New River Crossing Feasibility Technical Memorandum

Project Development & Environment (PD&E) Study Services for Tri-Rail Coastal Link (TRCL)
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1.0 EXECUTIVE SUMMARY

1.1 Introduction

In response to Legislative Specific Appropriation 1939 passed in July 2019, an evaluation was initiated by the Florida Department of Transportation (FDOT), District 4, to study the feasibility of new crossing alternatives at the New River to provide a solution which will meet reasonable needs of navigation, freight trains, and passenger trains within the crossing area. There is an existing rail bascule bridge spanning the New River within the existing Florida East Coast (FEC) right of way, currently used by freight and passenger trains, which are operated by FEC and Virgin Trains/Brightline, respectively.

1.2 Objective

The objective of the study is to evaluate the feasibility of a rail crossing at the New River to provide a solution which will meet reasonable needs of navigation, freight trains, and passenger trains within the crossing area. This study includes the evaluation of several crossing alternatives including movable bridges of various vertical clearances, a fixed bridge, and tunnel concepts to identify feasible alternatives that could be advanced into the Project Development and Environment (PD&E) Study phase.

1.3 Study Area

The limits of this study run parallel to Andrews Avenue and FEC Railway Corridor from approximately SR 838/Sunrise Boulevard (northern terminus) to SW 15th Street (southern terminus). The total length of the study is approximately 2.5 miles (refer to **Figure 1**).

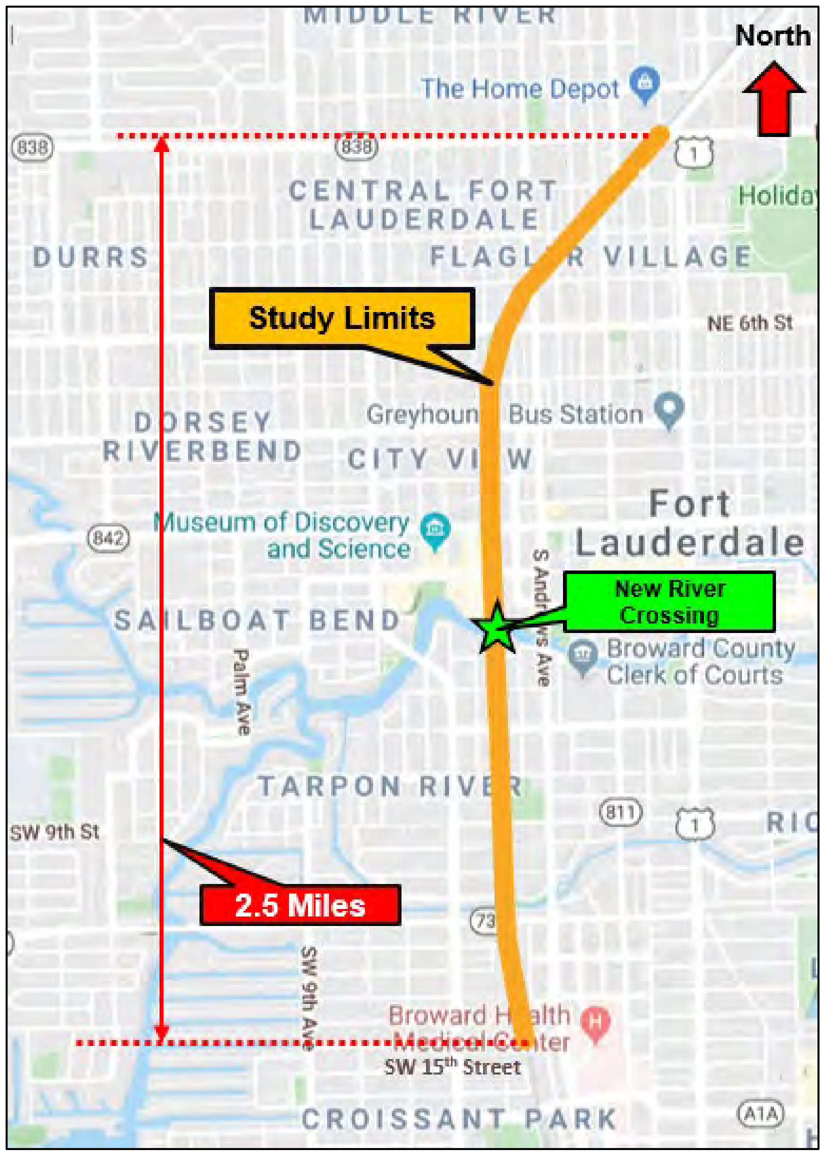


Figure 1: Location Map

1.4 Context and Background

The New River Crossing Feasibility Study is a continuation of the Tri-Rail Coastal Link (TRCL) Transit Analysis Study. As part of Legislative Specific Appropriation 1939, the legislation identifies the utilization of resources from the State Transportation Trust Fund that allows the FDOT to update the Tri-Rail Coast Link Study (formerly known as the South Florida East Coast Corridor Transit Study) Phase 2 Navigable Waterway Analysis Technical Memorandum (see **Appendix A**).

1.5 Conceptual Alternatives

Four crossing alternatives were evaluated as part of this study. Track horizontal and vertical alignments, typical sections, navigational clearances, structural analysis, environmental impacts, and constructability were evaluated in the development of the preliminary concept alternatives for further development and analysis during the PD&E phase and subsequent phases.

The alternatives evaluated are listed below:

- **Alternative 1** - Low-Level Bascule Bridge (21-foot clearance)
- **Alternative 2** - Mid-Level Bascule Bridge (56.5-foot clearance)
- **Alternative 3** - High-Level Fixed Bridge (80-foot clearance)
- **Alternative 4** - Tunnel (5-foot clearance below the riverbed; proposed track depth of 63-feet below existing track grade; total depth to bottom of bored tunnel is 75-feet below the existing track)

Figure 2 provides a schematic comparison between the different alternatives. The Low-Level Bascule Bridge Alternative requires approximately 1.1 miles of overall improvements which includes a new bascule bridge structure at the New River, and track work needed to re-establish track connections to existing railroad tracks on both the north and south side of proposed improvements. The Mid-Level Bascule Bridge, High-Level Fixed Bridge, and Tunnel alternatives require approximately 2.5 miles of overall improvements. The structural configurations differ between these alternatives, however, due to design constraints, and geometric needs based on design criteria, the overall length of track improvements are similar. All four alternatives would also re-establish connections to existing railroad tracks on both the north and south side of the proposed improvements. The following sections provide additional details regarding each alternative.

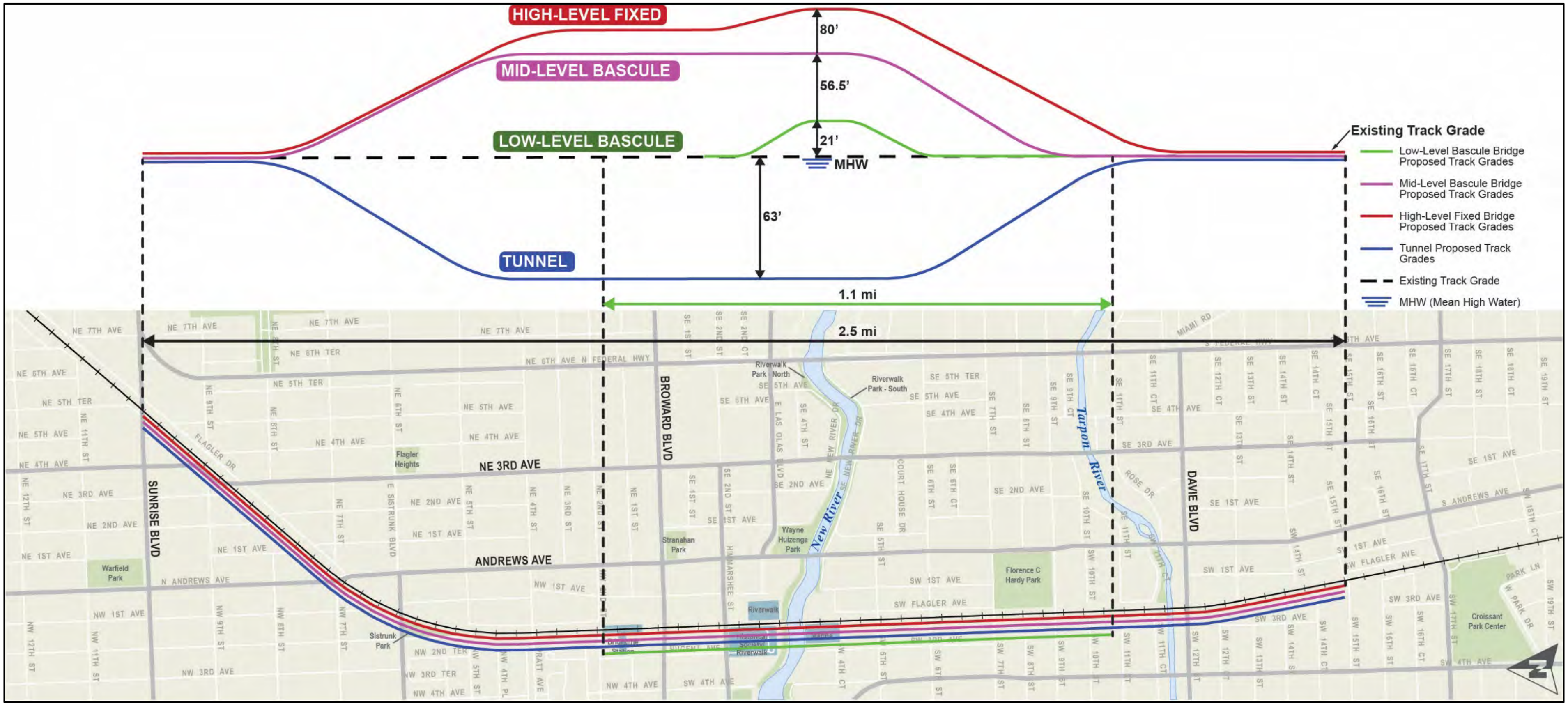


Figure 2: Overview of Alternatives (Schematic)

1.6 Stakeholder Coordination

Stakeholder coordination meetings were conducted throughout the duration of the study to introduce the project and receive input during the evaluation process. In general, the stakeholders support a new rail crossing of the New River. Meeting notes are included in **Appendix B**. **Table 1** shows the stakeholder meetings that were conducted between August 2019 and December 2019.

Table 1: Stakeholder Meeting Log

Stakeholder	Date/Time	Location
Virgin Trains (Brightline)	August 14th, 2019 1:30 PM	8075 Gate Parkway W, Suite 204 Jacksonville, FL 32216
United States Coast Guard (USCG) District 7	October 11, 2019 10:00 AM	909 SE 1st Avenue #510 Miami, FL 33131
Marine Industries Association of South Florida	October 15th, 2019 11:00 AM	221 SW 3rd Avenue Fort Lauderdale, FL 33312
Florida East Coast Railway (FEC)	October 25th,2019 11:00 AM	7150 Philips Hwy Jacksonville, FL 32256
Marine Advisory Board – City of Fort Lauderdale	November 7th, 2019 6:00 PM	100 N Andrews Avenue, 8th Floor Fort Lauderdale, FL 33301
City of Fort Lauderdale & Downtown Development Authority	November 14th, 2019 1:00 PM	290 NE 3rd Avenue Fort Lauderdale, FL 33301
Broward County	November 14th, 2019 4:00 PM	115 South Andrews Avenue, Suite 409G Fort Lauderdale, FL 33301
Marine Industries Association of South Florida	December 5th, 2019 10:30 AM	221 SW 3rd Avenue Fort Lauderdale, FL 33312
Marine Advisory Board – City of Fort Lauderdale	December 5th, 2019 5:30 PM	100 N Andrews Avenue, 8th Floor Fort Lauderdale, FL 33301
Broward County	December 6th, 2019 9:00 AM	115 South Andrews Avenue, Suite 409G Fort Lauderdale, FL 33301
City of Fort Lauderdale & Downtown Development Authority	December 10th, 2019 11:00 AM	290 NE 3rd Avenue Fort Lauderdale, FL 33301
Broward Metropolitan Planning Organization (MPO)	December 13th, 2019 1:30 PM	100 West Cypress Creek Rd., Suite 650 Fort Lauderdale, FL 33309

1.7 Analysis Results

In summary, all alternatives are considered feasible. A preliminary right of way impact assessment, environmental screening, constructability review, and cost estimate were conducted as part of this study. In addition, a high-level qualitative analysis was conducted to compare the feasibility of the alternatives. The summary of the qualitative analysis is presented in **Section 9.5**, **Table 17** of this report.

1.7.1 Right of Way Needs

Alternative 1 impacts seven parcels with a total impact area of 0.78 acres. Alternative 2 impacts 56 parcels with a total impact area of 6.81 acres. Alternative 3 impacts 65 parcels with a total impact area of 7.09 acres. Alternative 4 impacts 68 parcels with a total impact area of 8.16 acres, however, there are additional subterranean impacts that would need to be considered in the evaluation of the total impacts. **Table 2** lists the acreage impacted with each alternative.

Table 2: Right of Way Impacts Summary

Alternative	Parcels Impacted (Acres)
Alternative 1 Low-Level Bascule Bridge	0.78
Alternative 2 Mid-Level Bascule Bridge	6.81
Alternative 3 High-Level Fixed Bridge	7.09
Alternative 4 Tunnel	8.16

1.7.2 Environmental Considerations

Several potential cultural resources were identified within the study area. Those include potential Section 4(f) and Section 106 properties that may be publicly owned parks, recreational lands, wildlife and waterfowl refuge areas, or historic sites of national, state, or local significance.

Potential Section 4(f) resources:

- Sistrunk Park
- Riverwalk Linear Park
- Florence C. Hardy & Southside Park
- Tarpon River Park, Esplanade (Discovery) Park
- Bubier Park/Huizenga Plaza
- Marshall Point

Potential historic and archeological resources:

- Sears Town, Progress Plaza (8BD0176)
- Broward Plasma Corp./Archaeology Museum (8BD01330)
- Tom M. Bryan Building (8BD00227)
- King-Cromartie House (8BD00062)
- New River Inn (8BD00063)
- Philemon Bryan House (8BD00212)
- Antique Car Museum
- Himmarshee Street/SW 2nd Avenue Historic District (H-1)
- Fort Lauderdale Historic District (8BD181)
- Brickell Block (8BD02916)

Section 9.2 of this report discusses the location of the cultural resources with respect to the footprint of the alternatives. For Section 4(f) resources, the Determination of Applicability (DOA) will be made during the PD&E phase to determine as to whether Section 4(f) does or does not apply to the project and if the project is eligible for exceptions, exemptions, and exclusions to a Section 4(f) requirement. The PD&E phase will also initiate the Section 106 process by establishing the undertaking, conducting consultation, identifying historic properties, assessing adverse effects, and resolving adverse effects by avoiding, minimizing, or mitigating. A Cultural Resource Assessment Survey (CRAS) will need to be developed during the PD&E phase.

1.7.3 Constructability

A constructability review is a process that reviews and ensures that a project is buildable, while also being cost-effective, biddable, and maintainable. It is important to note that a constructability review in the early stages of a project has the best potential for providing meaningful benefits without having an adverse effect on project schedules. Conducting constructability reviews early and consistently throughout the project's life can also avoid potential project delays, increased costs, construction claims, and delays and/or disruptions to the public. As part of this study, construction factors were considered during the development of the alternatives. This includes identification of potential challenges, fatal flaws, assumptions, sequencing, temporary conditions, etc. In summary, all alternatives are considered constructible during this phase of the project. Additional constructability reviews will be needed during the PD&E and subsequent phases to ensure the project is buildable and biddable.

1.7.4 Cost Estimate

A preliminary order of magnitude cost estimate was developed for each alternative. Cost components associated with improvements include bridge structures, track, tunnel, stations, roadway, sitework, special conditions, rail signals/communications, construction, right of way, professional services, and operations & maintenance (O&M). **Table 3** shows the preliminary costs associated with each alternative.

Table 3: Preliminary Cost Estimate

Construction Costs	Alternative 1 Low Level Bascule Bridge (21 feet)	Alternative 2 Mid-Level Bascule Bridge (55 feet)	Alternative 3 High-Level Fixed Bridge (80 Feet)	Alternative 4 Tunnel
Structures	$50,170,640	$214,940,440	$245,477,908	$1,714,960
Track	$12,074,010	$15,402,114	$15,402,114	$15,409,030
Tunnel (including track, ventilation, emergency evacuation, fire suppression)	N/A	N/A	N/A	$2,315,256,047
Stations	N/A	$23,378,228	$23,378,228	$49,632,656
Roadway	$399,100	$2,772,900	$2,772,900	$1,078,350
Sitework and Special Conditions	$3,182,362	$10,207,549	$9,962,674	$8,909,927
Utility Relocation Allowance	$1,000,000	$2,800,000	$3,100,000	$8,000,000
Rail Signals/ Communications	$16,587,901	$17,430,183	$16,191,787	$17,357,371
Construction Cost	$83,414,013	$286,931,414	$316,285,611	$2,417,358,341
Right of Way Costs	$21,100,000	$54,200,000	$48,600,000	$53,400,000
Professional Services	$29,820,510	$102,577,980	$113,072,106	$864,205,607
Total Project Costs	**$134,334,523**	**$443,709,394**	**$477,957,717**	**$3,334,963,948**
Operations and Maintenance Cost ($/Year)	**$1,900,000**	**$3,300,000**	**2,400,000**	**$8,200,000**

1.8 Conclusion

1.8.1 Conclusions

The following are the consensus of the conclusions reached by the FDOT as part of this study:

- All alternatives were determined to be feasible and should be further developed and evaluated in the PD&E phase.
- Potential Section 4(f) and Section 106 resources will need to be further evaluated in the PD&E phase. At this time, this study did not determine a fatal flaw, however, additional coordination with the FDOT, FTA, stakeholders, and consultation parties will be needed as part of the PD&E study to provide appropriate documentation of identified environmental resources and whether there any adverse effects to environmental resources.
- Appropriate level of documentation to meet NEPA requirements will be on going and will be part of the PD&E phase.
- An in-depth traffic analysis should be conducted as part of the PD&E study to determine how local Downtown Fort Lauderdale traffic will be impacted by the various bridge crossing alternatives.
- A vessel survey update will need to be conducted as part of the PD&E study.
- A benefit cost analysis should be conducted as part of the PD&E phase to determine the life cycle benefits to the initial capital cost investment of the project.

1.8.2 Additional Considerations

Prior to initiation of a PD&E study, an agreement between the railroad owner and the public sector for public access and use of the rail corridor is required. The potential for the addition of a freight track to the east of the existing freight track alignment, and a review of the remaining lifespan of the existing freight bascule bridge should be considered. This will allow for an environmental assessment (PD&E) to minimize right of way impacts and costs, business damages and potential relocations, access impacts within the immediate river crossing vicinity, impacts to recreational or historic properties (Section 4(f) & Section 106) and potentially extend the life cycle of the existing freight bascule bridge. This study identified additional options that should be considered as part of the PD&E phase.

Option 1:

To achieve a shorter construction duration impact on freight and passenger operations, the existing bascule bridge could be relocated to the east within the railroad right of way with the construction of new foundations and a lifting and resetting of the existing bascule bridge mechanical equipment and bridge deck. This will allow 13 to 15 feet of additional horizontal distance for the construction of any of the bridge alternatives examined in this study.

Option 2:

A second option would be the addition of a new freight track to the east of the existing Track 2, and re-construction of the bascule bridge, thereby reducing the footprint of the new bascule bridge serving freight operations. This allows for additional horizontal space to locate the new passenger tracks and bridge structures within the existing right of way. This additional right of way will potentially allow the proposed Low-Level Bascule Bridge alternative 5 to 11 feet of additional space for improvements, resulting in minimal impact to the existing angle parking on SW 2nd Avenue, and maintain access to the businesses and Historic Society buildings north of the river and have no impacts to the existing boat storage facility on the river's south bank. For the Mid-Level Bascule Bridge and High-Level Fixed Bridge alternatives, the new freight track will provide additional right of way to construct the foundations and support columns for the bridge alternatives and will maximize the use of the existing right of way while minimizing impacts to parking along SW 2nd Avenue north of the river.

The limits of the additional freight track to the east of the existing freight Track 2, will be consistent with the limits of the track impacts identified for each of the bridge alternatives. These limits range from approximately 5,740 feet (1.1 mile) for the Low-Level Bascule Bridge alternative to approximately 13,215 feet (2.5 miles) for the Mid-Level Bascule and High-Level Fixed Bridge alternatives.

2.0 INTRODUCTION

2.1 Background

The New River Crossing Feasibility Study is a continuation of the Tri-Rail Coastal Link (TRCL) Transit Analysis Study. Legislative Specific Appropriation 1939 passed in July 2019 initiated the need to evaluate alternatives at the existing Florida East Coast (FEC) New River crossing. Currently, freight (FEC) and passenger (Virgin Trains/Brightline) trains utilize the existing FEC rail crossing over New River. The legislation outlines the utilization of resources from the State Transportation Trust Fund that allows the Florida Department of Transportation (FDOT) to update the Tri-Rail Coast Link Study (formerly known as the South Florida East Coast Corridor Transit Study) Phase 2 Navigable Waterway Analysis Technical Memorandum (see **Appendix A**).

2.2 Project Location

The New River is a major waterway that winds through the Fort Lauderdale Central Business District (CBD) in Broward County. West of the CBD, the river splits into the North and South Forks, shallow meandering tributaries of the New River which are bordered primarily by residences with private docks.

The limits of this study run parallel to Andrews Avenue along the FEC Railway Corridor from approximately Sunrise Boulevard (northern terminus) to SW 15th Street (southern terminus). The total length of the study is approximately 2.5 miles (refer to **Figure 3**).

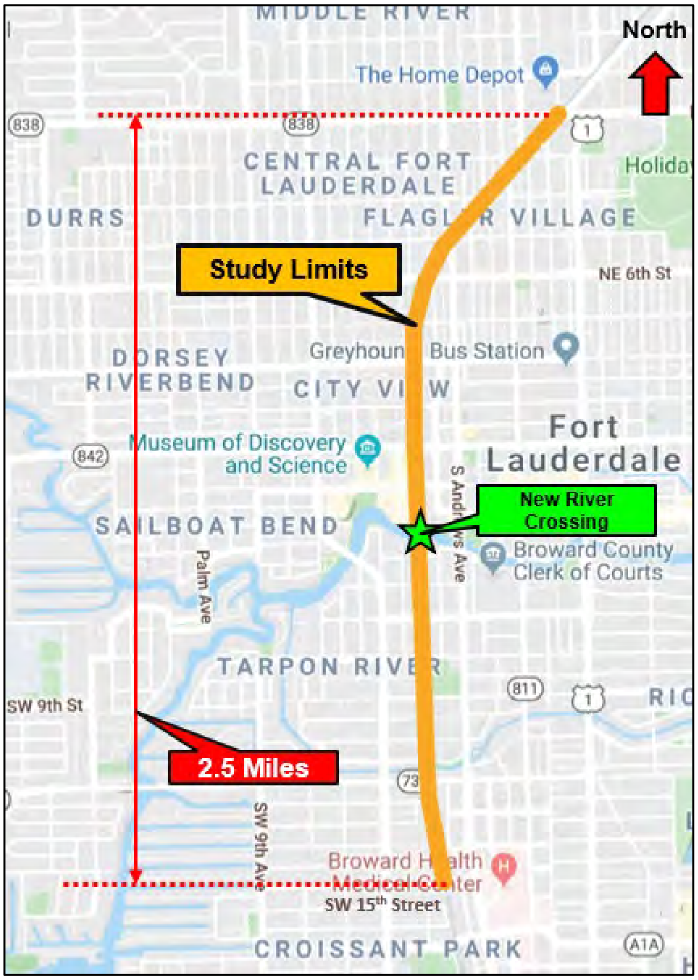


Figure 3: Location Map

2.3 Objective

The objective of the study is to evaluate the feasibility of a rail crossing at the New River to provide a solution which will meet reasonable needs of navigation, freight trains, and passenger trains within the crossing area. This study includes the evaluation of several crossing alternatives including movable bridges of various vertical clearances, a fixed bridge, and tunnel concepts to identify feasible alternatives that could be advanced into the Project Development and Environment (PD&E) Study phase. The study also includes a preliminary identification of environmental and right of way impacts, a summary of cost estimates, and identification of potential funding sources to comply with the requirements of Legislative Specific Appropriation 1939. The preliminary conclusions of the alternatives in this study will be supplemented further with in-depth evaluations during the PD&E phase. The PD&E phase will determine if any of the alignments discussed in this study would be recommended, and additional alternatives may be developed and evaluated during the PD&E phase.

