section 4(f)	Wetlands & Other Surface Waters	Noise & Vibration
Economic	Historic Sites/Districts	Aquatic Preserves	Air Quality
Land Use Changes	Archaeological Sites	Outstanding Florida Waters	Contamination
Mobility	Recreational Areas	Water Resources	Utilities
Aesthetic Effect	Protected Lands	Wild and Scenic Rivers	Construction
Relocation Potential		Floodplains	Navigation
Farmland		Coastal Zone Consistency	
		Coastal Barrier Resources	
		Protected Species & Habitat	
		Essential Fish Habitat	

Table 6-1 - The four categories of environment

When examining an alternative, one must consider the ultimate footprint and the footprint needed to construct the alternative, including laydown/staging areas. Even though the means and methods for construction will be determined in part by the design engineer and/or contractor, effort is made during the NEPA process to identify the most likely procedure that can be utilized while minimizing environmental impacts.

Public input regarding the alternatives is a part of the careful screening that takes place and is utilized in determining which alternatives are to be eliminated from further consideration.

6.3. Funding

Discretionary programs are competitively awarded through an application process for each program. Project details including good cost estimates are important aspects of any application as are finance plans to show that there is participation at the local and state level which will make an application even more competitive when considering federal funding availability. Each program has specific requirements that must be met as part of the application, e.g., funding for construction will require that the NEPA process be completed. Each program should be reviewed to determine if appropriate

6.4. Environmental Consideration for the Broward Commuter Rail at New River Crossing

Based upon the preliminary information, the following has been noted regarding the environmental aspects of the Broward Commuter Rail project, particularly in the area of the proposed Tunnel Alternative.

- From a social aspect, community connectivity is an important consideration. A negative impact on community connectivity is associated with physical obstructions, such as a new roadway or railway, that is to be constructed through a community. Conversely, community connectivity is enhanced through physical improvements, such as a trail, sidewalks or shared use path that provides additional modes of transportation or the removal of a physical obstruction that previously caused a community to be divided. A tunnel has the potential to increase connectivity of the community.

  To what degree will be dependent upon the removal of the existing freight line and the joint use of the tunnel between the commuter rail and the freight. If the existing freight line remains, a physical obstruction will also remain. A mid or high-level bridge could also be used jointly between the commuter trains and those carrying freight. The differential between the alternatives would be based upon the length of the alternative, the number of grade crossings eliminated and any negative impacts to existing grade crossings. Additionally, the length, depth/height and construction method of each alternative could impact local streets and business access and should be defined as clearly as possible and weighed appropriately in the analysis of impacts.

- Another important social aspect to consider is local government plans, such as a redevelopment plan of an area and the impact each alternative may have upon that plan. The City has been working towards the redevelopment of the area around the New River Crossing. Public engagement with developers and business owners will be important as the project moves forward.

- Mobility or vehicular traffic operations would be improved by a tunnel due to the avoidance of grade crossings. A bridge could potentially avoid the same crossings so the differential between the alternatives would be based upon the number of grade crossings eliminated by each alternative.

- Aesthetics, from a public perspective, would be better with a tunnel than with a high-level bridge.

- Preliminary information indicates a Historic District, an archaeological site, and archaeological zone in the area of the New River Crossing. Depending upon the construction method utilized, a tunnel may be an alternative that minimizes direct impacts to these resources. However, to do so may affect the length of tunnel. Additionally, the preliminary information denotes several historic structures in the vicinity of the New River Crossing. This can raise the concern of vibration associated with the tunnel which will need to be addressed during the next stages of the project.

- Vibrational effects during construction can be a concern with the potential for existing bascule bridge leaf misalignment. Vibration limitations may dictate specific means and methods to address.

- Noise impacts would be minimized by a tunnel within the project vicinity.

- Navigation would not be impacted or restricted by a tunnel, except during construction. The tunnel alternative and construction method will influence the extent of the impact. However, the high-level bridge is not expected to impact or restrict navigation unless there are vessels that exceed the vertical clearance of a bridge. The level of Coast Guard involvement and what they will allow will be dependent upon the alternative and potential construction method.