3.0 EXISTING CONDITIONS

The existing FEC Railway Railroad Bridge crosses the New River in a north/south direction on a tangent alignment. The existing bridge carries two tracks on 13'-0" track centers, approximately 210 feet in length and 30 feet wide. The bridge approach span on the north riverbank is 75 feet with an 85-foot bascule span followed by another 51 feet of bridge approach span on the south riverbank. The existing horizontal clearance is ± 60 feet (**Figure 4**). The associated foundation and mechanical equipment for the bascule operations is on the north approach to the bridge opening. The existing clearance from Mean High Water (MHW) to the bottom of the bascule structure in the closed position is approximately 4.5 feet. The foundations at the approach spans consist of cast-in-place concrete caps and a single row of 20" pre-stressed concrete piling driven into fractured limestone. The foundations for the bascule span consist of cast-in-place concrete piers on a cap of 20" pre-stressed concrete piling driven into fractured limestone. **Figure 4** and **Figure 5** show the existing bascule bridge over New River looking west and looking south in the open position, respectively.

Figure 4: Existing FEC bridge over New River - Looking West (Open Position)

Figure 5: Existing FEC bridge over New River - Looking South (Open Position)

3.1 Existing Land Use

Figure 6 shows the existing land use surrounding the study limits. As shown, the study corridor is adjacent to Retail/Office, Industrial, and Residential land uses. However, there are several locations where recreation/park land use areas were identified adjacent or within the study area such as Sistrunk Park, Riverwalk Linear Park, Florence C. Hardy & Southside Park, Tarpon River Park, Esplanade (Discovery) Park, Bubier Park/Huizenga Plaza, and Marshall Point.

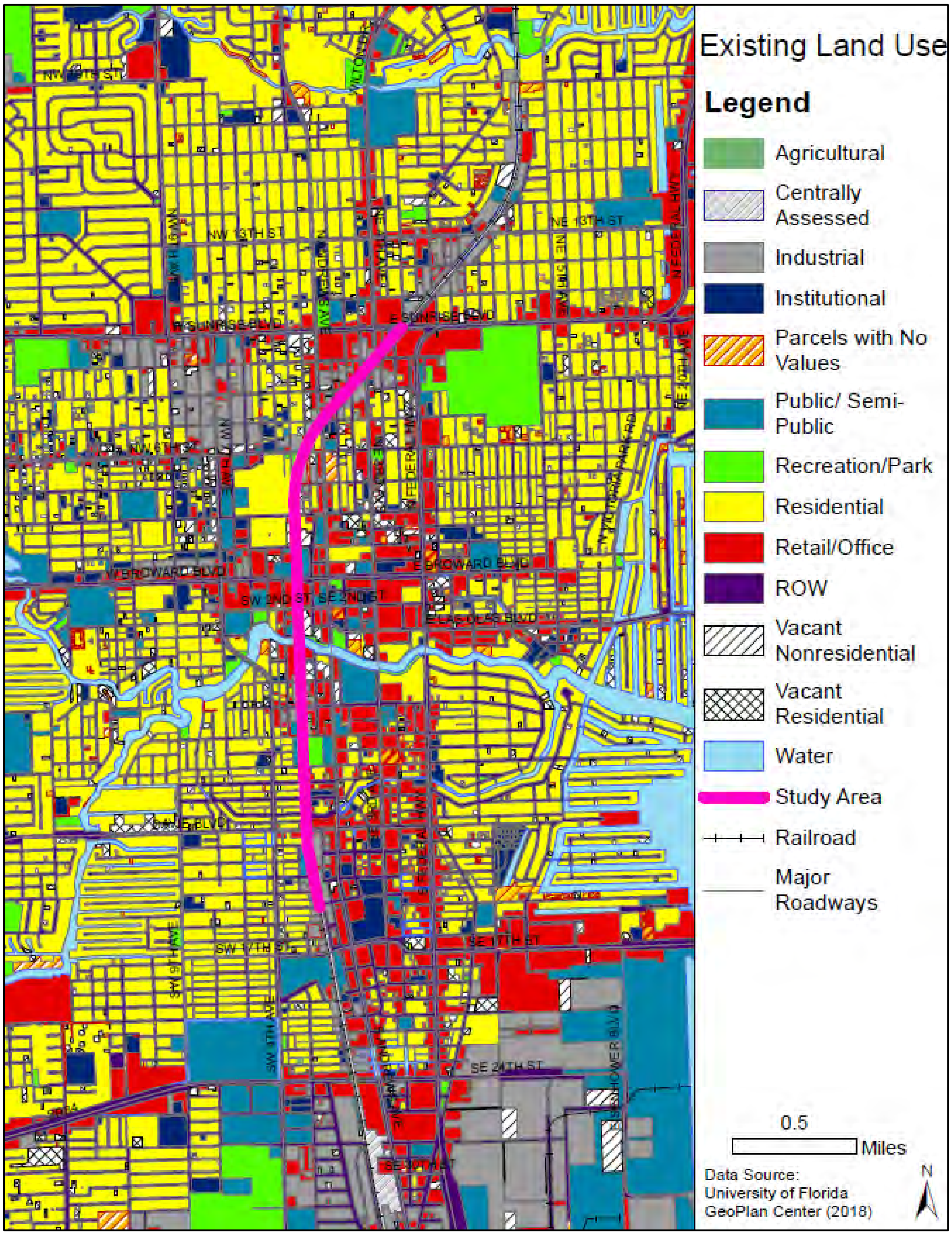


Figure 6: Existing land use map surrounding the study limits

3.2 Existing New River Crossings

Several bridges, including the aforementioned FEC Railway Railroad Bridge, cross the New River. Except for I-95, these bridges are movable (e.g., bascule) and either open upon request or on a schedule through coordination with the United States Coast Guard (USCG). The exception is the FEC Railway Railroad Bridge that remains in the open position offering virtually unlimited clearance until a freight and/or passenger train approach. In the down position, the FEC Railway Bridge has a vertical clearance of 4.5 feet. West of the FEC Railway Bridge, navigational vertical clearance is limited by two features along the South Fork of the New River, overhead power cables with a height of 80 ft and Interstate 95 (I-95) with a vertical clearance of 55 ft. See **Figure 7** and **Table 4** for the vertical clearances over existing river crossings. Vertical clearance refers to the distance from the Mean High Water (MHW) to the lowest structural member of a bridge's underside.

Figure 7: Location map of crossings over New River

Table 4: Existing vertical clearances over New River

Location	Crossing	Vertical Clearance
1	SE 17th Street[2]	55 ft*
2	SE 3rd Avenue[2]	16 ft*
3	South Andrews Avenue[2]	21 ft*
4	FEC Railroad[1,2]	4 ft*
5	FPL Transmission Line	80 ft
6	SW 4th Avenue[2]	20 ft*
7	Davie Boulevard[2]	21 ft*
8	Interstate 95	55 ft

*[1]Location of this Study | [2]Existing Movable Bridge | *Vertical clearance in down position.*

3.3 Existing New River Crossing Openings/Closings

According to the Phase 2 Navigable Waterway Analysis Technical Memorandum (November 2009), a boat survey was performed in April 2011 which identified 425 vessels upstream of the SE 3rd Avenue and South Andrews Avenue bridges that would require bridge openings. It was estimated that approximately 30 percent of the 2,592 vessels traversing the New River upstream of SE 3rd Ave have a vertical clearance requirement greater than 20 feet at the time the boating survey was completed and analyzed. According to the 2018 South Andrews Avenue Bridge Opening Logs, a total of 8,197 vessels were recorded from January to July of 2018. As part of this study, it is assumed that 95% of the South Andrews Avenue Bridge vessels (7,787 vessels) also traverse the existing New River crossing with the existing FEC Railway Railroad Bridge. Note that in coordination with maritime stakeholders, this data was obtained during off-season and vessel traffic would likely be higher in the second half of the year. **Table 5** summarizes the number of bridge vessel counts from January to July of 2018. Data from the 2019 FEC/ Virgin Trains (Brightline) New River Bridge Schedule indicates a range of 653 to 662 bridge closures are anticipated.

Table 6 and **Table 7** show FEC Railway bridge monthly closure data and hourly closure (schedule), respectively. On average, about 21 daily closures are anticipated from October to December of 2019. An updated vessel survey will be conducted as part of the PD&E study phase to obtain more recent data representative of the maritime operational conditions.

Table 5: South Andrews Avenue & FEC Railway Bridge Vessel Counts – 2018 South Andrews Avenue Bridge Opening Log

2018*	South Andrews Avenue** Number of Vessels	FEC Railway Bridge Number of Vessels***
January	1,075	1,021
February	1,214	1,153
March	1,552	1,474
April	1,301	1,236
May	1,088	1,034
June	1,084	1,030
July	883	839
Total	**8,197**	**7,787**

(*) Data retrieved from the 2018 Andrews Avenue Bridge Openings Logs
(**) South Andrews Avenue bridge closed during rush hour times (7-9 AM & 4-6 PM)
(***) Assumes 95% of vessels crossing South Andrews Avenue Bridge would also cross the FEC Railway Bridge

Table 6: FEC Railway Bridge Monthly Closure Data

2019*	Number of Closures	Weekday Totals	Weekend Totals	Weekday Average	Weekend Average	Average Daily Closures
October	653	506	147	24	18	21
November	672	527	145	25	16	22
December	662	526	135	24	15	21

(*) Data retrieved from the 2019 FEC/Virgin Trains (Brightline) New River Bridge Schedule

Table 7: FEC Railway Bridge Average Hourly Closure (Schedule)

Average Weekday Freight Train Closure Times*	Average Weekday Virgin Trains (Brightline) Closure Times**	Average Weekend Freight Train Closure Times*	Average Weekend Virgin Trains (Brightline) Closure Times**
12:15 AM – 12:35 AM	6:30 AM – 6:45 AM	12:45 AM – 1:05 AM	8:30 AM – 8:45 AM
1:15 AM – 1:35 AM	7:00 AM – 7:15 AM	1:15 AM – 1:35 AM	9:30 AM – 9:45 AM
2:15 AM – 2:35 AM	7:30 AM – 8:15 AM	5:15 AM – 5:35 AM	11:30 AM – 11:45 AM
2:45 AM – 3:05 AM	9:00 AM – 9:15 AM	7:30 AM – 8:05 AM	12:30 PM – 12:45 PM
4:30 AM – 5:05 AM	11:00 AM – 11:15 AM	10:15 AM – 10:45 AM	1:30 PM – 1:45 PM
5:15 AM – 5:45 AM	12:00 PM – 12:15 PM	2:15 PM – 2:45 PM	3:30 PM – 3:45 PM
7:30 AM – 8:15 AM	2:00 PM – 2:15 PM	7:15 PM – 7:45 PM	4:30 PM – 4:45 PM
10:00 AM – 10:35 AM	3:00 PM – 3:15 PM	11:15 PM – 11:45 PM	5:30 PM – 5:45 PM
1:00 PM – 1:35 PM	4:00 PM – 4:15 PM		6:30 PM – 6:45 PM
5:30 PM – 6:35 PM	5:00 PM – 5:15 PM		8:30 PM – 8:45 PM
8:00 PM – 8:35 PM	5:30 PM – 6:35 PM		9:30 PM – 9:45 PM
9:45 PM – 10:15 PM	7:00 PM – 7:15 PM		10:30 PM – 10:45 PM
11:30 PM – 12:05 AM	9:00 PM – 9:15 PM		

(*) Weekday Average: 12 Freight Train Closures lasting 30-40 minutes per closure
13 Virgin Trains (Brightline) Closures lasting 15-20 minutes per closure
(**) Weekend Average: 9 Freight Train Closures lasting 20-35 minutes per closure
10 Virgin Trains (Brightline) Closures lasting 15-20 minutes per closure

4.0 ENVIRONMENTAL RESOURCES

The National Environmental Policy Act (NEPA) requires all federal agencies to go through a formal process before taking any action anticipated to have substantial impact on the environment. Enacted in 1969 and signed into law in 1970, part of the NEPA process requires assessment of the potential environmental impact of proposed actions in accordance with NEPA policy goals. The primary responsibility for overseeing implementation of NEPA rests with the Council of Environmental Quality (CEQ), which was created by the U.S. Congress as part of NEPA. CEQ promulgated regulations in 40 Code of Federal Regulations (CFR) parts 1500-1508 for implementing he procedural provisions of NEPA.

A transportation federal action requires the development of an environmental document to satisfy NEPA policies and procedures. The FDOT's procedure for complying with NEPA is outlined in the Project Development and Environment (PD&E) Manual.

A project is considered a federal action if one of the following conditions exists and must comply with NEPA:

1. Federal funds or assistance is or is expected to be used during any phase of project development or implementation;
2. Federal funding or assistance eligibility is being maintained for subsequent phases;
3. Consultation with the federal permitting agency results in the determination that a FDOT NEPA document is required to support the permit;
4. Federal approval of an action is required.

The Class of Action (COA) of a project establishes the level of documentation required in the NEPA process. The following outlines the three different classes of action:

1. Environmental Impact Statement (EIS) (Class I) – Applies to actions that significantly affect the environment as defined by CEQ regulations.
2. Categorical Exclusion (CE) (Class II) – Applies to actions that do not individually or cumulatively have significant environmental effect.
3. Environmental Assessment (EA) (Class III) – Applies to actions in which the significance of the environmental impact is not clearly established. All actions that are not Class I or Class II are Class III. All actions in this class require the preparation of an EA to determine the appropriate environmental documentation required. Depending on the significance of the impact, an EA will result in a Finding of No Significant Impact (FONSI) or an EIS if the analysis indicates significant environmental impacts.

Table 8 outlines the environmental resources to be identified and evaluated with proposed action to comply with NEPA. This study conducted a preliminary identification of potential environmental resources for consideration for on-going project development efforts. There was limited data available during this study, however, the following potential environmental resources were identified:

- Floodplains
- Section 4(f) and Recreation Areas
- Archaeological and Historic Resources

At the conclusion of this study, additional analysis will need to be completed in the PD&E phase in order to comply with NEPA.

Table 8: Environmental Resources

Social and Economic
Social
Economic
Land Use Changes
Mobility
Aesthetics
Relocation Potential
Farmland
Cultural
Historic & Archaeological
Section 4(f) and Recreation Areas
Natural
Protected Species Habitat
Wetlands and Other Surface Waters
Essential Fish Habitat
Floodplains
Water Quality and Stormwater
Aquatic Preserves and Outstanding Florida Waters
Wild and Scenic Rivers
Coastal Barrier Resources
Physical
Noise
Air Quality
Contamination
Utilities and Railroads

4.1 Floodplains

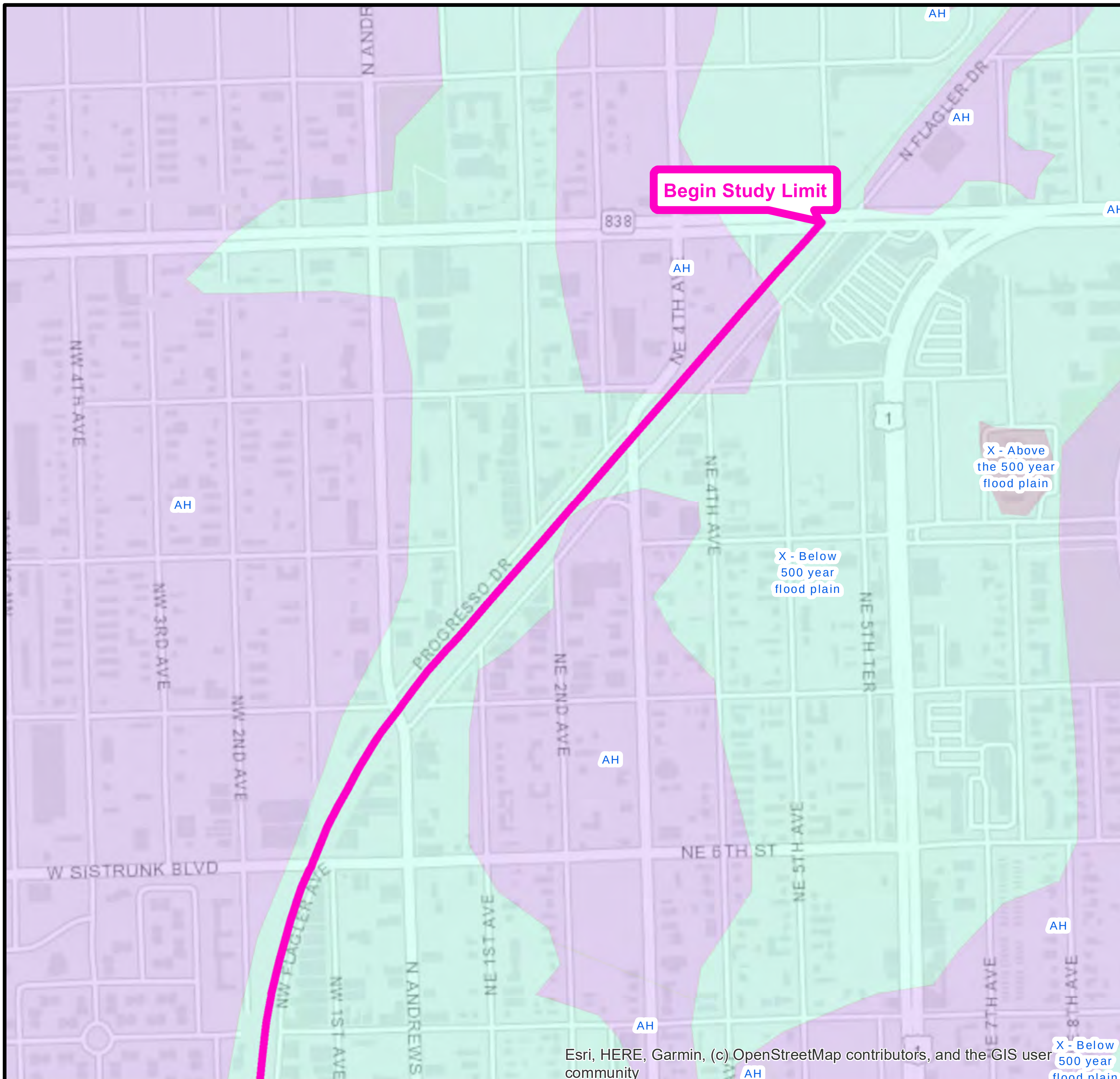
The entire portion of the study area is in either Zone AE, AH, or Zone X (on the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRM) Panels 12011C0369H and 12011C0557H. See Figure 8 to Figure 12 for the flood zones with respect to the study limits. Table 9 provides a description of the flood zone designations.

Table 9: Flood Zone Designations

Designation	Definition
Zone AE	Flood insurance rate zone that corresponds with flood depths greater than 3 feet. Mandatory flood insurance purchase requirements apply.
Zone AH	Flood insurance rate zone that corresponds to areas of shallow flooding with average depths between 1 and 3 feet. Mandatory flood insurance purchase requirements apply.
Zone X	Flood insurance rate zones that are outside the flood plain or the average flood depths of less than 1 foot. Flood insurance purchase is not mandatory.

Since there are some areas of the study limits that would likely encroach on the 100-year floodplain, an evaluation with respect to the following should be conducted in the PD&E phase: the level of flooding risk; effects on beneficial floodplain values; the extent to which the project may support incompatible floodplain development; and measures to minimize floodplain impacts and to preserve beneficial floodplain values. The floodplain assessment would state whether the county or other local jurisdiction is a participant in the National Flood Insurance Program (NFIP) and should be included in the NEPA document.

Executive Order 11988, Floodplain Management, requires federal agencies to avoid actions, to the extent practicable, which will result in the location of facilities in floodplains and/or affect floodplain values. As the project progresses, hydraulic studies will be carried out to ensure that the project will not increase base flood elevations to a level that will violate applicable floodplain regulations and ordinances.



New River Bridge Feasibility Study

Floodplains

FDOT

LEGEND

New River Crossing

Study Limits

Flood Zone

AE

AH

AREA NOT INCLUDED

X - Above the 500 year flood plain

X - Below 500 year flood plain

Credit: FEMA

The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1 percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA).

Figure 8

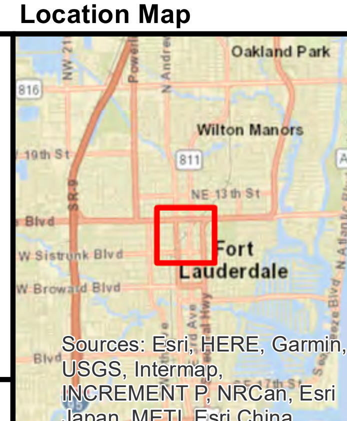
Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

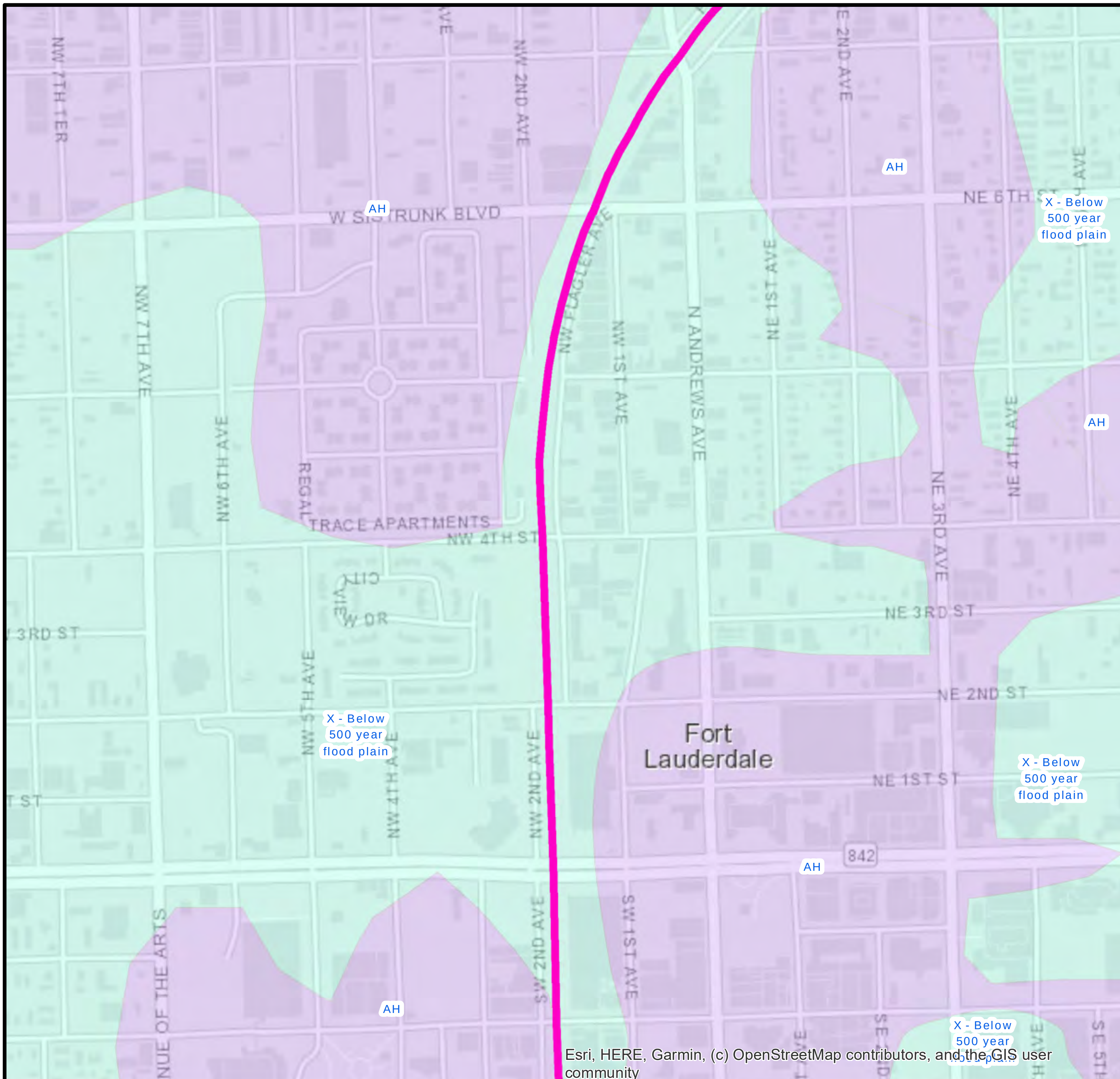
N

350 Feet

Broward County

Location Map





New River Bridge Feasibility Study

Floodplains

FDOT

LEGEND

☆ New River Crossing

Study Limits

Flood Zone

- AE
- AH
- AREA NOT INCLUDED
- X - Above the 500 year flood plain
- X - Below 500 year flood plain

Credit: FEMA

The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1 percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA).

Figure 9

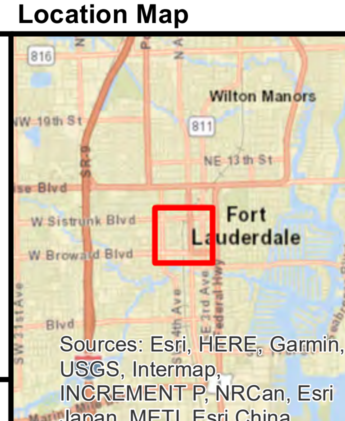
Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

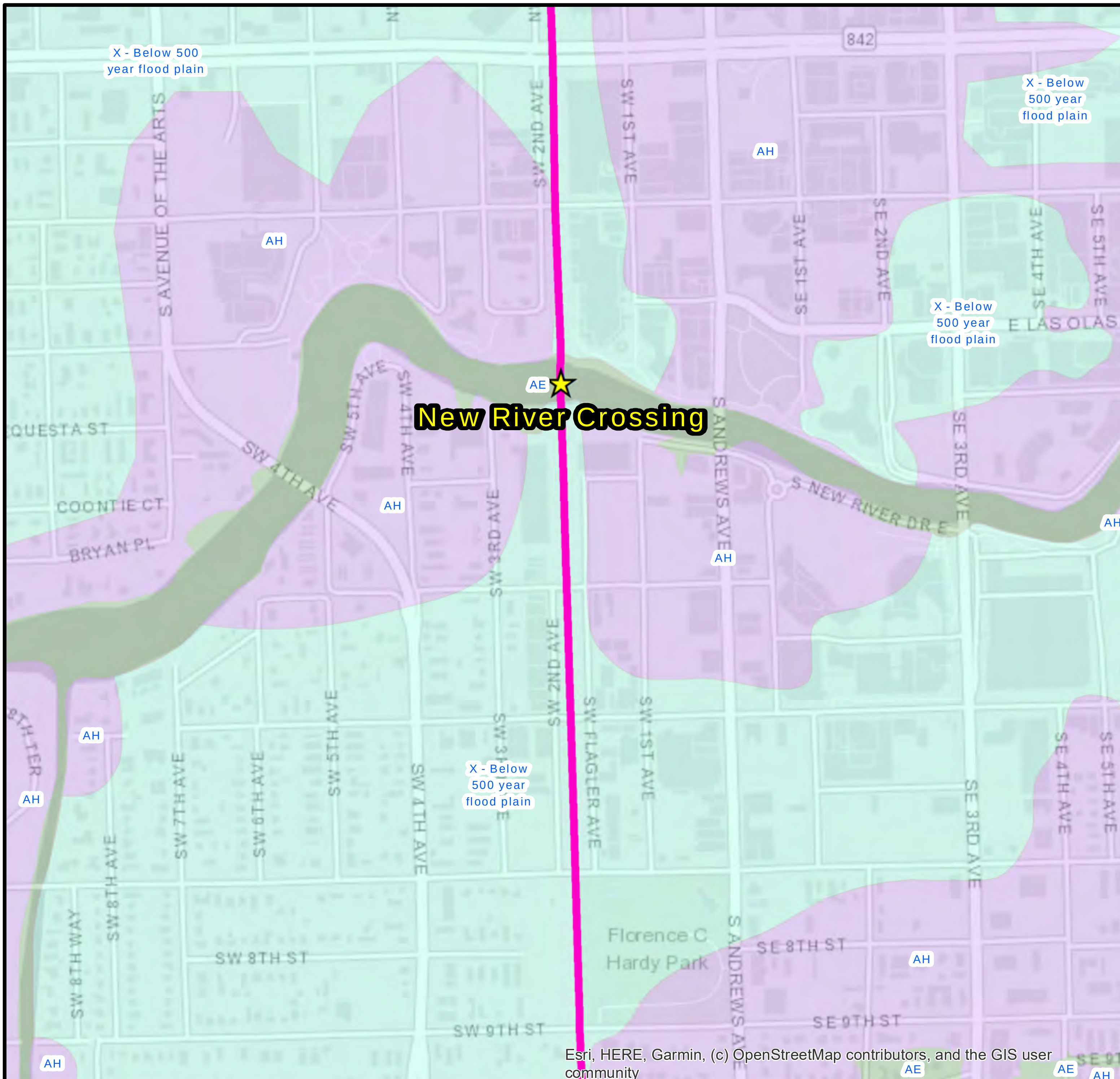
N

350 Feet

Broward County

Location Map



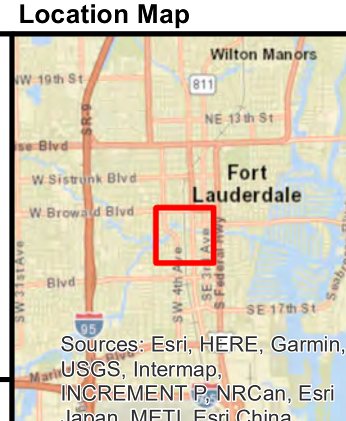


New River Bridge Feasibility Study

Floodplains

FDOT

Location Map



N

350 Feet

LEGEND

- New River Crossing
- Study Limits

Flood Zone

- AE
- AH
- AREA NOT INCLUDED
- X - Above the 500 year flood plain
- X - Below 500 year flood plain

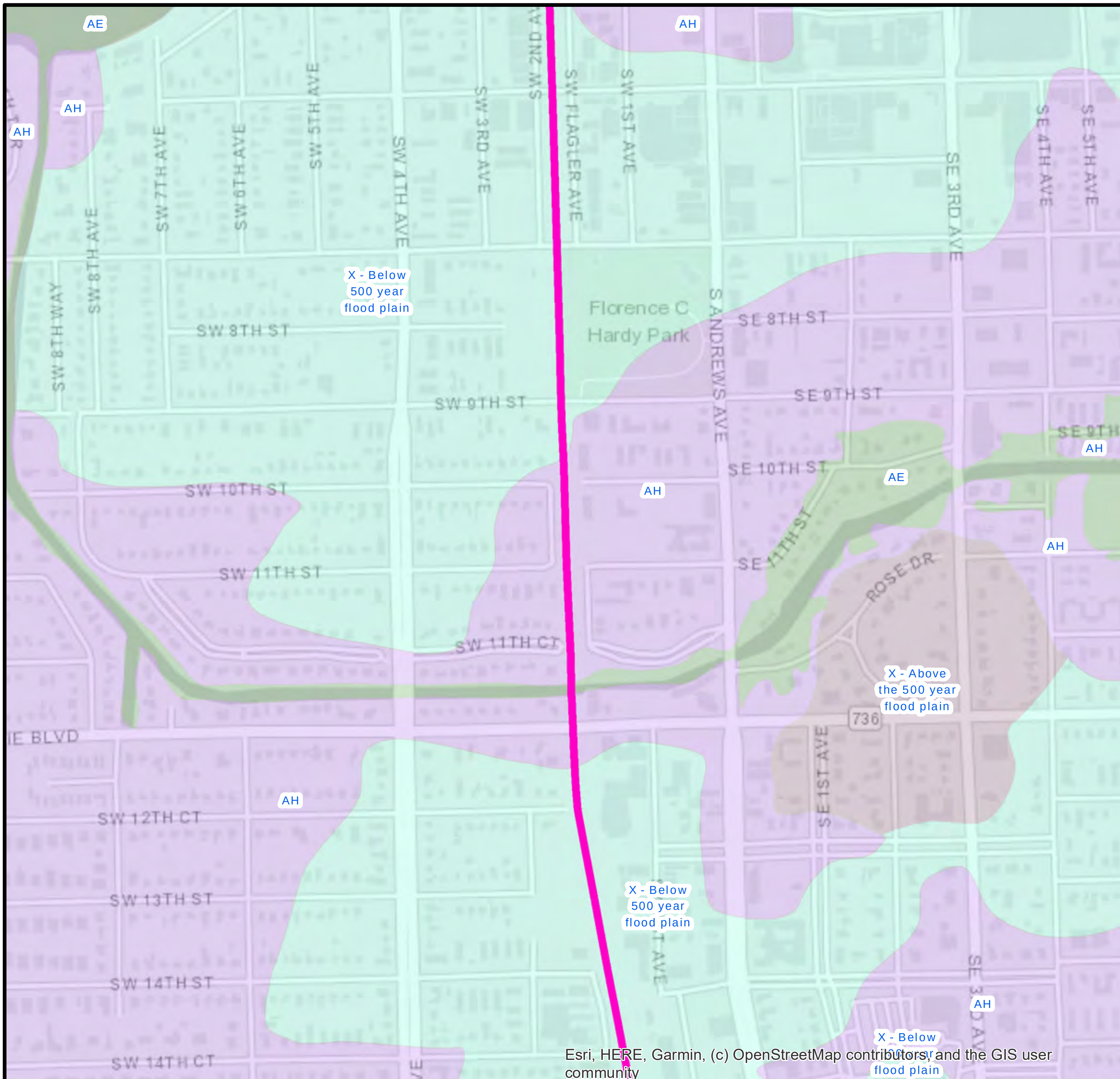
Credit: FEMA

The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1 percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA).

Figure 10

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County

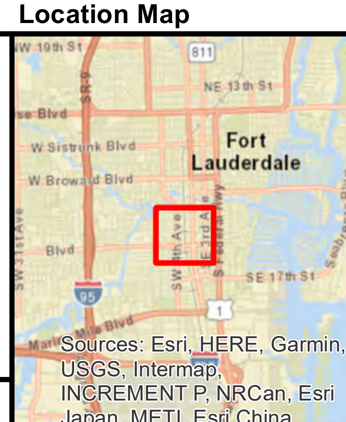


New River Bridge Feasibility Study

Floodplains

FDOT

Location Map



N

350
Feet

LEGEND

- ☆ New River Crossing
- Study Limits

Flood Zone

- AE
- AH
- AREA NOT INCLUDED
- X - Above the 500 year flood plain
- X - Below 500 year flood plain

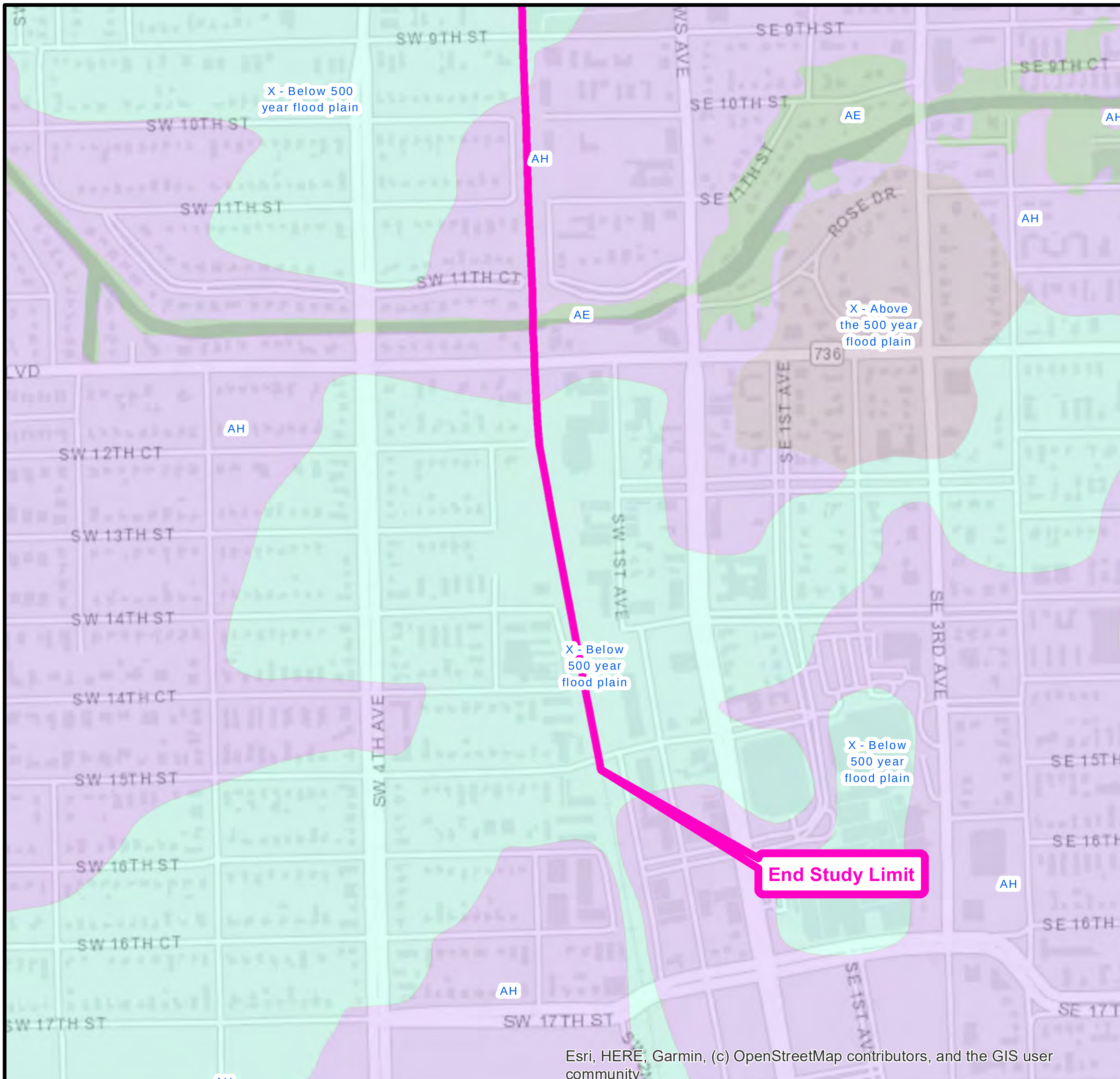
Credit: FEMA

The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1 percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA).

Figure 11

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Floodplains

LEGEND

New River Crossing

Study Limits

Flood Zone

AE

AH

AREA NOT INCLUDED

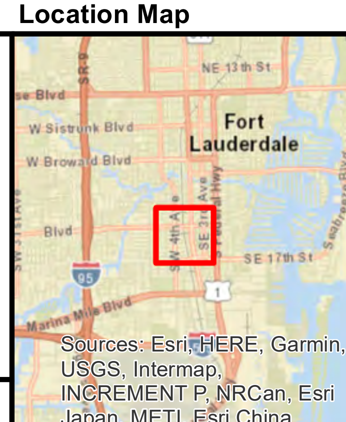
X - Above the 500 year flood plain

X - Below 500 year flood plain

Location Map

N

350 Feet



Credit: FEMA

The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1 percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA).

Figure 12

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County

4.2 Cultural Resources

4.2.1 Section 4(f)

Section 4(f) of the Department of Transportation Act of 1966, as amended, provides for the protection of certain public lands affected by transportation projects. Section 4(f) states that publicly owned parks, recreational lands, wildlife and waterfowl refuge areas, or historic sites of national, state, or local significance may not be used for United States Department of Transportation (USDOT) funded projects unless there is no feasible and prudent alternative to the use of such land, and such projects include all possible planning to minimize harm to these lands.

For determinations and approvals, Section 4(f) resources can be divided into two categories:

1. Publicly owned parks, recreation areas, and wildlife or waterfowl refuges
2. Historic and archaeological sites of national, state, or local significance in public or private ownership.

Section 4(f) only applies to publicly owned parks, recreation areas, and wildlife and waterfowl refuges that have been determined to be significant. Section 4(f) does not apply to privately owned parks, recreation areas, and wildlife or waterfowl refuges even if such areas are open to the general public. Section 4(f) applies to historic and archeological sites regardless of whether it is publicly or privately owned.

The FDOT PD&E Manual outlines the Section 4(f) analysis as the following:

1. Identification of properties which may represent Section 4(f) resources.
2. Initial consultations and determinations of the significance of potential Section 4(f) properties between the FDOT District and the appropriate Officials with Jurisdiction (OWJ).
3. Identification and documentation of the findings of "use" or "no use" of Section 4(f) resources. When there is no use of lands protected by Section 4(f), then the project does not require an approval under Section 4(f).
4. Documentation of the appropriate Section 4(f) approval option when an approval under Section 4(f) is required.

Additional data collection and analysis will be conducted in the PD&E phase.

4.2.2 Recreation/Park Areas

There are several publicly owned recreational facilities within the study area which may represent Section 4(f) resources: Sistrunk Park, Riverwalk Linear Park, Florence C. Hardy & Southside Cultural Center, Tarpon River Park, Esplanade (Discovery) Park, Stranahan Park, Peter Feldman Park, Holiday Park, Warfield Park, Bubier Park/Huizenga Plaza, Marshall Point, New River Boating Facility, and Cooley's Landing Marine Facility.

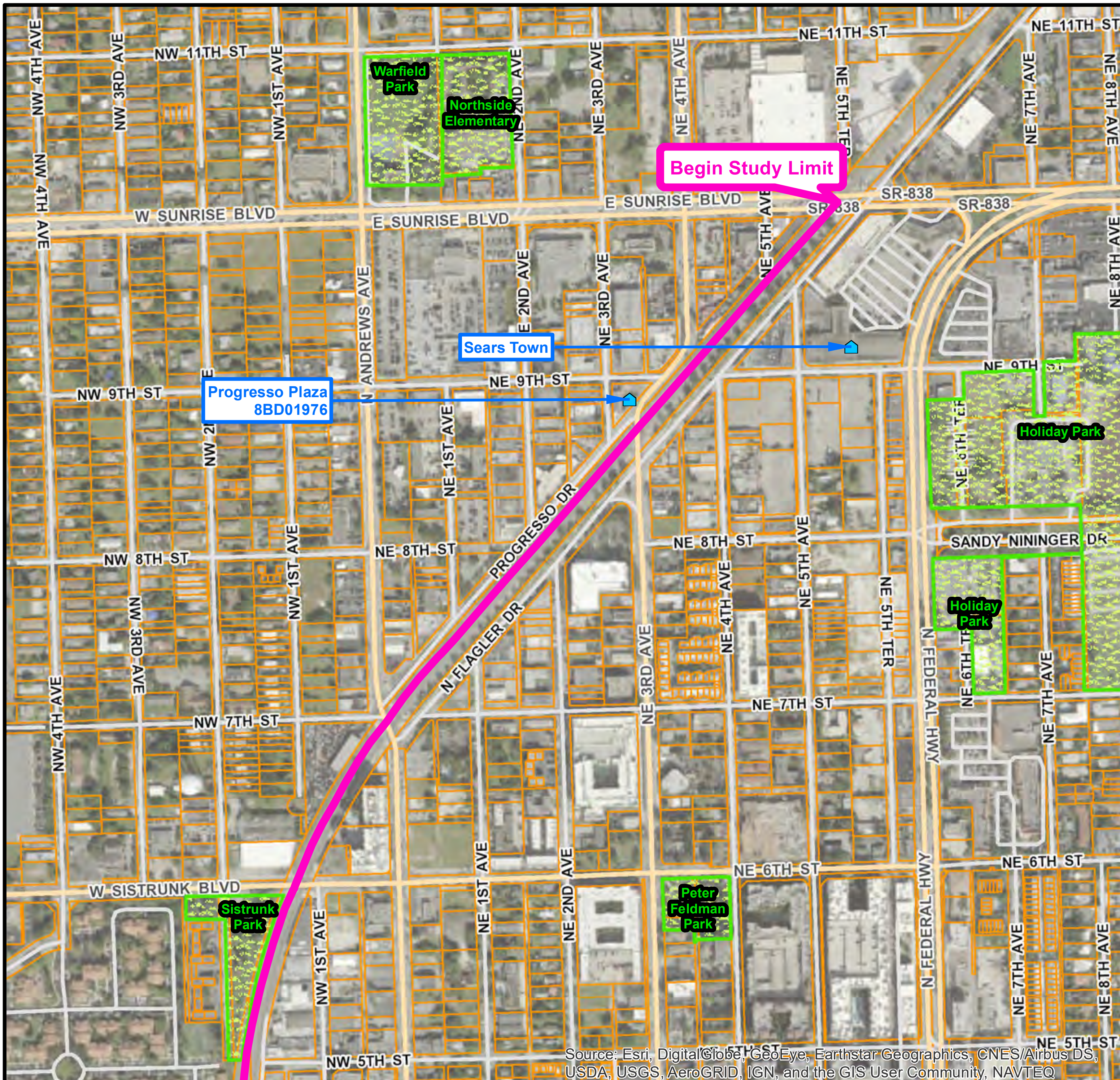
4.2.3 Section 106: Historic/Archaeological Resources

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires federal agencies to consider the effects on historic properties, and to assist, fund, permit, license, or approve throughout the country. It requires federal agencies to seek out consulting parties to request their views and participate in consultation regarding a project's effect on historic properties. The goal of consultation is to identify historic properties potentially being affected by the undertaking, assess its effects, and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties. Historic properties include any prehistoric or historic district, site, building, structure, or object considered eligible for listing on the National Register of Historic Places (NRHP). As a part of this effort, federal agencies must provide the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the undertakings.

Section 4(f) established the policy that a "special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites." Transportation projects that use publicly owned land of a public park, recreation area, or wildlife and waterfowl refuge of nation, state or local significance, or land of an historic site of national, state, or local significance may not be approved unless a determination is made that there is no feasible and prudent alternative, and that all possible planning has been done to minimize harm. Section 4(f) resources can be Section 106 resources in the case of historic sites. Under USDOT regulations (23 CFR § 771.135), historic sites qualify as Section 4(f) resources if they are on or are eligible for listing on the NRHP.

A preliminary review of the Florida Master Site File (FMSF) data was conducted to determine the potential for cultural resources within the study area that are listed, eligible, or considered eligible for listing in the NRHP. The following are several potential historic and archeological resources identified along with their FMSF ID Numbers within the study area: Sears Town, Progress Plaza (8BD0176), Broward Plasma Corp./Archaeology Museum (8BD01330), Bryan Tom M. Building (8BD00227), King-Cromartie House (8BD00062), New River Inn (8BD00063), Philemon Bryan House (8BD00212), Antique Car Museum, Himmarshee Street/SW 2nd Avenue Historic District (H-1), Fort Lauderdale Historic District (8BD181), and Brickell Block (8BD02916).

See **Figure 13** to **Figure 17** for the locations of potential section 4(f), historic and archeological resources with respect to the study limits. Additional data collection and analysis will be conducted in the PD&E phase.