- A shorter, less costly and functional tunnelled river crossing option may well resolve the on-going navigational and bridge opening issues, but the current longer tunnel solution could offer better value for the City because it also facilitates and improves the mobility and access into and out of Downtown, and secures a more sustainable future for the expectations of growth in the City. The values and benefits could well be monetised by an independent consultant if they worked alongside L&L and a cost verses value proposition could be developed for the City in order to quantify the sustainable and commercial benefits and gains for the City.
- The natural environment will be impacted by any work performed in New River. This includes wetlands, listed and endangered species, and Essential Fish Habitat. Additionally, turbidity will also be an important consideration for the alternatives and related construction.
- Based upon preliminary information, the potential for contamination along the area of alternatives exists. The excavation and dewatering related to a tunnel would place it at a higher risk for encountering contamination that other alternatives. Additionally, Karst Limestone soils exist within the project area and would require special geotechnical considerations.
- Resiliency is another consideration for this study. The FDOT study indicated that based upon the latest flood maps and storm surge projections, the County confirmed that the area near the New River Crossing is likely to witness impacts. The FDOT study noted that the Broward County Chief Resiliency Officer, and other local academics, urban planning professionals, and resiliency specialists suggest that to modernize and stabilize train connections in the Atlantic coastal areas, projects should be designed to elevated tracks. The philosophy is a bridge does not normally suffer major damages as a result to flooding/storm surge unless foundations are unprotected and exposed of strong current/erosion. However, hardening measures, such as retractable covers, can be implemented in tunnels and should be explored in more detail for the tunnel alternative.
- Utility conflicts could be significant for the tunnel. However, additional information would be needed to determine the extent.

7. BENEFITS OF A TUNNEL

7.1. As discussed in the previous section, growth in transportation can have impacts on the surrounding environment. With that said, there are potential, additional benefits associated with the implementation of a tunnel. These include:

- Reduced visual, noise and dust during construction
- Reduced visual, noise and particulate emissions during operations
- Mitigated delays for surface traffic during construction and during operations
- Safer interfaces with public and traffic during construction
- Improved/protected corridor context, particularly with important features and facilities to the community such as the Riverwalk and Historic District of Ft. Lauderdale
- Potential to maintain/increase land and property values and overall community appeal
- Reduced long term maintenance cost and more durable structural solution
- Long term surface mobility benefits
- Supporting and facilitating growth strategies, such as those in place for the City of Fort Lauderdale
- Improved traffic safety in an urban area

7.2. There are many U.S. and International examples where cities have strategically chosen to adopt underground infrastructure solutions to mitigate serious environmental impacts of surface or elevated road and rail infrastructure to preserve and to protect the existing urban realm. In Spain, the route of the M30 through downtown Madrid was located underground so as to provide surface parks and leisure facilities for the city. In Boston and Seattle, aging and unsightly elevated freeways have been dismantled and replaced by underground infrastructure, thus freeing up a new urban `green` surface environment with adjacent properties and businesses' enjoying the benefits (i.e., desirable property, land value, and attractive urban real estate). Also, in Seattle there are sections of urban freeway where `urban lids` have been retrofitted over a major subsurface freeway allowing separated communities better local connectivity and providing parks and meeting places for residents. Improving the urban realm by constructing underground infrastructure is becoming an expectation as cities around the world seek to make their environment more sustainable and attractive to business and residents, all while minimizing the impacts of separating communities.

8. NEXT STEPS

8.1. The purpose and need statement is considered the most important section of an environmental document. It establishes the reason an agency is proposing the project. It is utilized in the justification of the expenditure of dollars and the environmental impacts involved. It is also considered the starting point for the development of alternatives. It is recommended that the City of Fort Lauderdale work with their alternative funding consultant (Deloitte) upon completion of this study to gauge whether a detailed purpose and need document may be required for alternative grant applications, as requirements can vary between grants. For example, the CRISI Program expects the applicant to identify only one of the following tracks for an eligible activity: Track 1—Systems Planning; Track 2—Project Development; Track 3—FD/Construction; Track 4—Research, Safety Programs and Institutes; or Track 5- Deployment of Magnetic Levitation Transportation Projects. Applicants are strongly encouraged to seek funding for the appropriate Lifecycle Stage of a Capital Project, consistent with these application tracks.

8.2. FDOT has been leading an active NEPA study for the Broward Commuter Rail and recently reduced the project length and revised the northern project limit from Deerfield Beach to the City of Fort Lauderdale. FDOT noted that as an important step to enable potential future commuter rail service to the north, a consensus must be reached between the County and City of Fort Lauderdale regarding the New River alternative. As part of the next steps, the City, County and FDOT should meet to consider and set expectations, perhaps as a scope item in the proposed study being administered by the MPO/Broward County. This would include discussing the purpose and need as preferred by the City, examining its difference from the previous purpose and need statement for the full Broward Commuter Rail Study, and the best methods to reconcile the two approaches.