New River Bridge Feasibility Study

Potential Cultural Resources

FDOT

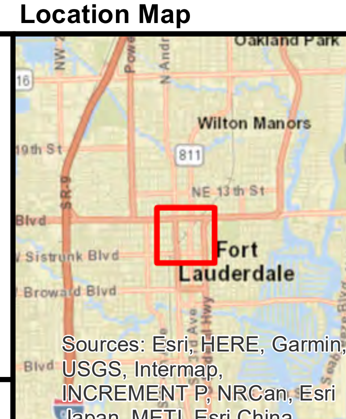
LEGEND

- New River Crossing
- Study Limits
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

N

330 Feet

Location Map

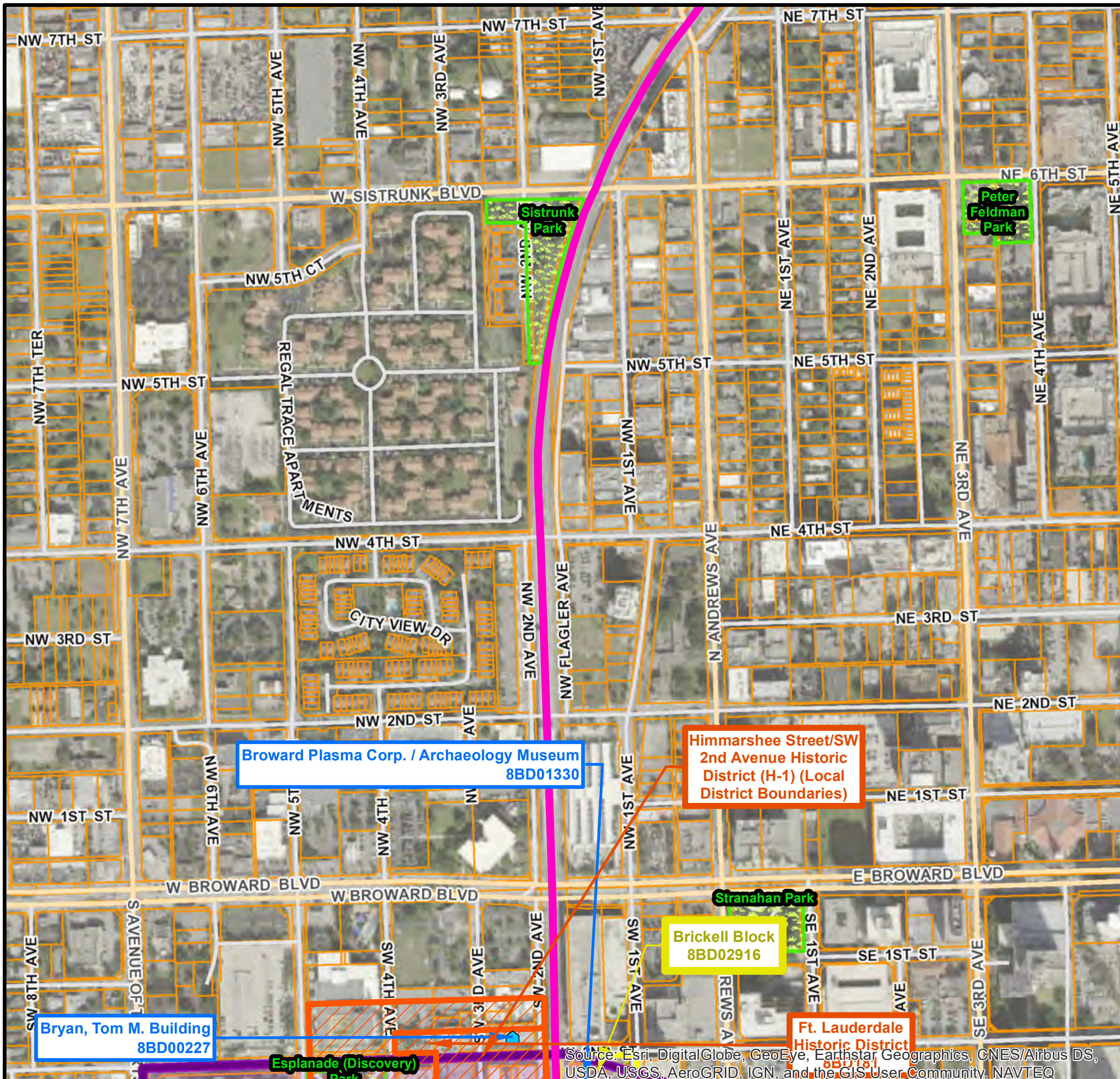


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 13

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Potential Cultural Resources

FDOT

LEGEND

- New River Crossing
- Study Limits
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 14

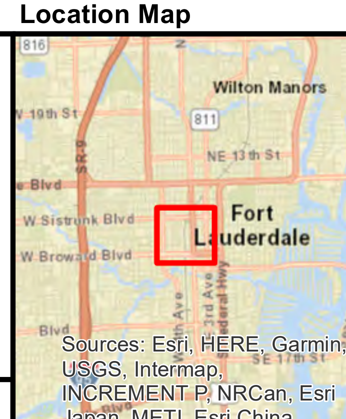
Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

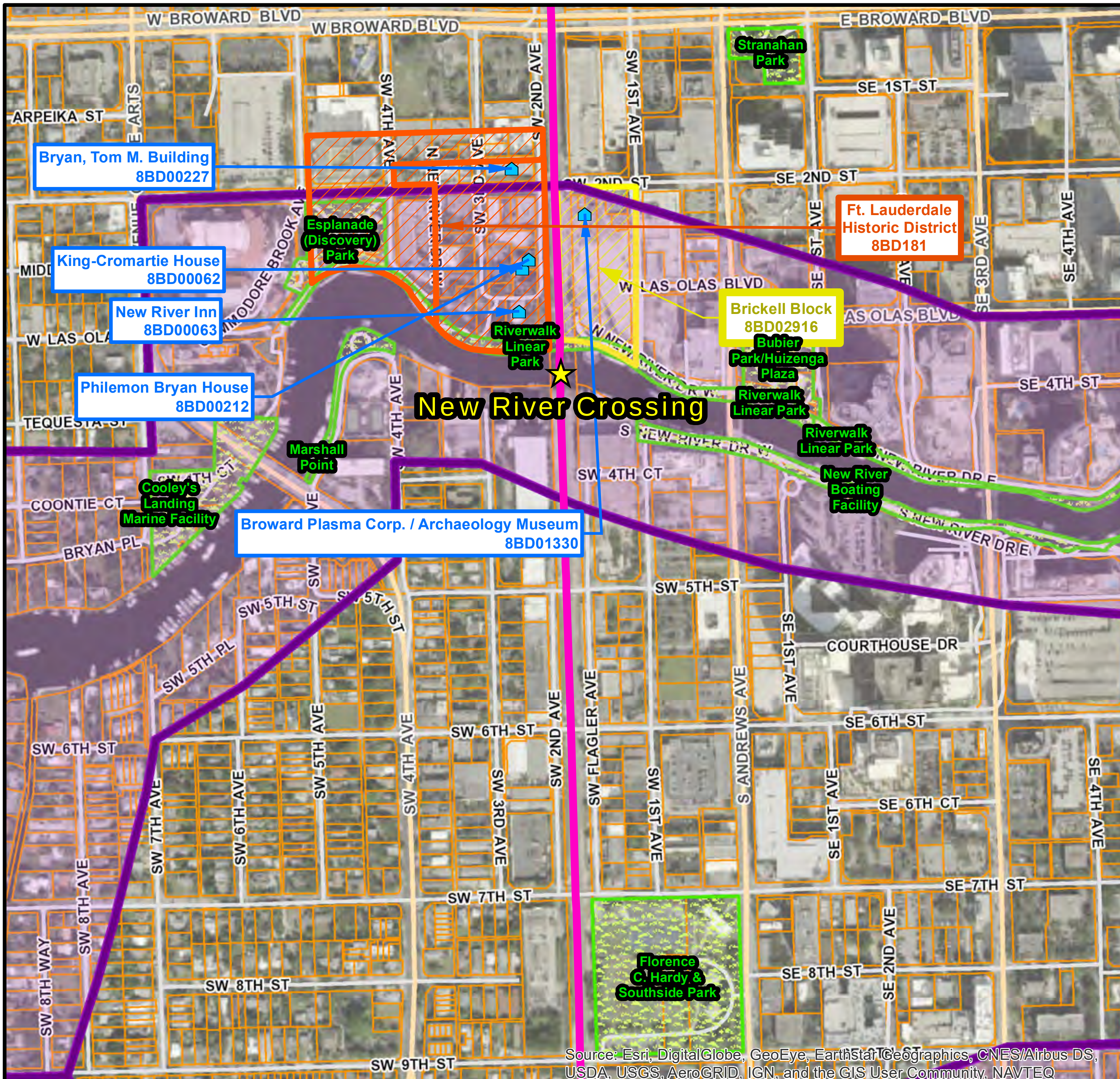
N

330
Feet

Broward County

Location Map





New River Bridge Feasibility Study

Potential Cultural Resources

FDOT

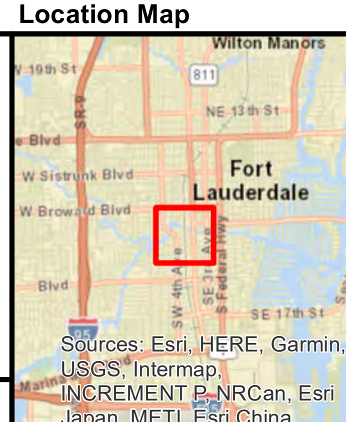
LEGEND

- ★ New River Crossing
- Study Limits
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

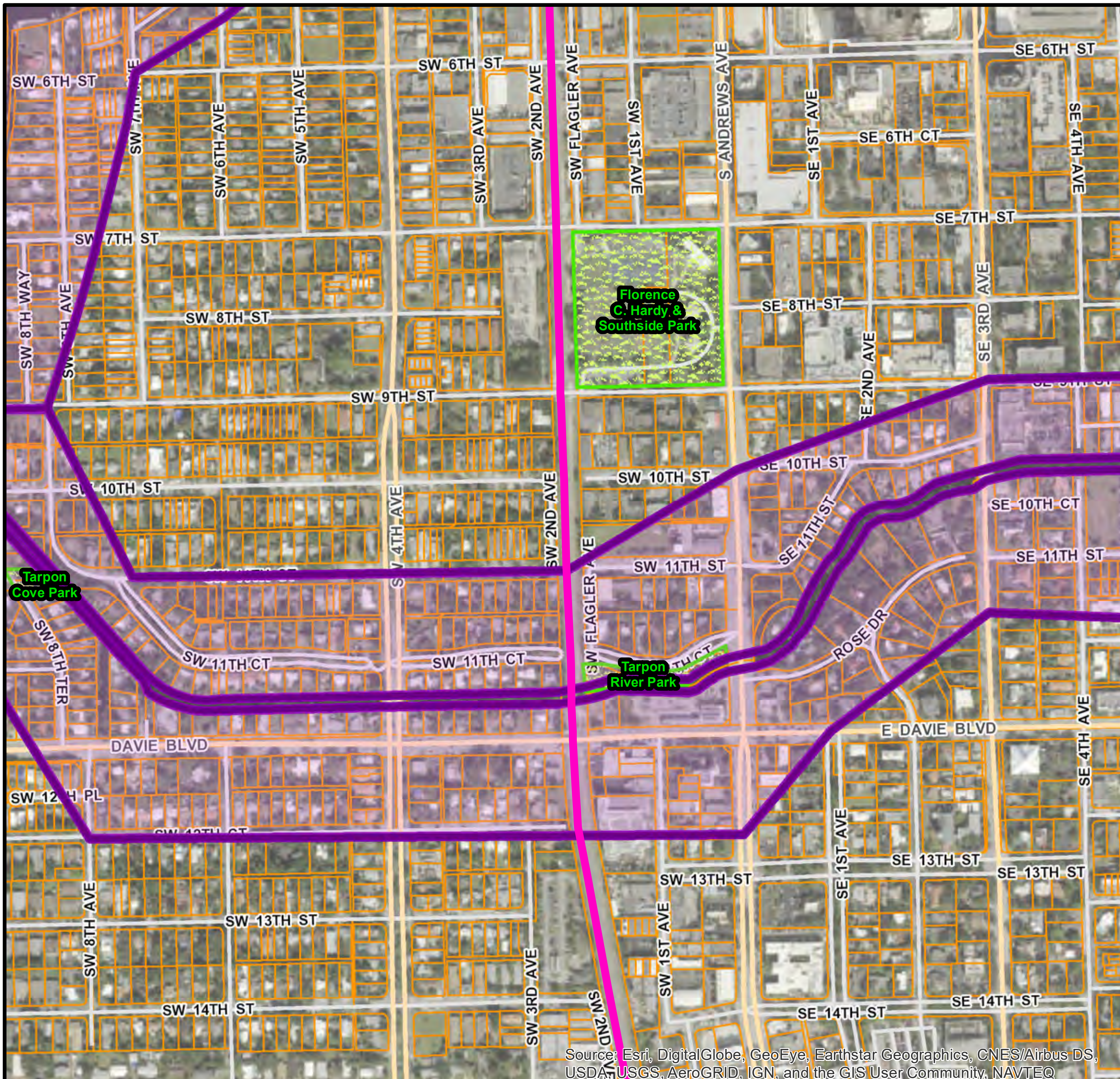


Broward County

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 15

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01



New River Bridge Feasibility Study

Potential Cultural Resources

FDOT

LEGEND

- New River Crossing
- Study Limits
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 16

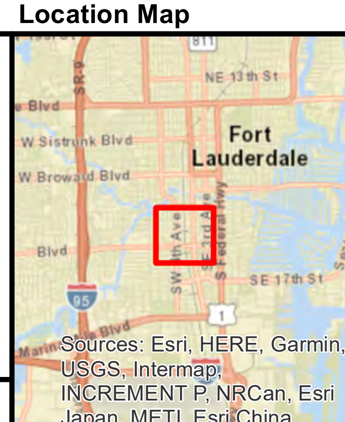
Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

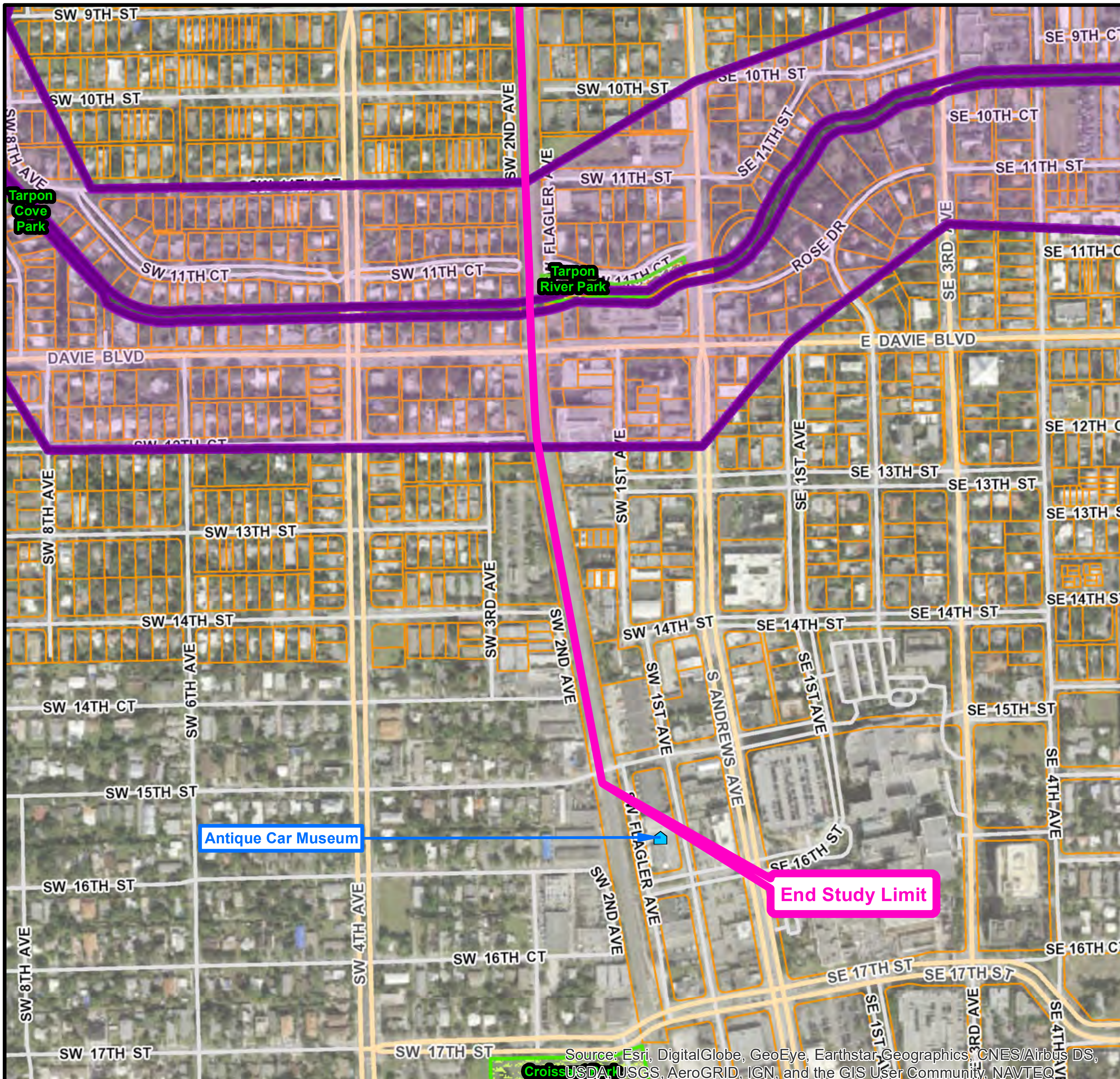
N

330 Feet

Broward County

Location Map





New River Bridge Feasibility Study

Potential Cultural Resources

FDOT

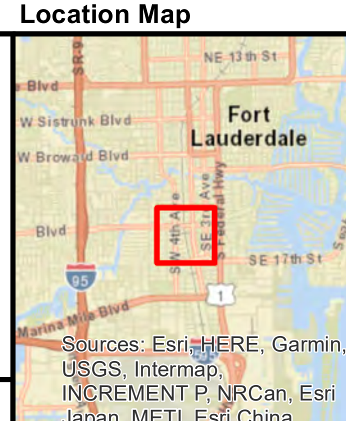
LEGEND

- New River Crossing
- Study Limits
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet



Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 17

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County

5.0 STAKEHOLDER COORDINATON

Stakeholder coordination meetings were conducted throughout the duration of the study to introduce the study and receive input during the evaluation process. Meeting notes are included in **Appendix B**. **Table 10** shows the stakeholder meetings that were conducted between August 2019 and December 2019.

Table 10: Stakeholder Meeting Log

Stakeholder	Date/Time	Location
Virgin Trains (Brightline)	August 14th, 2019 1:30 PM	8075 Gate Parkway W, Suite 204 Jacksonville, FL 32216
United States Coast Guard (USCG) District 7	October 11, 2019 10:00 AM	909 SE 1st Avenue #510 Miami, FL 33131
Marine Industries Association of South Florida	October 15th, 2019 11:00 AM	221 SW 3rd Avenue Fort Lauderdale, FL 33312
Florida East Coast Railway (FEC)	October 25th,2019 11:00 AM	7150 Philips Hwy Jacksonville, FL 32256
Marine Advisory Board – City of Fort Lauderdale	November 7th, 2019 6:00 PM	100 N Andrews Avenue, 8th Floor Fort Lauderdale, FL 33301
City of Fort Lauderdale & Downtown Development Authority	November 14th, 2019 1:00 PM	290 NE 3rd Avenue Fort Lauderdale, FL 33301
Broward County	November 14th, 2019 4:00 PM	115 South Andrews Avenue, Suite 409G Fort Lauderdale, FL 33301
Marine Industries Association of South Florida	December 5th, 2019 10:30 AM	221 SW 3rd Avenue Fort Lauderdale, FL 33312
Marine Advisory Board – City of Fort Lauderdale	December 5th, 2019 5:30 PM	100 N Andrews Avenue, 8th Floor Fort Lauderdale, FL 33301
Broward County	December 6th, 2019 9:00 AM	115 South Andrews Avenue, Suite 409G Fort Lauderdale, FL 33301
City of Fort Lauderdale & Downtown Development Authority	December 10th, 2019 11:00 AM	290 NE 3rd Avenue Fort Lauderdale, FL 33301
Broward Metropolitan Planning Organization (MPO)	December 13th, 2019 1:30 PM	100 West Cypress Creek Rd., Suite 650 Fort Lauderdale, FL 33309

In general, the stakeholders support a new rail crossing of the New River. In coordination with FEC, key concerns were identified regarding maintaining the existing freight operations relative to the development of the alternatives. According to FEC, freight trains will not utilize a new higher structure. As a result of any new crossing, operational speeds of freight trains and the existing number of freight tracks cannot be reduced during construction, double track crossovers are preferred over diamond track crossovers, and FEC will not consider shifting the existing freight tracks to the east. During a coordination meeting on 10/11/2019, USCG provided key information which includes the need for a full-time bridge tender house for movable bridge options and clarified the existing clearance requirements. Specifically, it was noted that the existing vertical clearance over the river is 80 feet and it should be maintained with any bridge alternative. USCG also indicated that all the feasibility concepts could be permitted.

6.0 FUTURE LAND USE

According to the Broward County Land Use Plan, one of the strategies as part of the plan includes prioritizing development and redevelopment to existing and planned downtowns and major transit corridors and transit hubs. Broward County supports new development and redevelopment activities within established and planned "activity centers" such as municipal downtowns and established and planned "transit oriented" corridors and hubs, as long as such areas have sufficient public facilities and services, and a mixed- use character which supports a high quality of life, work and play for residents and businesses. Some of the implementation strategies include:

- Broward County Land Use Plan amendment for appropriately located "activity centers" such as downtowns and transit corridors and hubs shall be given preference when considering new or redevelopment proposals.
- Within established and planned "activity centers", Broward County shall utilize multi-modal levels of service standards, and take all committed and funded modes of transportation fully into account when considering development proposals.
- To facilitate the availability of affordable housing in proximity to public facilities, services, amenities, and economic opportunities, the County's Affordable Housing Density Bonus Program shall be structured to target established and planned "activity centers" such as downtowns and transit corridor and hubs.

As shown in **Figure 18**, the study limits traverse a designated "Activity Centers" per the Broward County Land Use Plan.

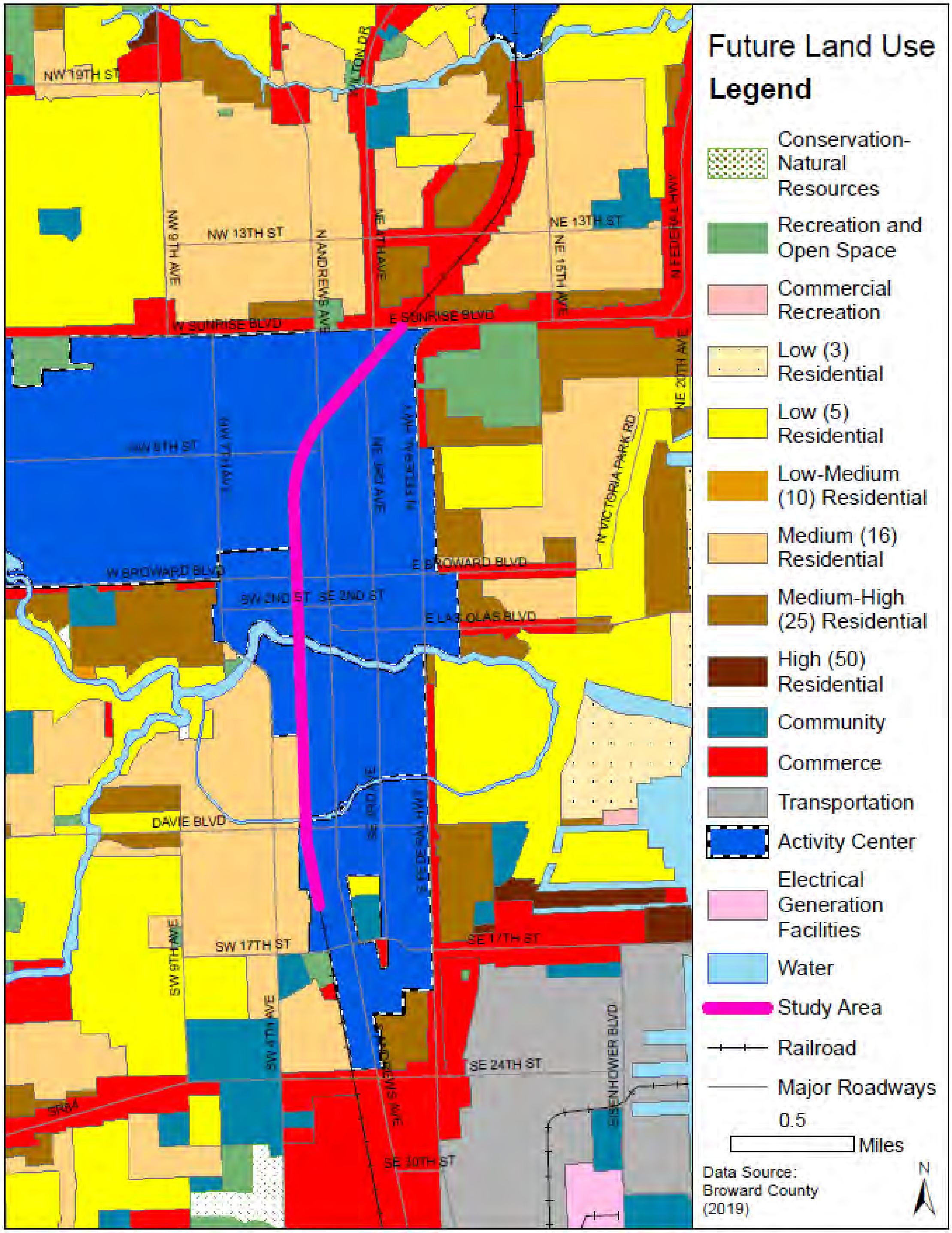


Figure 18: Future land use map surrounding the study limits

7.0 OTHER CONSIDERATIONS

7.1 Central Broward East-West Transit Study (CBT)

In 2012, the FDOT, Broward County Transit (BCT), the Broward Metropolitan Planning Organization (MPO), and the South Florida Regional Transportation Authority (SFRTA), in cooperation with the Federal Transit Administration (FTA) evaluated potential transit options in central Broward County. The CBT study area covers the central portion of Broward County, from Oakland Park Boulevard south to Griffin Road and Stirling Road, and from I-75/Sawgrass/Weston to the Intracoastal Waterway. A Locally Preferred Alternative (LPA) was identified which overlaps with existing FEC railway tracks along Broward Boulevard. As part of this study, a fixed guideway envelope for a potential premium transit system approximately 24-feet above Broward Boulevard is incorporated into the overall analysis of alternatives for the New River crossing. See **Figure 19** for the LPA alignment as a result of the CBT study.

Figure 19: CBT Study LPA Alignment

8.0 CONCEPTUAL ALTERNATIVES

8.1 Design Criteria

The development of the alternative concepts referenced the following standards and guidelines. Refer to the **Appendix C** for the design criteria utilized throughout concept development.

- AREMA Manual for Railway Engineering (2019)
- All Aboard Florida (AAF) Structures Design Criteria v1.2 (June 30, 2014) [Virgin Trains/Brightline]
- Tri-Rail Coastal Link (TRCL) Design Criteria (April 4, 2014)

8.2 Design Constraints

Several design constraints influenced the overall development of alternatives during this study. Features that were considered as constraints are as follows:

- Maintain existing pedestrian bridge between NW 4th Street and Broward Boulevard
- Maintain CBT premium transit guideway envelope along Broward Boulevard
- Existing rail passenger operations at Virgin Trains/Brightline station must be maintained during construction and permanent condition (identified in coordination with Virgin Trains/Brightline)
- Design speed of 40 mph along the FEC tracks must be maintained during construction and permanent condition (identified in coordination with FEC)
- Existing freight operations for FEC must be maintained in existing location during construction and permanent condition (identified in coordination with FEC)
- Existing freight tracks must remain (identified in coordination with FEC)
- NW 2nd Avenue to remain open after construction; maintenance of traffic (MOT) must maintain drop off/pickup area during construction (requested by Virgin Trains/Brightline)
- 1000-foot station platform plus 75-foot tangents on both ends of station platform needed for Virgin Trains/Brightline future expansion (requested by Virgin Trains/Brightline)
- Proposed station platform width is to match existing platform in operation; 35-foot wide center platform (requested by Virgin Trains/Brightline)
- SW 2nd Avenue must remain open during construction and permanent condition - North of Broward Boulevard for Virgin Trains/Brightline station access and South of Himmarshee Street for business and historic district access (Anticipated by City of Fort Lauderdale)

This study abided by the above list of constraints as much as possible to avoid additional impacts to the existing infrastructure, future improvements, existing passenger and freight rail operations, and surrounding environment.