8.3. Once the purpose and need is reconciled and incorporated into the ongoing NEPA study, all alternatives , including those described herein should be evaluated for their fulfilment of the revised purpose and need. Critically, several technical assessments should be undertaken to confirm ground conditions and rail operational requirements, refine the alignment with respect to long and short tunnel options, and provide more detailed costing analysis, risk analysis and scheduling, etc. Additionally, effects of the construction footprint upon the environment and mobility, both on land and in the river, should be analysed. During this process, as much of the data already obtained by the FDOT Study should be utilized to reduce unnecessary time, effort, and expense. This work should be considered as mandatory scope within the study currently being considered/administered by the County/MPO.

8.4. The next phase of work would provide more confidence in the feasibility, benefits, and costing of a tunnel alternative and would provide a more equitable comparison of costs with the three alternative bridge crossings. It could also assess the opportunities that a longer tunnel might bring to the City, i.e., not just under the New River, but extended to meet the needs of the City's longer term transportation plan. The cost of a tunnel solution will probably be more than the bridge alternatives, but a fresh review of tunnelling options could also bring strategic, environmental, social and other indirect value-enhancing benefits to the City. The cost of the additional road connectivity made necessary with the bridge alternative must be taken into account, and would potentially increase the overall cost of a bridge solution, and as pointed out in Section 7, the maintenance and life cycle costs of a bridge are more significant than for a tunnel. These additional indirect costs would need to be considered in the next steps and in the NEPA study.

Appendix A - **Table of challenges, issues, and benefits of the tunnelling options**

Conceptual Tunnelling Options

	1. Twin Bored Tunnel with Cross Passages (TBM-driven)	2. Single Large Tunnel SCL Construction	3. Sequential Cofferdam with Concrete Precast or Insitu Tunnel within C&C Approach
Benefits	• Proven Technology • Easily deal with Karst ground • Little or no railway interruption	• Economic section • Removes need for X passages • Could be just under river	• High level solution • Possible river-jack up barge crossing • North side station could be at surface • Proven technology • C&C approaches shorter and economic • Reduced footprint under river
Issues	• Ventilation • Escape and rescue • Tunnel management systems • Low level Brightline station • Long tunnel length to achieve gradients	• May require more cover to riverbed (go deeper) • Escape and rescue would have to be thought through • Ground treatment issues	• Possible interruption to marine traffic • Existing abutments conflict • Shortest tunnel crossing • Least depth required to construct box structure • Marine working issues/unsuitable ground conditions • Piling noise
Challenges	• Currently most expensive • Reduces possible concurrent multi-location working sites • Wide footprint due to bore separation • Requires extensive modifications at station north of river	• May need to be deeper and longer to avoid unfavorable geology • May have to do extensive grouting in Karst to achieve stable tunnel support	• Need to better understand draught requirement and navigable width • Need to understand environmental constraints in regard to working in the river and open cut ramps on either side of the river crossing • Rail owner/operator may have stringent operational requirements during construction • Sheet piling into the karst could be a problem

Conceptual Tunnelling Options

	4. Submerged Tube Built of Precast Concrete Element placed on a Dredged and Prepared Riverbed (C&C Approach)	5. Pipe Arch Crossing under the Riverbed and Single Large Section Tunnel Constructed Beneath/Within (C&C Approach)	6. Two Tunnels One for Brightline Tracks, One for Mainline Track
Benefits	• High level solution so C&C approaches shorter and economic • Units precast, floated into position and sunk	• Low key activity • Requires good access at riverside • Could be driven from caisson shafts at the bankside • Could use modern drilling techniques (Hyperbore) • Very flexible solution; maybe a pipe jack access first	• Could be delivered by a number of the high-level options as well • Removed need for bridge
Issues	• Dredging could be a problem and may need a half-depth sheet piling • Draught would remain limited and top of box would need some protection • Same as Opt. 3, Sequential Cofferdam	• Ground conditions, hydrology • For driving the "pipes" • For driving the final excavation and support • Would require cover to riverbed	• Some more cost depending on the level of the crossing • Long approaches if low-level solution
Challenge	• Need to better understand draught requirement and navigable width • Same as Opt. 3, Sequential Cofferdam • Sheet piling into the karst could be a problem	• May need to be deeper and longer to avoid unfavorable geology • May have to do extensive grouting in Karst to achieve stable tunnel support	• Would provide single track for freight so would need crossings on each side's surface