8.3 Alternatives Overview

Four crossing alternatives were evaluated as part of this study. Track horizontal and vertical alignments, typical sections, navigational clearances, structural analysis, environmental impacts, and constructability were evaluated in the development of the preliminary concept alternatives for further development and analysis during the PD&E phase and subsequent phases.

The alternatives evaluated are listed below:

1. Low-Level Bascule Bridge (21-foot clearance)
2. Mid-Level Bascule Bridge (56.5-foot clearance)
3. High-Level Fixed Bridge – Two clearance envelopes were evaluated:
    a. 65-foot clearance[1]
    b. 80-foot clearance
4. Tunnel (5-foot clearance below the riverbed; proposed track depth of 63-feet below existing track grade; total depth to bottom of bored tunnel is 75-feet below the existing track)

Figure 20 provides a schematic comparison between the different alternatives. The Low-Level Bascule Bridge Alternative requires approximately 1.1 miles of overall improvements which includes a new bascule bridge structure at New River, and track work needed to re-establish track connections to existing railroad tracks on both the north and south side of proposed improvements. The Mid-Level Bascule Bridge, High-Level Fixed Bridge, and Tunnel alternatives require approximately 2.5 miles of overall improvements. The structural configurations differ between these alternatives, however, due to design constraints, and geometric needs based on design criteria, the overall length of track improvements are similar. All four alternatives would also re-establish connections to existing railroad tracks on both the north and south side of proposed improvements. The following sections provide additional details regarding each alternative.

[1] The 65- and 80-foot bridges were analyzed as individual alternatives. The 65-foot bridge was eliminated from further analysis since it was not consistent with the existing 80-foot high FPL transmission lines within the vicinity of the study area.

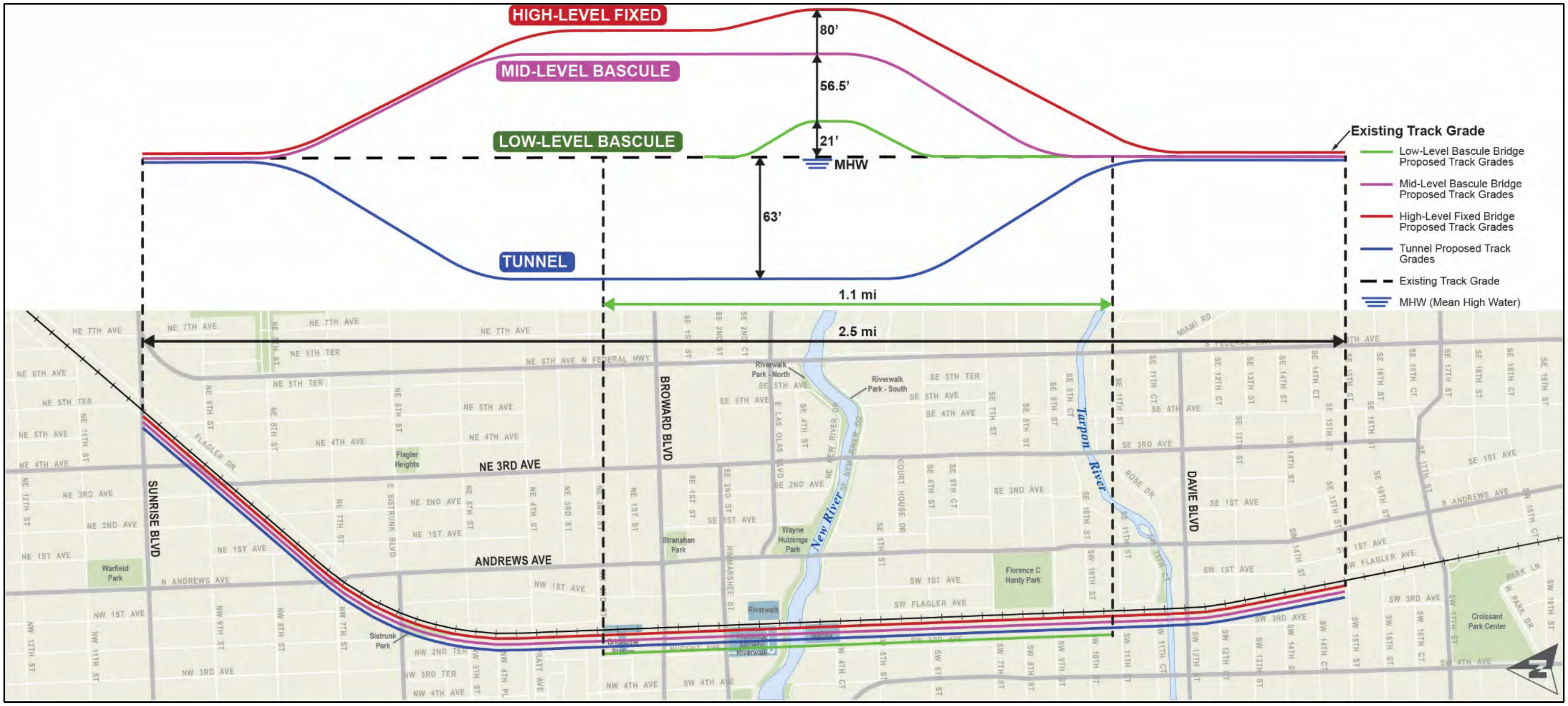


Figure 20: Schematic of Alternatives

8.4 Alternative 1: Low-Level Bascule Bridge

The Low-Level bascule bridge alternative consists of a 1,020-foot bridge structure with a vertical clearance of 21 feet above the Mean High Water (MHW) level to the bottom of the bascule steel span. Approximately 211 feet of the bridge will span over the river, and 809 feet will span over land on the approaches. The 21-foot clearance is consistent with other bridges crossing New River. This alternative bridge concept crosses the New River to the west of the existing rail bridge with a track offset of 35 feet between existing track and proposed new track. The proposed bridge would carry two tracks on 14'-0" track centers on the bridge structure. This alternative is similar to the adjacent bascule bridge along South Andrews Avenue (see **Figure 21**) in Fort Lauderdale, Florida.

Figure 21: Low-Level Bascule Bridge along South Andrews Avenue

The grade for the north approach is a (+) 2.89% up-grade, starting approximately 300 feet south of Broward Boulevard. A vertical retained earth wall would begin at this location and continue for approximately 430 feet before the bridge structure begins 200 feet south of Himmarshee Street. The existing rail crossing at Himmarshee Street would be closed to vehicular or pedestrian access. Any options to allow for pedestrian access under the bridge on Himmarshee Street do not allow for freight and passenger train operations to be maintained during construction. As the bridge structure approaches New River, the track profile would be at 0% grade for the bridge approaches and the 80-foot bascule bridge opening. South of the river, the vertical profile would be at a (-) 2.50% down-grade starting approximately 350 feet north of SW 5th Street (see **Figure 22**). A retained earth wall approximately 550 feet long would close the SW 5th Street crossing to vehicle and pedestrian traffic with the vertical profile meeting existing ground 200 feet south of SW 5th Street. The bridge would span 1,020 feet. The length of trackwork for the proposed realignment to provide connection between the two existing freight tracks and the two new passenger tracks is approximately 1 mile (5,000 feet) from the Virgin Trains/Brightline station to SW 11th Street. The bridge spans will be cast in place concrete beams supported on concrete hammerhead drilled shaft piers.

Sufficient clearance is provided to accommodate the future CBT guideway envelope over Broward Boulevard, however, due to vertical geometric needs, Himmarshee Street and SW 5th Street would need to be permanently closed along proposed alignment. The existing Virgin Trains/Brightline passenger and FEC freight operations would be maintained during construction and permanent condition. There are some constructability challenges associated with this alternative involving extensive need for temporary tracks to maintain freight and passenger operations. In addition, SW 2nd Avenue would be closed south of Broward Boulevard during construction. This alternative would have permanent right of way impacts affecting several features such as the Pioneer House Museum, Historic Fort Lauderdale, Riverfront Marina, Riverwalk on the north side of New River, and other local businesses. Environmental impacts to consider in the PD&E are visual aesthetics, noise, and resources such as historic sites and recreation areas. **Table 11** provides a summary of the advantages and disadvantages of the Low-Level Bascule Bridge alternative. **Figure 22** depicts the schematic configuration of the alternative in the horizontal and vertical configuration. **Figure 23** and **Figure 24** depicts a rendering of the alternative in the context of this section of the river. **Appendix D** includes the conceptual typical section, plan, and profile for the Low-Level Bascule Bridge alternative.

Table 11: Alternative 1 Low-Level Bascule Bridge - Summary of Advantages and Disadvantages

Advantages	Disadvantages
No impacts on Broward Boulevard	Closes Himmarshee and SW 5th Street
No impact on existing Virgin Trains/Brightline station	Significant constructability impacts involving extensive temporary track to maintain freight and passenger operations
Maximizes use of existing track	New interim signal system needed during construction
Consistent vertical clearance with other river crossings, i.e. South Andrews Avenue Bridge	Significant permanent impact to SW 2nd Ave and access to businesses fronting SW 2nd Ave, Riverfront Marina, Riverwalk, and Historic Fort Lauderdale.
Minimal visual, noise, and environmental impacts relative to other alternatives	Maritime operational improvements are less than the other alternatives.

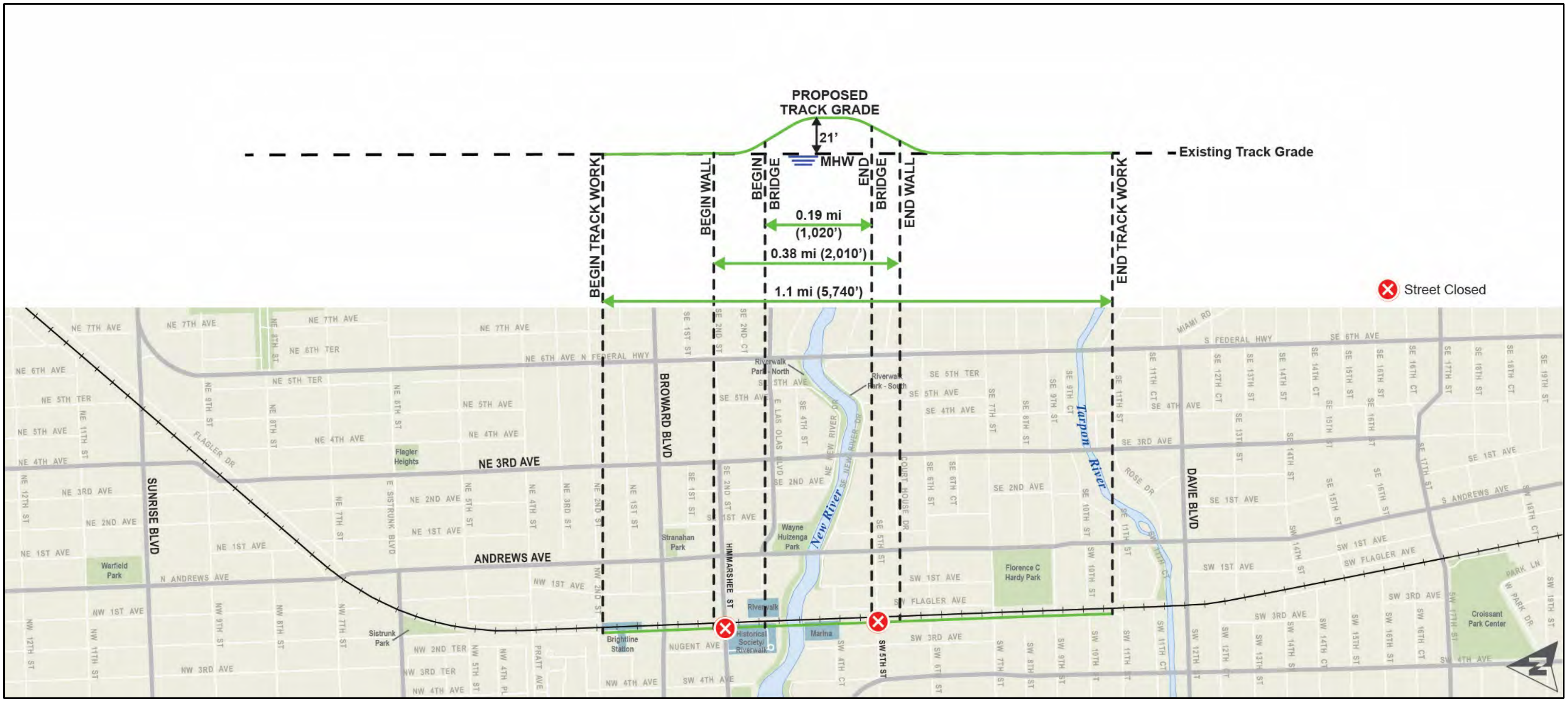


Figure 22: Alternative 1 Low-Level Bascule Bridge Alternative Schematic

Figure 23 | Page 8-7
Rendering provided by RS&H, Inc.

View - Looking Northeast

LOW LEVEL BASCULE BRIDGE (21 FT CLEARANCE)

Figure 24 | Page 8-8
Rendering provided by RS&H, Inc.

8.5 Alternative 2: Mid-Level Bascule Bridge

The Mid-Level Bascule Bridge concept considered future improvement plans for an east-west transit system along Broward Boulevard (CBT). The CBT system would potentially include premium technologies on an exclusive guideway which would provide a grade separated (bridge structure) over the existing FEC freight tracks crossing Broward Boulevard. As the Mid-Level Bascule Bridge alternative was developed, the track profile to accommodate crossing over this future transit guideway would place the passenger tracks at the Virgin Trains/Brightline station at 55 feet above the existing freight tracks. The proposed Mid-Level Bascule Bridge alternative at the New River crossing would provide a vertical clearance from MHW to the bottom of the proposed bascule bridge of 56.5 feet. The 56.5-foot clearance would not meet permitting requirements of a fixed bridge; therefore, a bascule bridge is proposed to provide clearance of all marine vessel needs. The proposed bridge structure would cross the New River to the west of the existing bridge with a track offset of 35 feet between existing freight track and proposed passenger track. The proposed bridge would carry two tracks each approximately 7,010 feet long from north of NW 7th Street to south of SW 6th Street. This alternative is similar in height to the SE 17th Street Causeway Movable Bridge but would have a single bascule leaf (see **Figure 25**) in Fort Lauderdale, Florida.

Figure 25: SE 17th Street Causeway Bridge

The grade for the north approach is a (+) 2.50 up-grade, beginning with retained earth wall approximately 200 feet south of SE 3rd Avenue. The retaining wall would extend 895 feet to the beginning of the bridge structure located 300 feet north of North Andrews Avenue. No cross streets would be closed north of the

New River with the Mid-Level Bascule Bridge alternative. The bridge structure would span 7,010 feet (1.33 miles) from north of North Andrews Boulevard to south of the river with vertical profile of (-) 2.50% down-grade to 250 feet south of SW 6th Street. From this location a retained earth wall would extend 790 feet, to 150 feet north of SW 9th Street. This retaining wall would permanently close SW 7th Street. All cross streets from North Andrews Avenue to SW 6th Street would have an elevated crossing of the passenger tracks with the existing freight track and operations remaining at-grade. The bascule bridge over the river would be an 80-foot open deck span. The length of trackwork to tie the proposed passenger tracks back to the freight tracks would extend from Sunrise Boulevard to SW 15th Street, a distance of 2.5 miles.

The bridge typical section would allow for the structure to be constructed on single column, hammerhead shaped pier supports that would minimize the right of way impacts allowing for SW 2nd Avenue north and south of the New River to remain in operation and therefore minimize business impacts and access to historical sites. Several features such as the Juvenile Justice Department, Pioneer House Museum, Historic Fort Lauderdale, Riverfront Marina, Riverwalk on the north side of New River, Sistrunk Park, and other local businesses are located within the footprint of the bridge structure. Environmental impacts to consider in the PD&E are the visual aesthetics, noise, and resources such as historic sites and recreation areas. The Virgin Trains/Brightline station platform and canopy will be reconstructed at a 3rd level, approximately 55 feet above the existing station at a leveled grade. The elevated station would accommodate a center platform and be 70 feet wide consistent with the current station configuration. This area of the station platform would be supported on bridge structure consisting of a cast-in-place concrete deck and prestressed beams on a straddle bent configuration allowing station operations, drop off/pick up areas, to be maintained with SW 2nd Avenue remaining open below the platform. Freight and passenger operations would require a temporary third track in the vicinity of the Virgin Trains/Brightline station to maintain current operations.

Table 12 provides a summary of the advantages and disadvantages of the Mid-Level Bascule Bridge alternative. **Figure 26** depicts the schematic configuration of the alternative in the horizontal and vertical configuration. **Figure 27** and **Figure 28** depicts a rendering of the alternative in the context of this section of the river. **Appendix D** includes the conceptual typical section, plan, and profile for the Mid-Level Bascule Bridge alternative.

Table 12: Alternative 2 Mid-Level Bascule Bridge - Summary of Advantages and Disadvantages

Advantages	Disadvantages
Improved maritime navigation with the bridge in a closed position compared to Alternative 1	SW 7th Street permanently closed
At-grade passenger rail crossings eliminated from North Andrews Avenue through SW 6th Street improving safety and traffic operations	New elevated station platform at 3rd level
	Significant permanent impact to SW 2nd Ave and access to businesses fronting SW 2nd Ave, Riverfront Marina, Riverwalk, and Historic Fort Lauderdale.
	Visual aesthetics, noise, and historic/recreational impacts

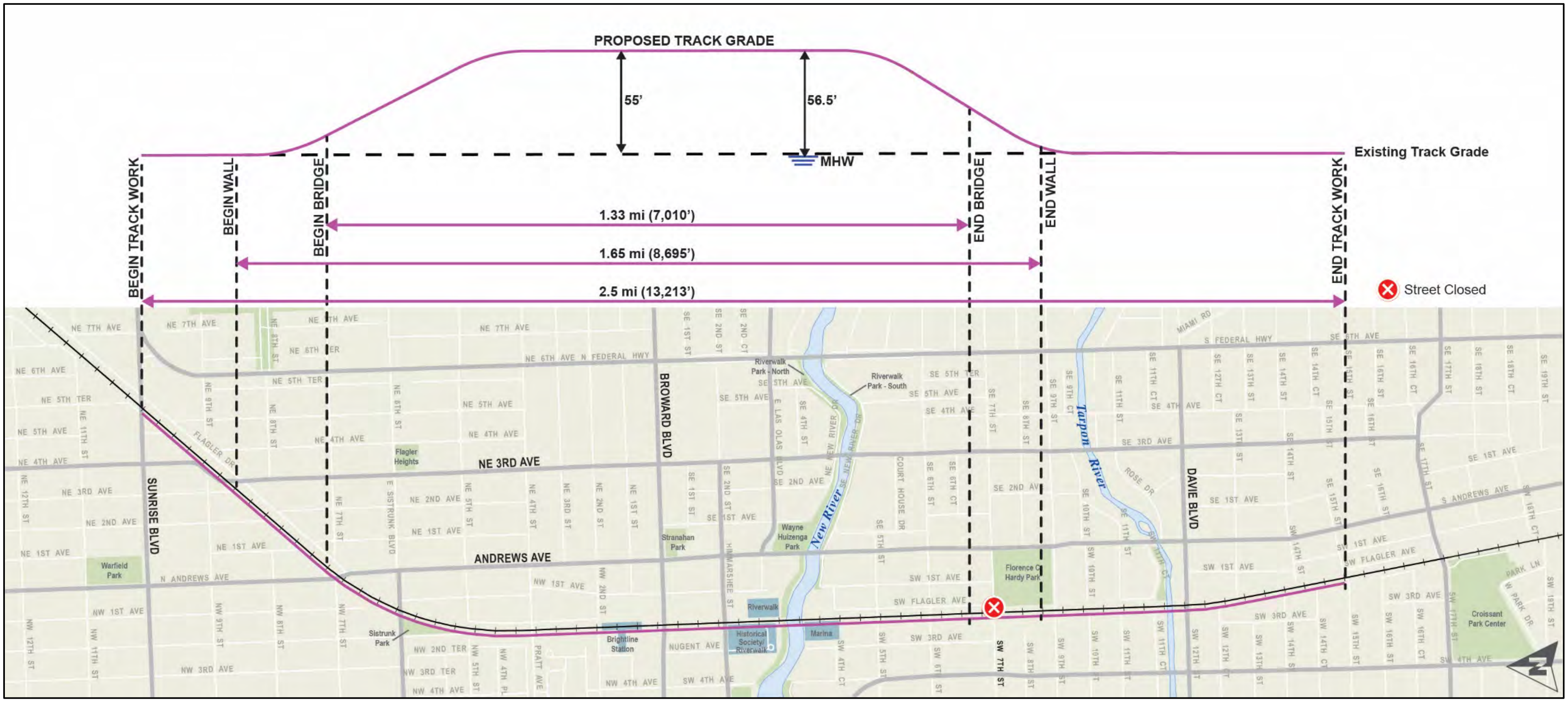


Figure 26: Alternative 2 Mid-Level Bascule Bridge Alternative Schematic

Rendering provided by RS&H, Inc.

View - Looking Northeast

MID LEVEL BASCULE BRIDGE (56 FT CLEARANCE)

Rendering provided by RS&H, Inc.

8.6 Alternative 3: High-Level Fixed Bridge

The High-Level Fixed Bridge alternative at the New River crossing would provide an 80-foot vertical clearance from the MHW to the bottom of the fixed structure. This alternative would also accommodate future improvement plans for an east-west transit system along Broward Boulevard (CBT) providing for a premium transit technology on an exclusive grade separated guideway (bridge structure) over the existing freight tracks crossing Broward Boulevard. As a result of the 80-foot crossing at the river and the provision of the transit guideway, the new Virgin Trains/Brightline platform would be at a higher 3rd level elevation than the Mid-Level Bascule Bridge alternative, located at 68 feet above the existing at-grade platform. The proposed bridge structure will cross the New River to the west of the existing bridge with a track offset of 40 feet between the existing freight track and proposed passenger track. The proposed bridge would carry two tracks approximately 8,095 feet (1.53 miles) long spanning from north of Andrews Avenue to south of SW 9th Street. The vertical profile of this alternative is similar to the existing Metromover bridge over the Miami River, in Miami Florida (see **Figure 29**), which is also ± 80 feet over the Miami River.

Figure 29: Metromover bridge over the Miami River

The grade for the north approach is a (+) 2.42% up-grade, beginning with a retained earth wall about 100 feet south of SE 3rd Avenue. The retaining wall would extend 910 feet, to approximately 300 feet north of Andrews Avenue. No cross streets would be closed north of New River with the High-Level Fixed Bridge alternative. The bridge structure would span 8,095 feet (1.53 miles) from north of Andrews Avenue to south of the river with a vertical profile of (-) 2.53% down-grade to 100 feet south of SW 9th Street. The vertical clearance is not adequate to keep SW 9th Street open to crossing vehicles. A retained earth wall would extend 800 feet from the south end of the bridge to 200 feet north of the Tarpon River. The new tracks crossing Tarpon River would match the at-grade elevation of the existing freight track crossing of this river. The length of the track work would extend 2.5 miles from Sunrise Boulevard to SW 15th Street.

Similar to the Mid-Level Bascule Bridge alternative, the bridge typical section would allow for the structure to be constructed on single column, hammerhead shaped pier supports that would minimize the right of way impacts allowing for SW 2nd Avenue, north and south of the New River to remain in operation and therefore minimizing business impacts and access to historical sites. The Virgin Trains/Brightline station would be reconstructed at a 3rd level, approximately 68 feet above the existing station at a leveled grade. The elevated station would accommodate a center platform and be 70 feet wide consistent with the current station track configuration. This area of the station platform would be supported on bridge consisting of a cast-in-place concrete deck and prestressed concrete beams on a straddle bent configuration with SW 2nd Avenue remaining open below the platform, allowing station operations, and the drop off/pick up areas, to remain operational during construction and after construction is completed.

The existing Virgin Trains/Brightline passenger and FEC freight operations would be maintained. Freight and passenger operations would require a temporary third track in the vicinity of the Virgin Trains/Brightline station to maintain current operations. This alternative would grade separate passenger rail tracks from Andrews Avenue to SW 7th Street which would improve local traffic operations by minimizing at-grade railroad crossings at the cross streets. However, due to vertical geometric needs, SW 9th Street would need to be permanently closed. Enough clearance is provided to accommodate the CBT guideway envelope over Broward Boulevard. The vertical clearance over the river is consistent with the lowest fixed feature within the area consisting of FPL transmission power lines at 80 feet above the MHW.

With an 80-foot clearance over New River, vessels would be able to navigate the crossing without a need for a bridge opening/closing as necessary with a bascule/movable bridge. However, some of the tallest vessels may need to lower their masts, which is currently needed at the crossing under the FPL transmission lines.

This alternative would have temporary construction impacts from the foundations of the structure with potential permanent impacts at the location of the bridge support columns. Aerial impact considers would occur at several features such as the Juvenile Justice Department, Pioneer House Museum, Historic Fort Lauderdale, Riverfront Marina, Riverwalk on the north side of New River, Sistrunk Park, and other local businesses. Additional environmental impacts to consider in the PD&E are the visual aesthetics, noise, and resources such as historic sites and recreation areas. **Table 13** provides a summary of the advantages and disadvantages of the High-Level Fixed Bridge alternative. **Figure 30** depicts the schematic configuration of the alternative in the horizontal and vertical configuration. **Figure 31** and **Figure 32** depicts a rendering of the alternative with respect to the context of this section of the river. Appendix D includes the conceptual typical section, plan, and profile for the High-Level Fixed Bridge alternative.

Table 13: Alternative 3 High-Level Fixed Bridge - Summary of Advantages and Disadvantages

Advantages	Disadvantages
At-grade passenger rail crossings eliminated from North Andrews Avenue through SW 7th Street improving traffic operations	SW 9th Street permanently closed
80-foot fixed vertical clearance over New River – No bridge openings/closings. No delays or operations & maintenance cost when compared to bascule bridges.	New elevated station platform would be at a 3rd level (higher than Mid-Level Bascule Bridge alternative)
Consistent with vertical clearance control point located at the fixed FPL transmission lines over the river	Significant permanent impact to SW 2nd Ave and access to businesses fronting SW 2nd Ave, Riverfront Marina, Riverwalk, and Historic Fort Lauderdale.
	Visual, noise, and historic/recreational impacts

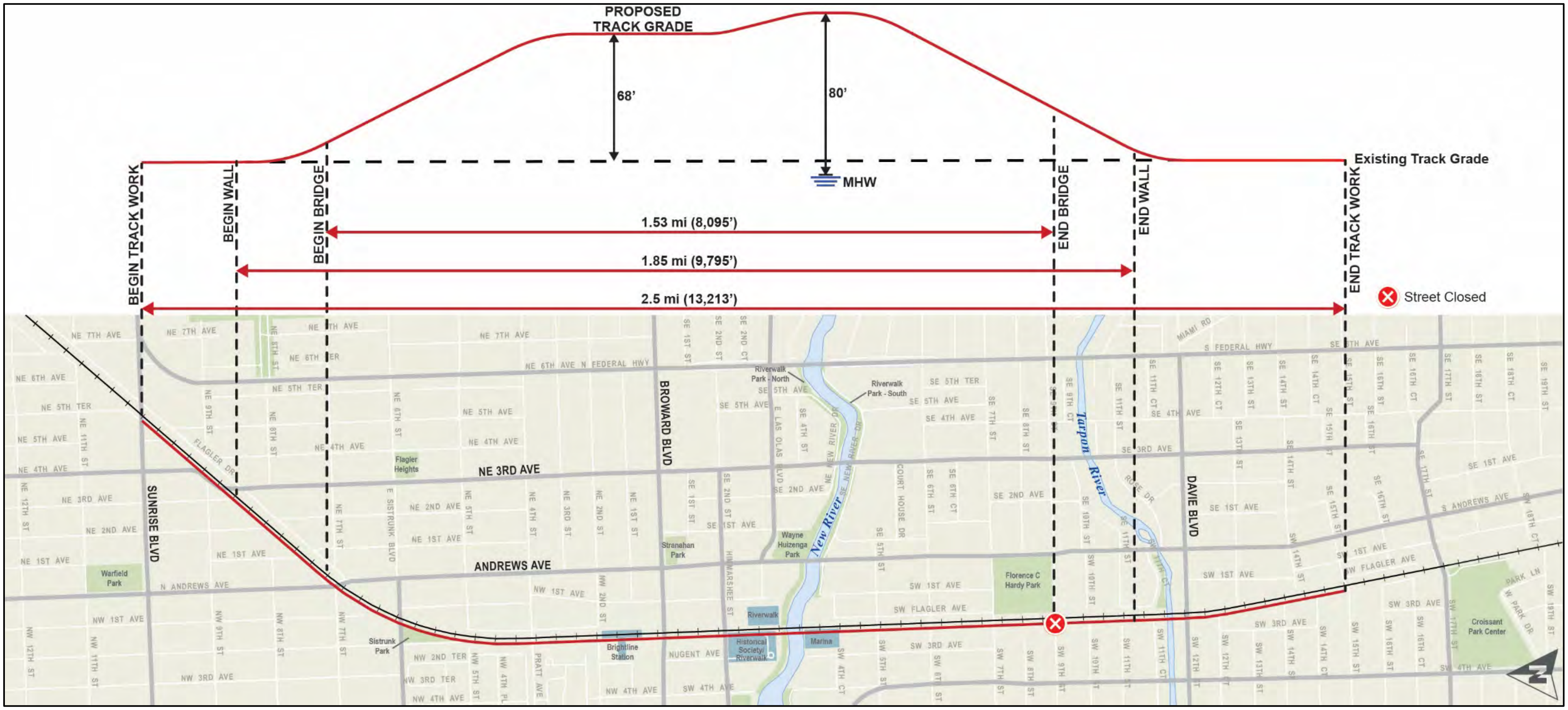


Figure 30: Alternative 3 High-Level Fixed Bridge Alternative Schematic

Rendering provided by RS&H, Inc.

View - Looking Northeast

HIGH LEVEL FIXED SPAN BRIDGE (80 FT CLEARANCE)

Rendering provided by RS&H, Inc.

View - Looking East

HIGH LEVEL FIXED SPAN BRIDGE (80 FT CLEARANCE)

8.7 Alternative 4: Bored Tunnel with Cut/Cover at Station

The proposed tunnel alternative will cross under New River with the proposed tracks within a tunnel approximately 63 feet below existing track grade. The tunnel would need to be 40-foot in diameter making the bottom of the tunnel approximately 75 feet below the existing track grade. The 40-foot diameter tunnel is needed to accommodate 14-foot center to center tracks, train dynamic envelopes, air ventilation, and emergency access points. To provide emergency catwalks, the tracks would be 12 feet above the bottom of the 40-foot diameter tunnel. A Tunnel Boring Machine (TBM) will be utilized to construct the 40-foot diameter tunnel from the proposed station platform. This equipment is typically specialized and manufactured outside the United States. See **Figure 33** for an example of a TBM. The tunnel is proposed to be a flat 0% grade from the river north through the Virgin Trains/Brightline station.

Figure 33: Example of TBM for tunnel construction

The beginning of the tunnel walls would be approximately 100 feet south of NE 3^{rd} Avenue. The NE 3^{rd} Avenue roadway grade would have to be raised approximately 2 feet and would require the existing freight tracks to be regraded. With a (-) 2.92% down-grade, the walls would extend 1,270 feet to just north of North Andrews Avenue where the tunnel portal would be constructed. See **Figure 34** for a photo of the tunnel portal for the PortMiami Tunnel project in Miami, Florida.

Figure 34: PortMiami Tunnel – Portal

At the tunnel portal, the track would be completely underground from Andrews Avenue to just south of SW 7th Street, a length of 7.085 feet (1.34 miles). From the portal, U-walls with a grade up of 3.0% would extend 1,440 feet to 300 feet north of Tarpon River. With the placement of the walls, SW 9th Street would be permanently closed. The track work to tie into the existing freight tracks extends from Sunrise Boulevard to SW 15th Street, a distance of 2.5 miles.

The underground Virgin Trains/Brightline station would be constructed with a center platform consistent with the current station operations. The width of the tunnel at the platform would be approximately 75 feet wide. The construction method at the station area would be cut and cover. The length of this construction would extend from the limits of where the track is at on 14-foot centers (40-foot tunnel width) to each end of the transition to a 75-foot station width. This distance is 4,780 feet (0.9 miles) extending from Andrews Avenue to south of Himmarshee Street. During construction, temporary bridges would be needed at Broward Boulevard with one additional temporary bridge at NW 6th Street, NW 4th Street and/or Himmarshee Street to maintain downtown traffic circulation. For construction of the 40-foot diameter tunnel, the TBM would be placed in the cut section of the station area and would be drilled outward to the location of the portals, one end at a time.

The tunnel option, with completion of construction would remove the passenger rail crossings from north of North Andrews Avenue through SW 7th Street. NE 3rd Avenue will need regrading and SE 9th Street will be closed. Use of the right of way above the tunnel will need to be determined regarding encroachments, safety and security issues but will likely be returned to current uses. The construction method will impact traffic circulation, businesses and local access for an extended construction duration. The tunnel option will remove any passenger rail impacts to maritime operations at the river. Environmental considerations will be considered temporary, though significant, during construction. Fire and life safety measures would need to be provided for the public and ventilation requirements would need to be addressed with use of diesel fuel locomotive engines. The overall construction costs and annual operation and maintenance costs are significant with this option. **Table 14** provides a summary of the advantages and disadvantages of the tunnel alternative. **Figure 35** depicts the schematic configuration of the alternative in the horizontal and vertical configuration. **Figure 36** and **Figure 37** depicts a rendering of the tunnel portal and cross section with respect to the surrounding environment. **Appendix D** includes the conceptual typical section, plan, and profile for the tunnel alternative.

Table 14: Alternative 4 Tunnel - Summary of Advantages and Disadvantages

Advantages	Disadvantages
Minimal surface impacts once construction is completed	Cut and cover at station, approximately 70 feet wide platform
Passenger rail crossings eliminated from North Andrews Avenue through SW 7th Street improving safety and traffic operations	SW 9th Street would be closed; SE 3rd Ave would need re-grading
No impact to marine navigation	Constructability challenges with cut and cover at the station. Temporary impacts from South of Broward Boulevard to North of 5th Street for extensive period of time
Tunnel alternative results in minimal environmental considerations: visual aesthetics, noise, historic resources	Construction duration is extensive
	Severe disruption to downtown traffic circulation and business operations during construction
	Highest constructions and annual operation & maintenance (O&M) cost
	Fire and life safety measures
	Freight trains cannot use tunnel (hazmat)

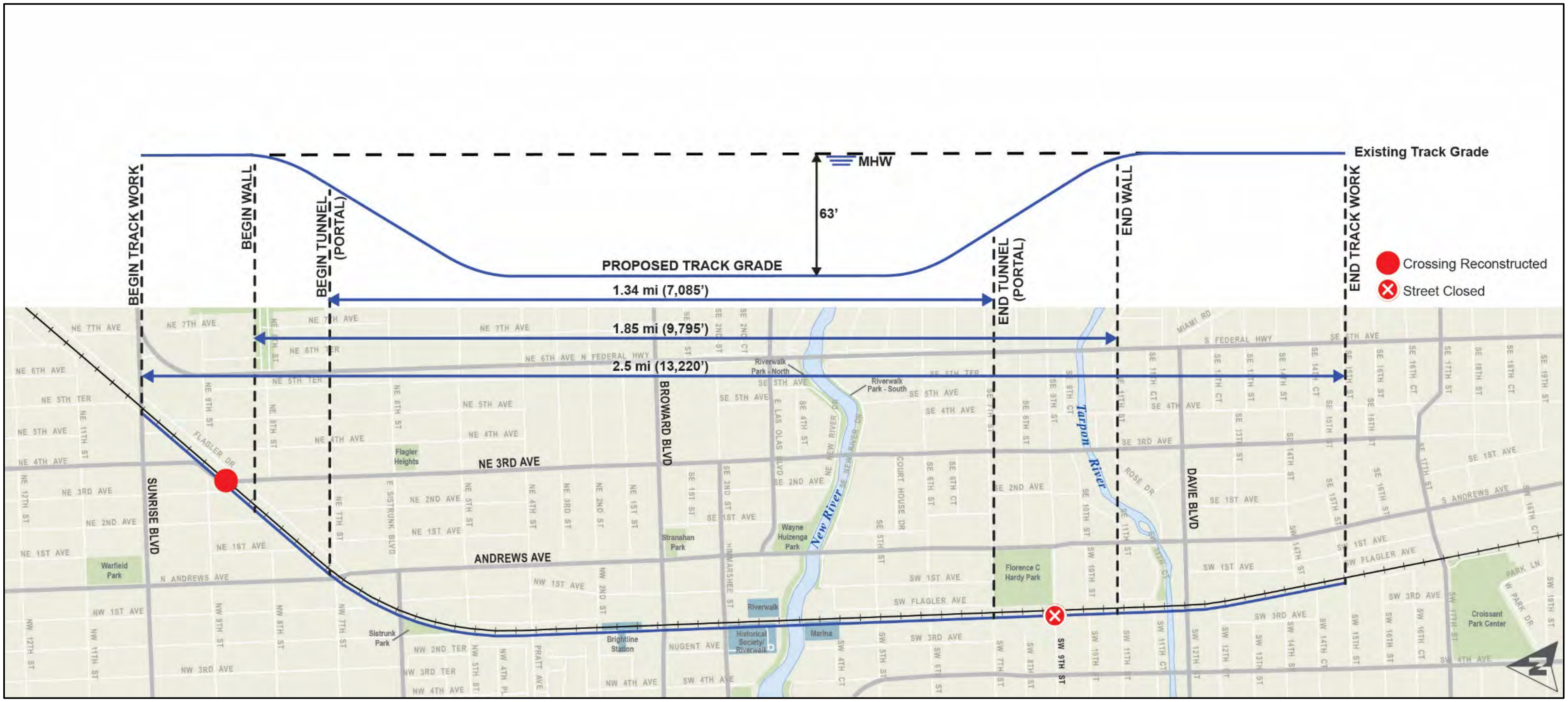


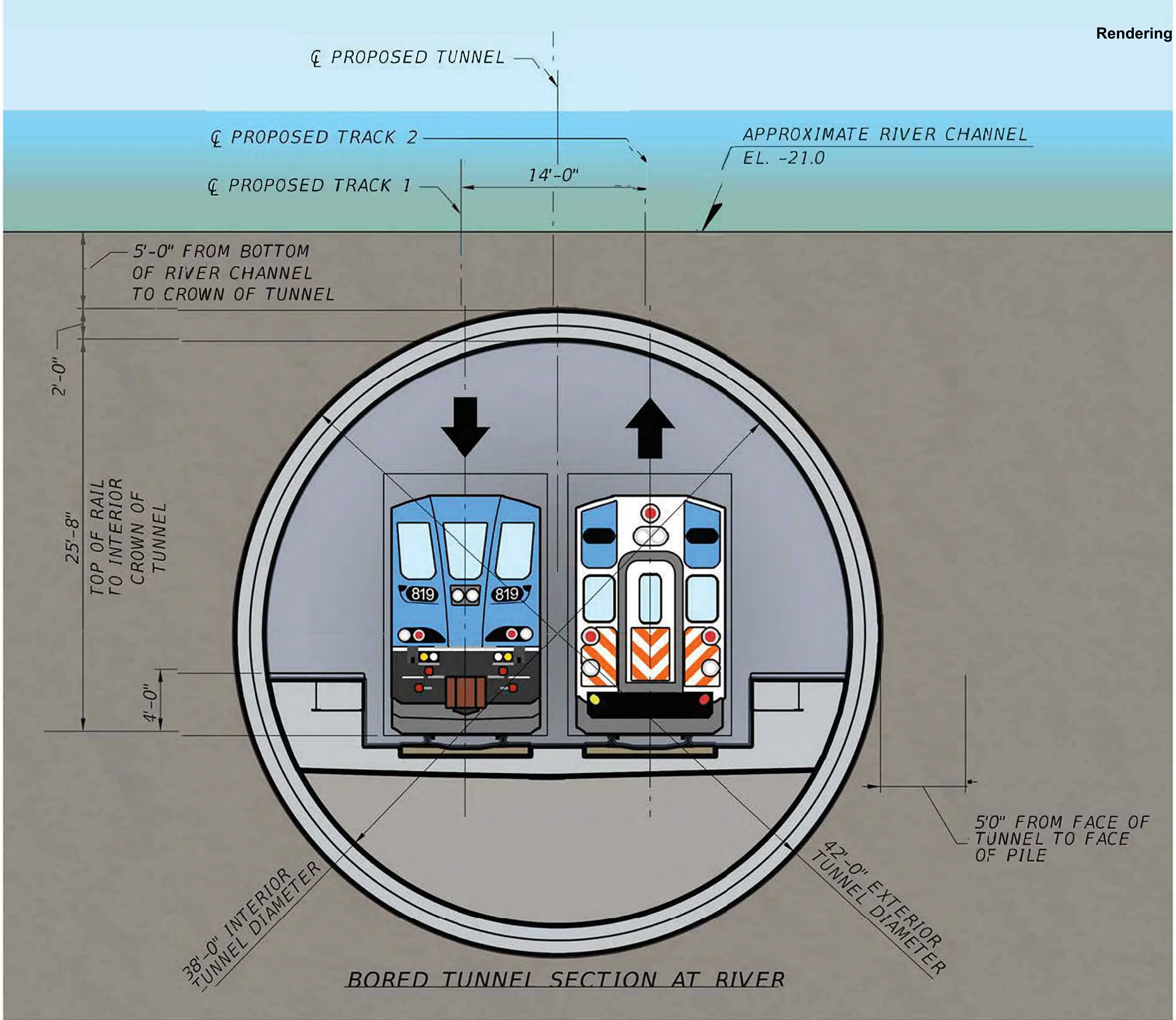
Figure 35: Alternative 4 Tunnel Schematic

View - Looking North

Tunnel Alternative

Figure 36 | Page 8-25

Rendering provided by RS&H, Inc.



BORED TUNNEL SECTION AT RIVER

9.0 COMPARATIVE ANALYSIS

As discussed in **Section 8.0 Conceptual Alternatives**, four alternatives were evaluated to address the needs of navigational traffic, freight trains, and passenger transit for the New River in Fort Lauderdale, Florida. The following section presents a high-level comparative analysis between the different alternatives discussed in this memorandum. The alternatives will have the following designations for the purposes of discussing the comparative analysis.

- **Alternative 1:** Low-Level Bascule Bridge (21-foot clearance)
- **Alternative 2:** Mid-Level Bascule Bridge (56.5-foot clearance)
- **Alternative 3:** High-Level Fixed Bridge (80-foot clearance)
- **Alternative 4:** Tunnel (Tunnel Tracks 63-feet below existing at-grade tracks)

9.1 Right of Way Needs

A preliminary right of way impact assessment was conducted for each of the alternatives. Alternative 1 impacts seven parcels with a total impact area of 0.78 acres. Alternative 2 impacts 56 parcels with a total impact area of 6.81 acres. Alternative 3 impacts 65 parcels with a total impact area of 7.09 acres. Alternative 4 impacts 68 parcels with a total impact area of 8.16 acres, however, there are additional subterranean impacts that would need to be considered in the evaluation of the impacts. **Table 15** lists the acreage impacted with each alternative. Refer to **Appendix E** for a detailed list of parcels, corresponding parcel information, right of way costs, and impacts exhibits.

Alternative 1 resulted in the least impacts to right of way when compared to the other alternatives. Alternatives 2 & 3, similar in terms of right of way impacts, have higher impacts to right of way due to the increased track improvements and aerial rights needed along the limits of the bridges in both alternatives. Even though Alternative 4 offers the ability to restore the area to an existing or improved state in the ultimate final configuration, the impacts to right of way from the tunnel construction would be severe and extensive, thus Alternative 4 has the most severe right of way impacts to the area.

Table 15: Right of Way Impacts Summary

Alternative	Parcels Impacted (Acres)
Alternative 1 Low-Level Bascule Bridge	0.78
Alternative 2 Mid-Level Bascule Bridge	6.81
Alternative 3 High-Level Fixed Bridge	7.09
Alternative 4 Tunnel	8.16

9.2 Environmental Considerations

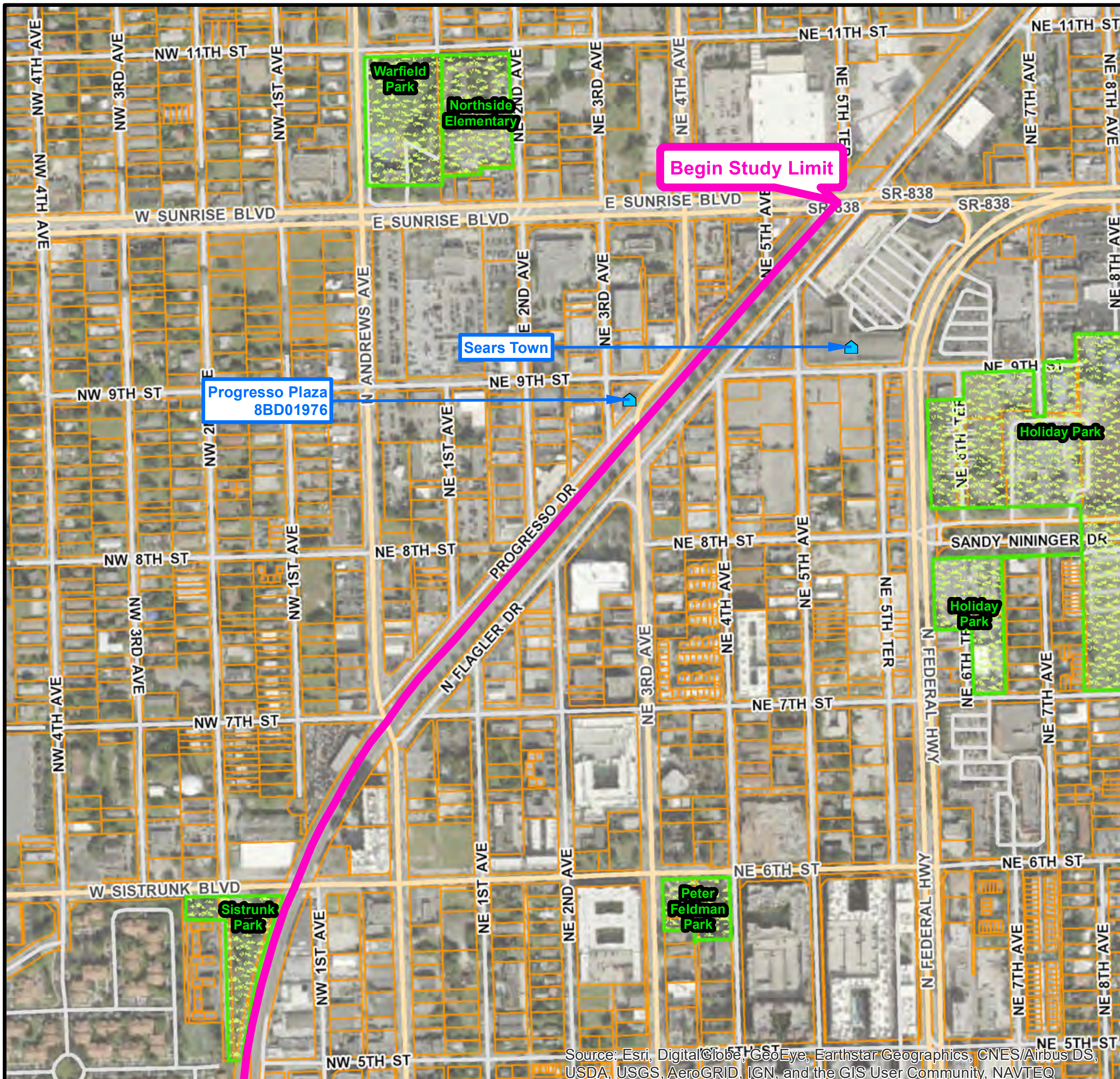
Several potential cultural resources were identified within the study area. Those include potential Section 4(f) and Section 106 properties that may be publicly owned parks, recreational lands, wildlife and waterfowl refuge areas, or historic sites of national, state, or local significance. There are several publicly owned recreational facilities within the study area which may represent Section 4(f) resources:

- Sistrunk Park
- Riverwalk Linear Park
- Florence C. Hardy & Southside Park
- Tarpon River Park, Esplanade (Discovery) Park
- Bubier Park/Huizenga Plaza
- Marshall Point

There are several potential historic and archeological resources within the study area such as:

- Sears Town, Progress Plaza (8BD0176)
- Broward Plasma Corp./Archaeology Museum (8BD01330)
- Tom M. Bryan Building (8BD00227)
- King-Cromartie House (8BD00062)
- New River Inn (8BD00063)
- Philemon Bryan House (8BD00212)
- Antique Car Museum
- Himmarshee Street/SW 2nd Avenue Historic District (H-1)
- Fort Lauderdale Historic District (8BD181)
- Brickell Block (8BD02916)

Figure 38 to **Figure 42** show the location of the cultural resources with respect to the footprint of the Alternative 1. **Figure 43** to **Figure 47** show the location of the cultural resources with respect to the footprint of the Alternative 2. **Figure 48** to **Figure 52** show the location of the cultural resources with respect to the footprint of the Alternative 3. **Figure 53** to **Figure 57** show the location of the cultural resources with respect to the footprint of the Alternative 4. For Section 4(f) resources, the Determination of Applicability (DOA) will be determined during the PD&E phase as to whether Section 4(f) does or does not apply to the project and if the project is eligible for exceptions and exclusions to a Section 4(f) requirement. The PD&E phase will also initiate the Section 106 process by establishing the undertaking, conducting consultation, identifying historic properties, assessing adverse effects, and resolving adverse effects by avoiding, minimizing, or mitigating. A Cultural Resource Assessment Survey (CRAS) will need to be developed during the PD&E phase.



New River Bridge Feasibility Study

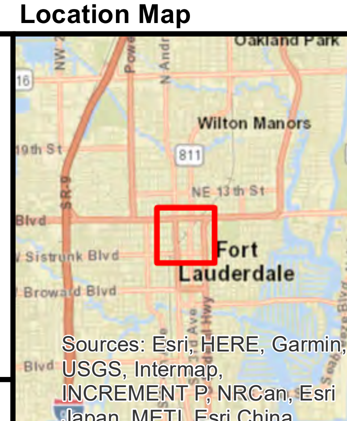
Alternative 1 Low-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- Low-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map



N

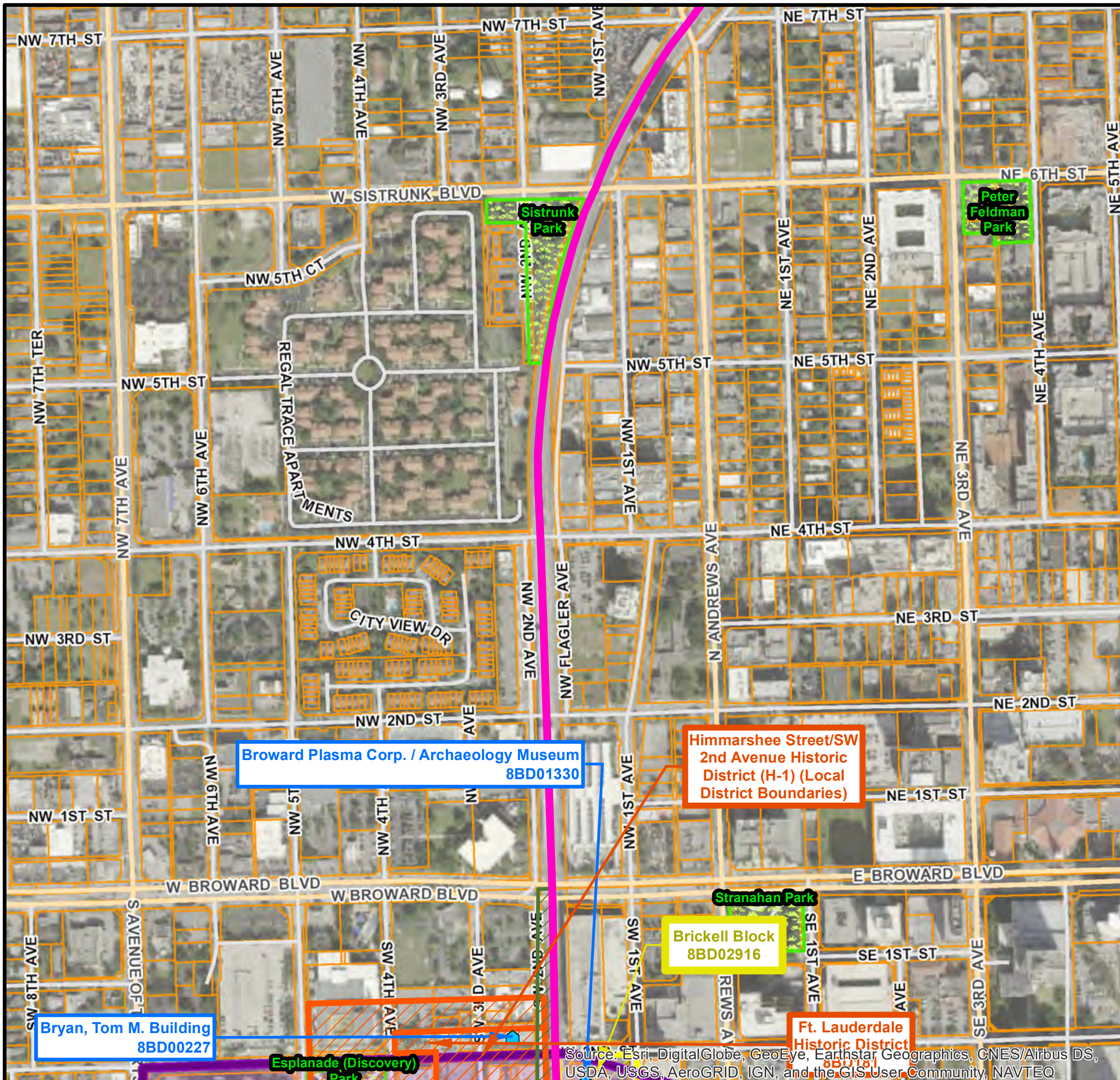
330 Feet

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 38

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

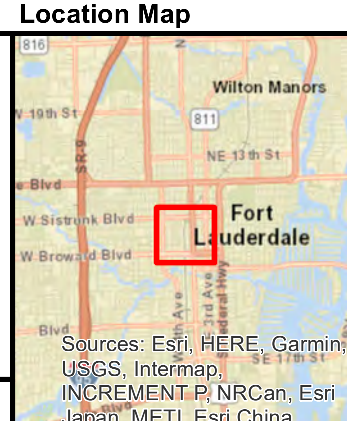
Alternative 1 Low-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- Low-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map



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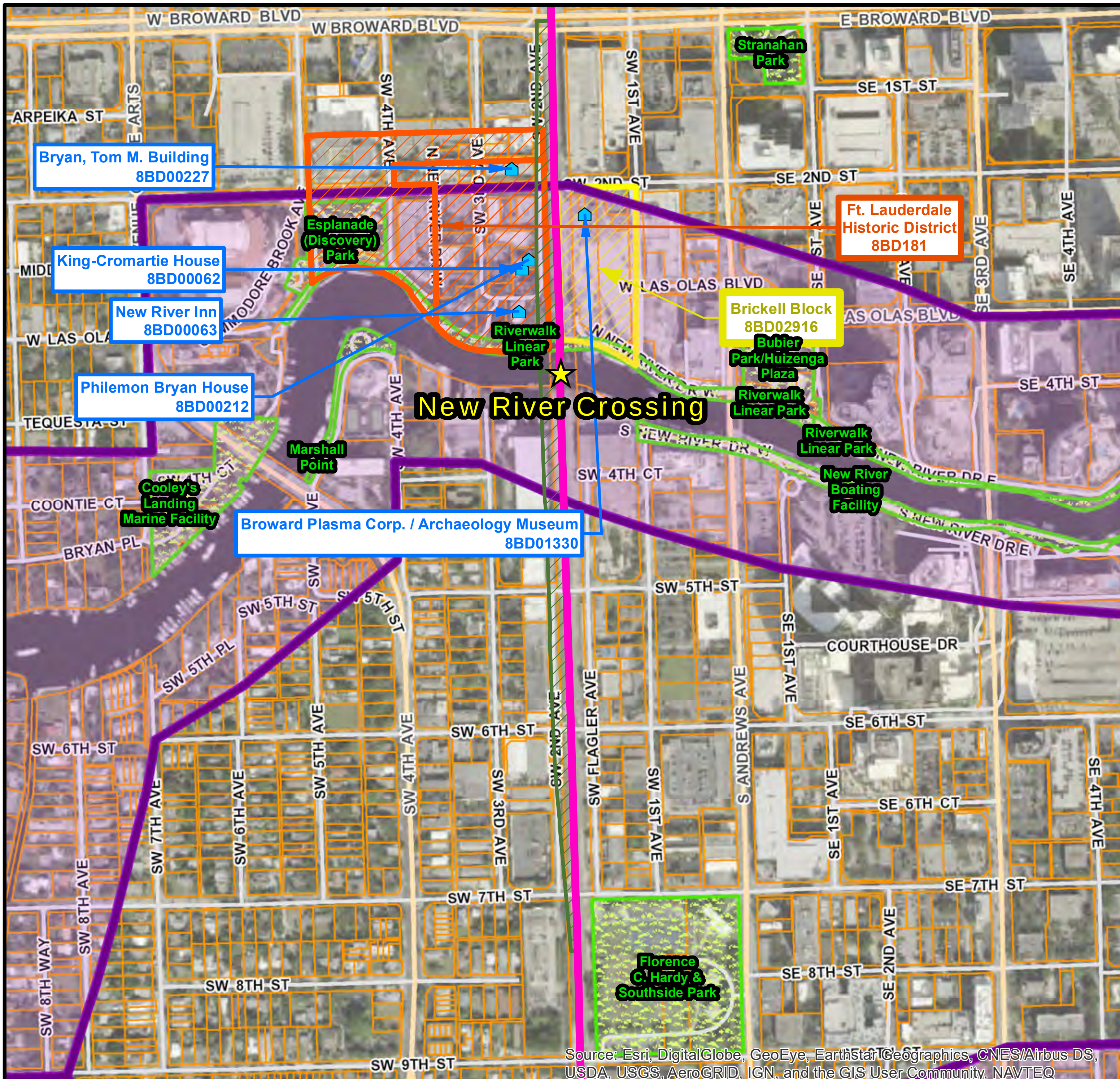
Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 39

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 1 Low-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- Low-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

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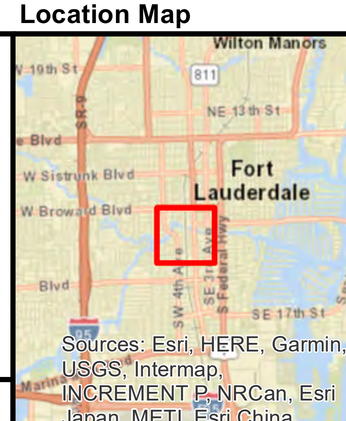
330 Feet

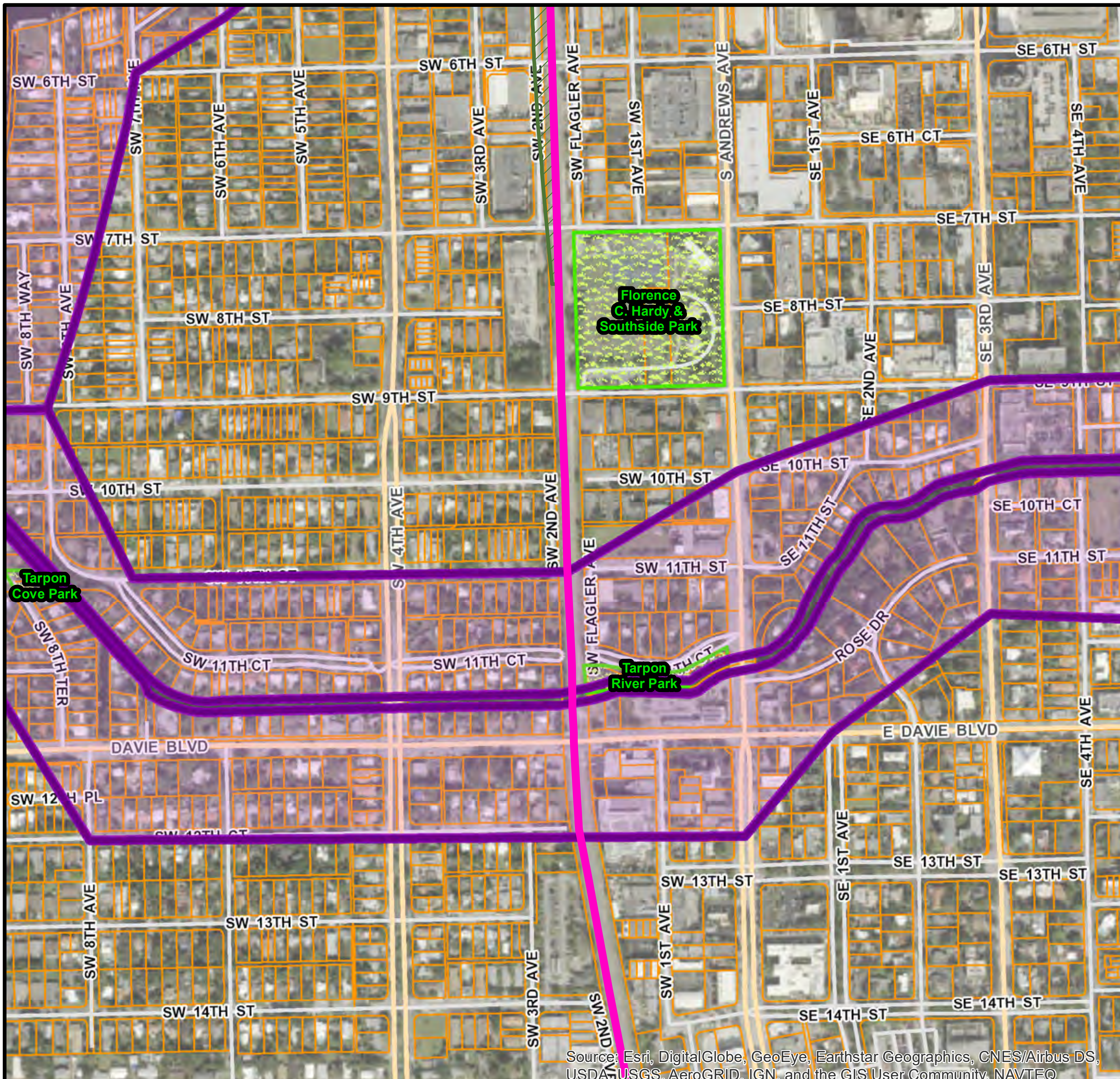


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 40

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

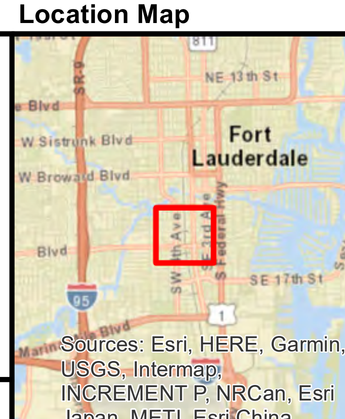
Alternative 1 Low-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- Low-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map



N

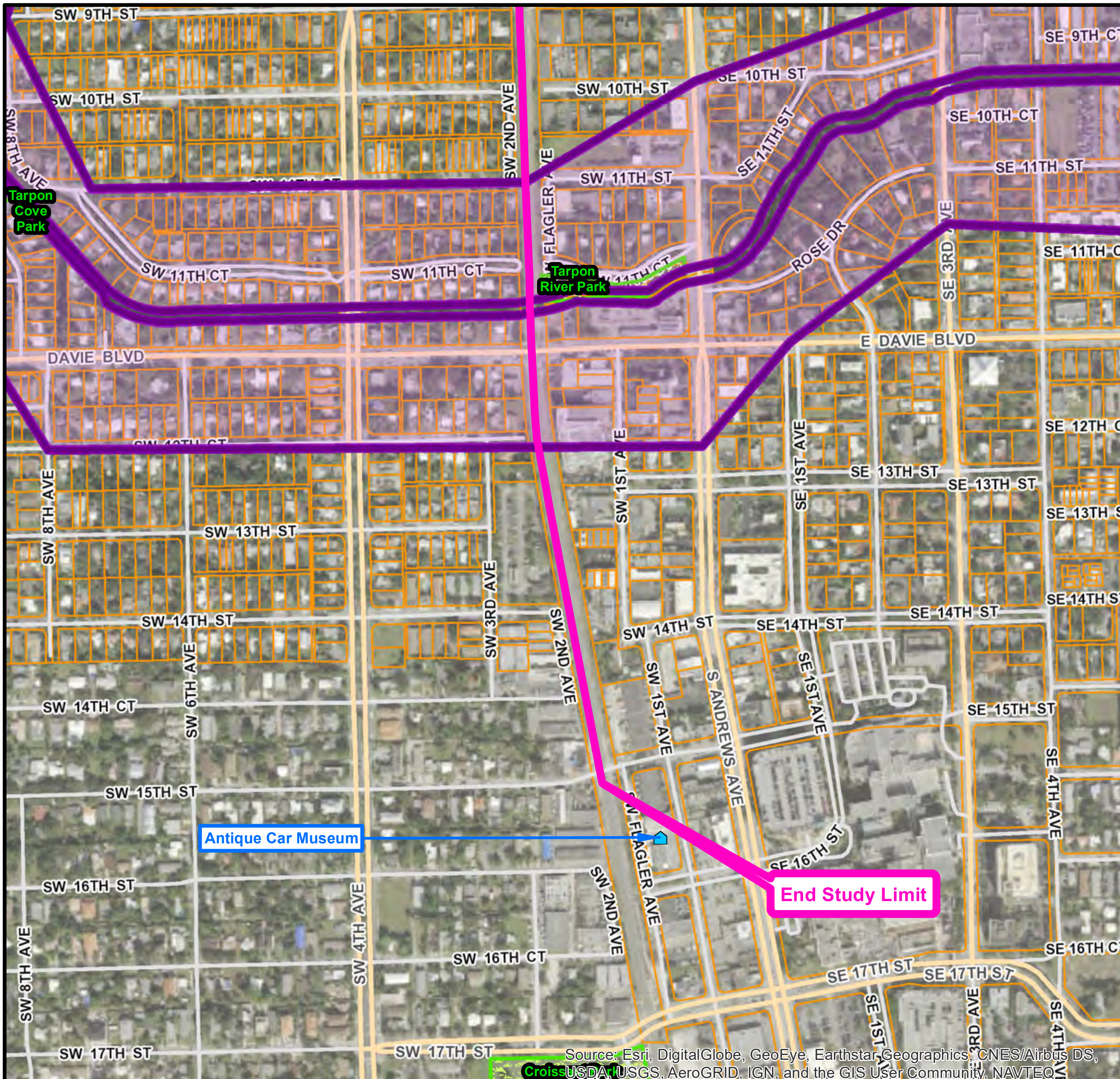
330 Feet

Broward County

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 41

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01



New River Bridge Feasibility Study

Alternative 1 Low-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

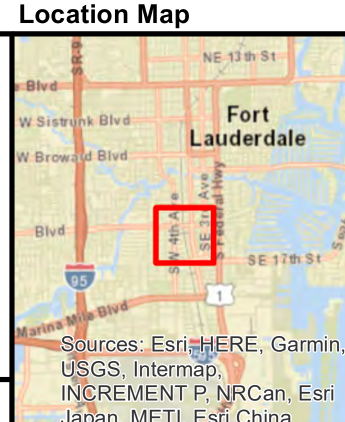
LEGEND

- New River Crossing
- Study Limits
- Low-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

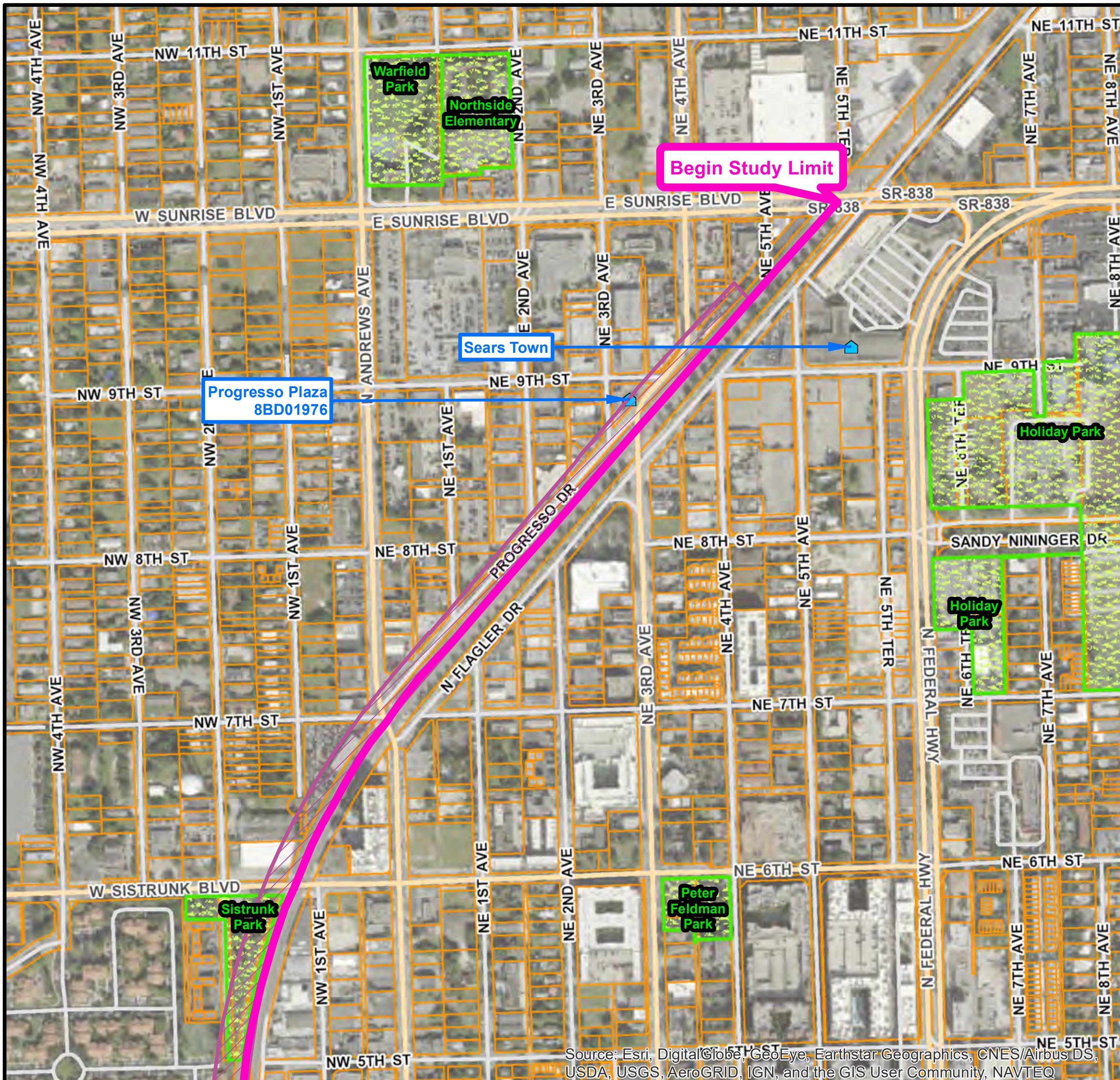


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 42

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 2 Mid-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

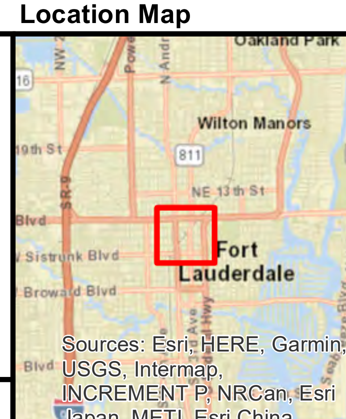
LEGEND

- New River Crossing
- Study Limits
- Mid-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

N

330 Feet

Location Map

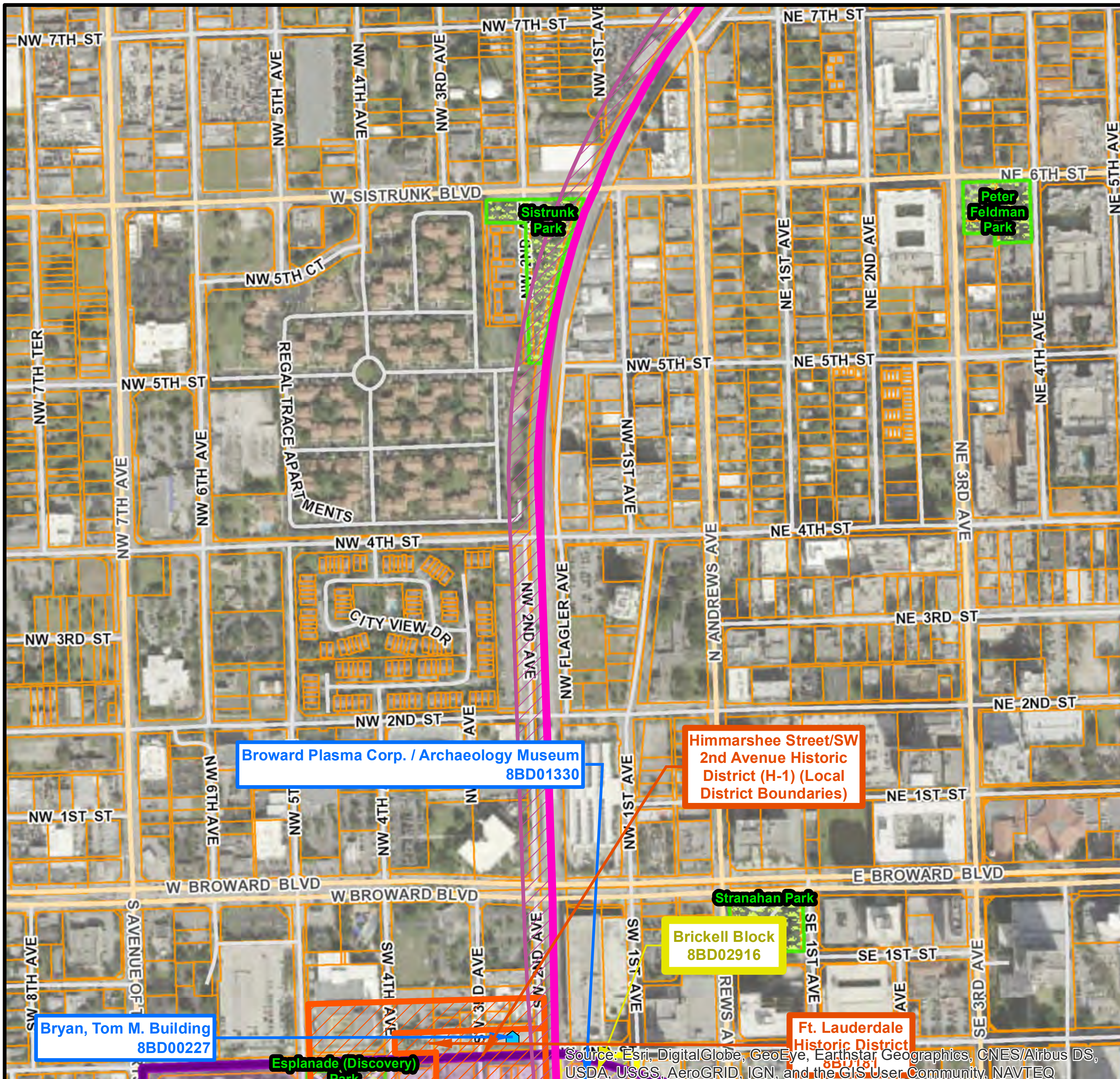


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 43

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 2 Mid-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

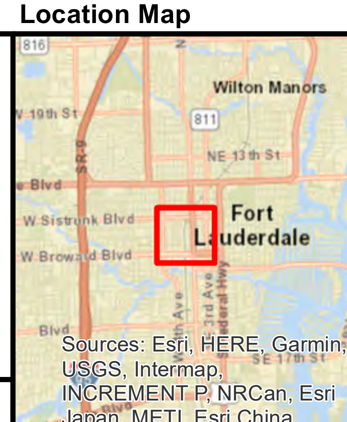
LEGEND

- New River Crossing
- Study Limits
- Mid-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

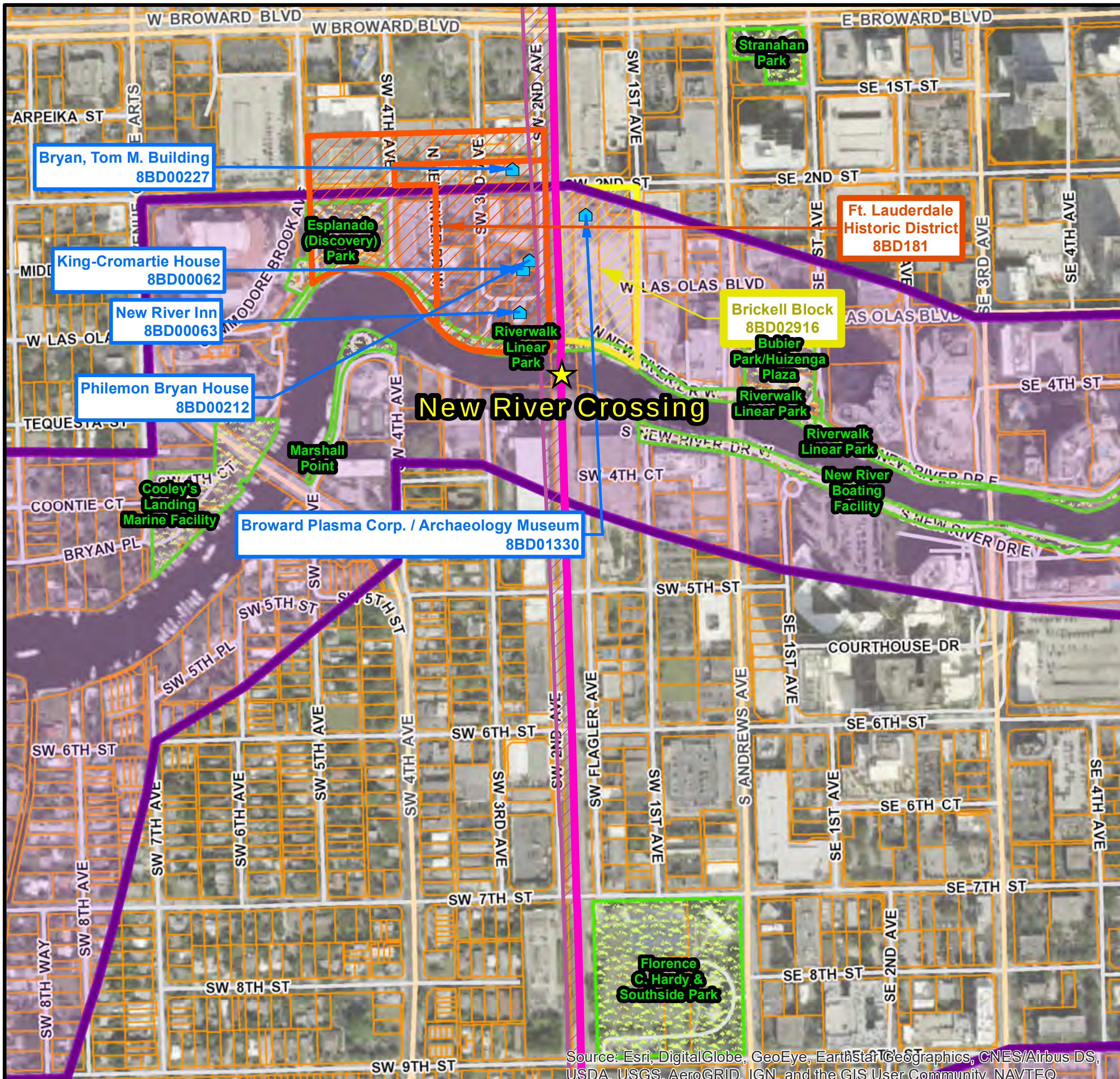


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 44

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 2 Mid-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

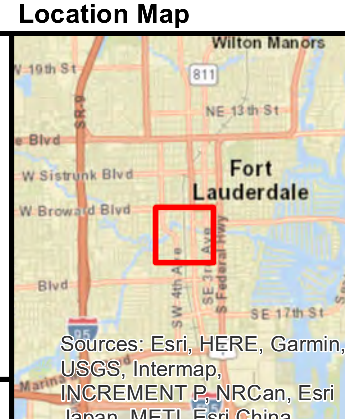
LEGEND

- New River Crossing
- Study Limits
- Mid-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

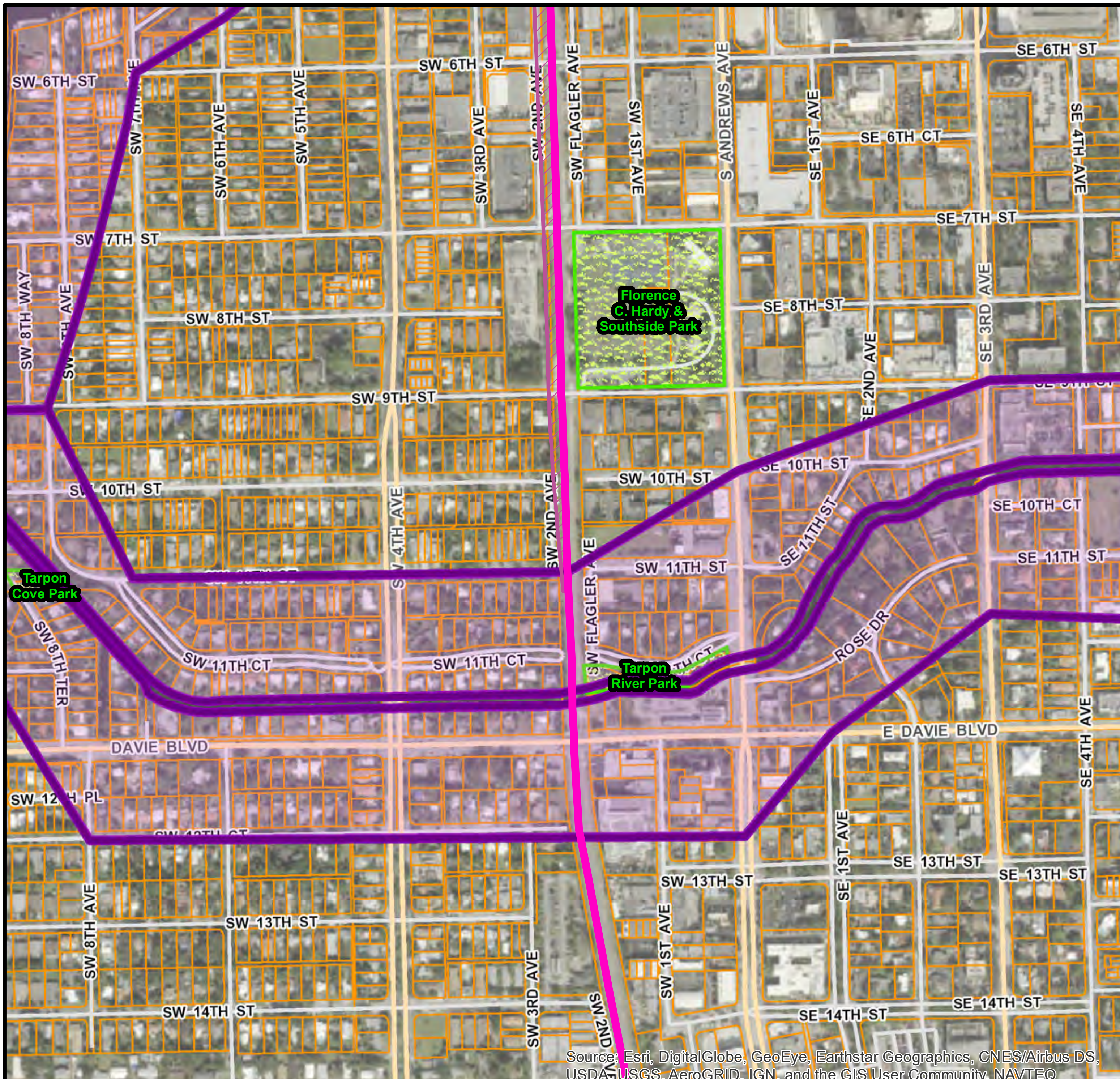


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 45

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 2 Mid-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

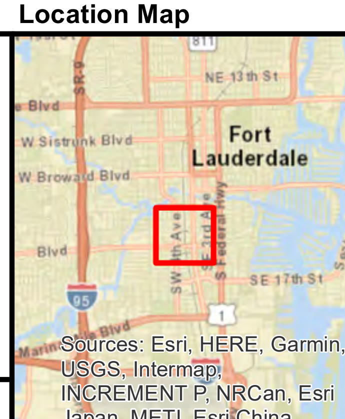
LEGEND

- New River Crossing
- Study Limits
- Mid-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

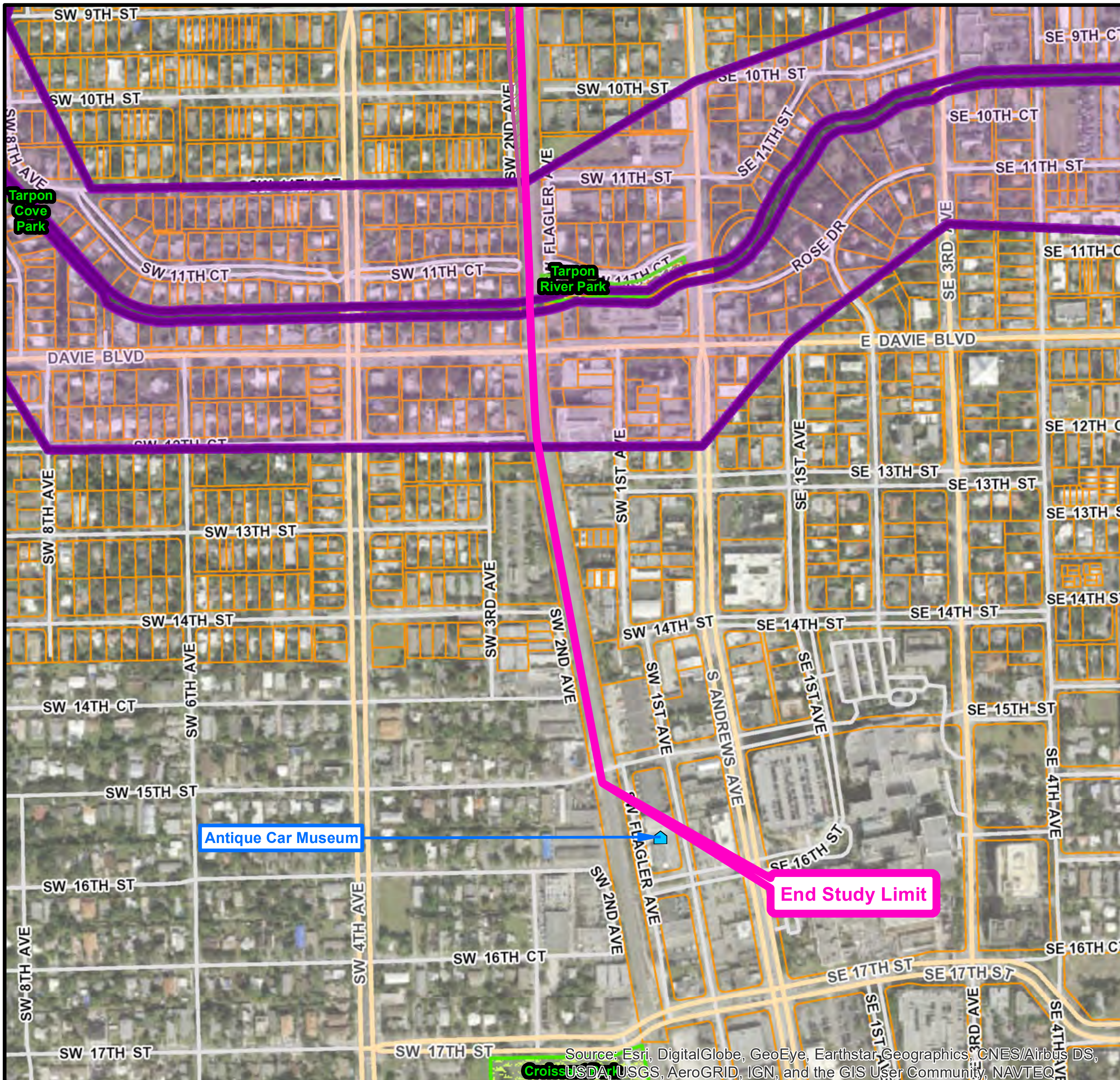


Broward County

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 46

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01



New River Bridge Feasibility Study

Alternative 2 Mid-Level Bascule Bridge - Potential Cultural Resources Considerations

FDOT

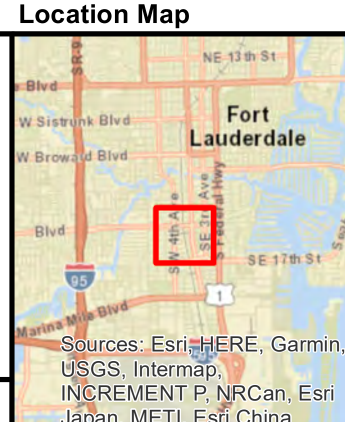
LEGEND

- New River Crossing
- Study Limits
- Mid-Level Bascule Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

N

330 Feet

Location Map

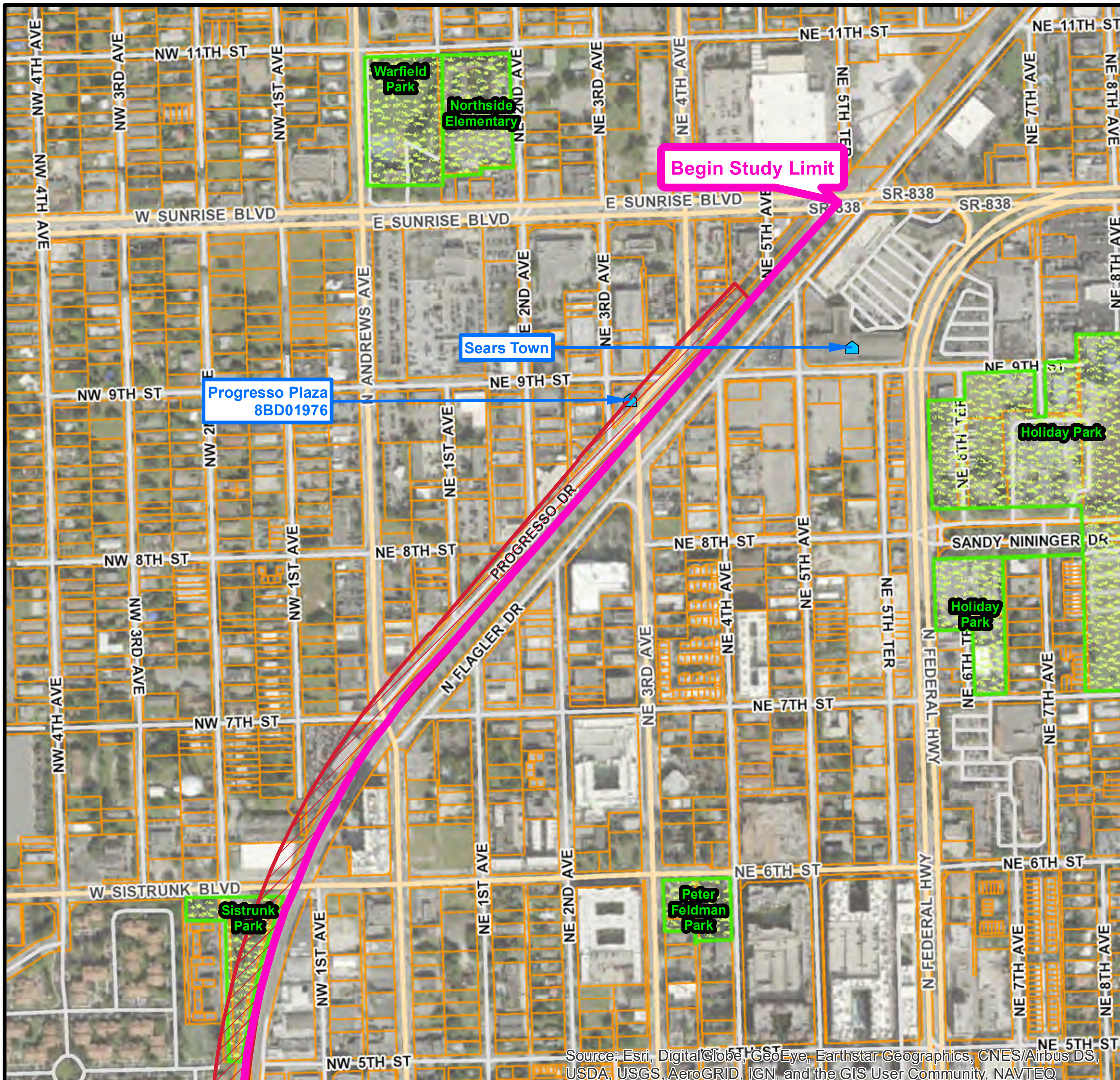


Broward County

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 47

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01



New River Bridge Feasibility Study

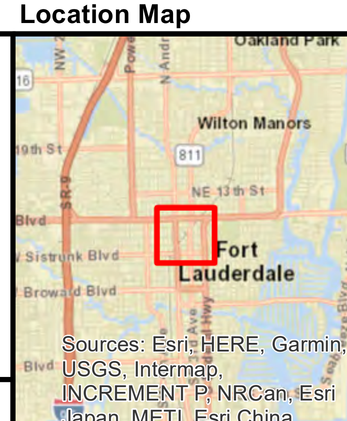
Alternative 3 High-Level Fixed Bridge - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- High-Level Fixed Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map



N

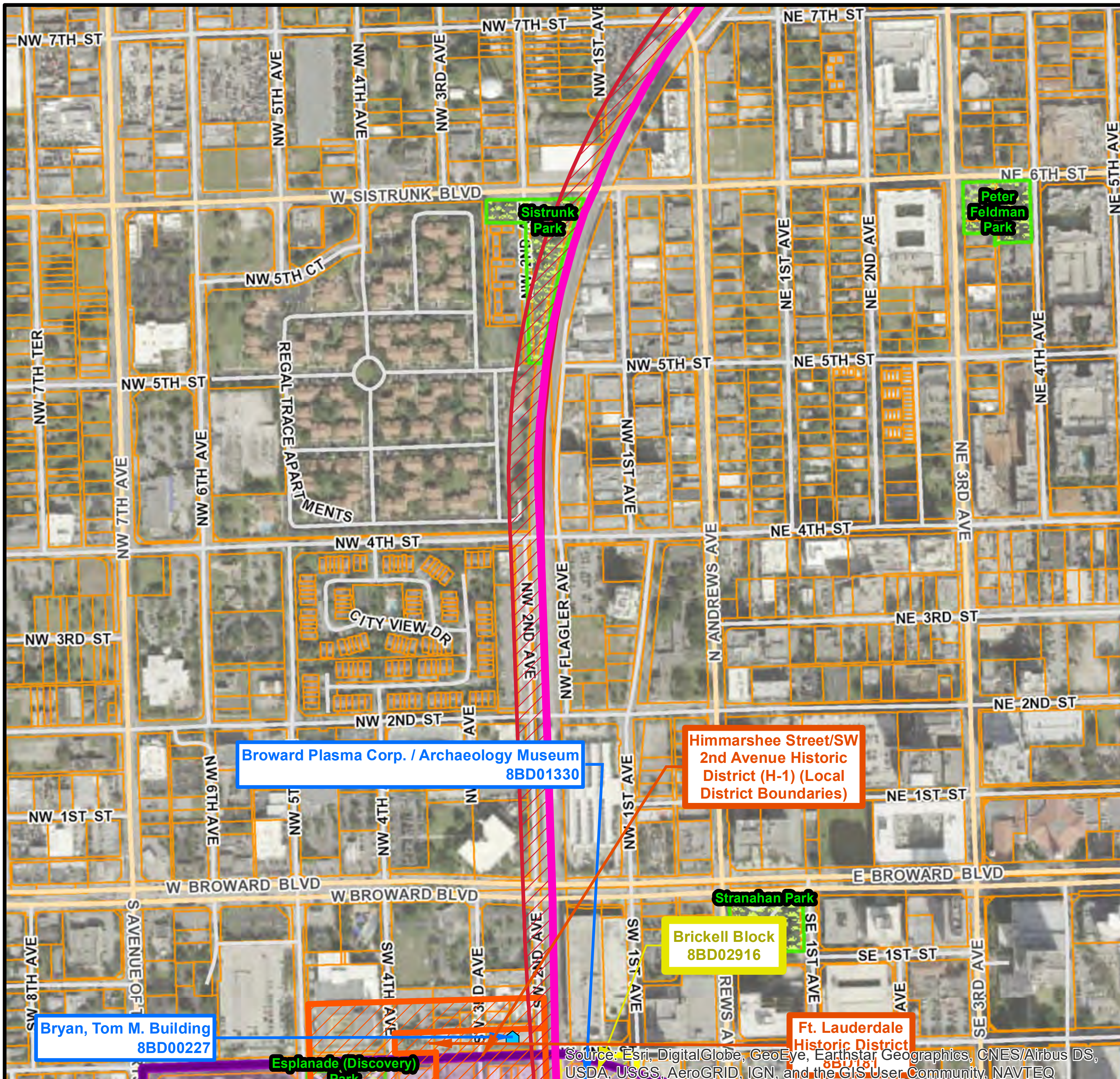
330 Feet

Broward County

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 48

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01



New River Bridge Feasibility Study

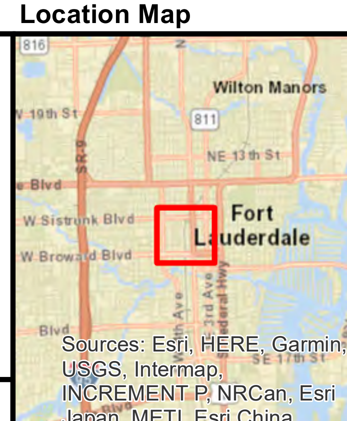
Alternative 3 High-Level Fixed Bridge - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- High-Level Fixed Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map



N

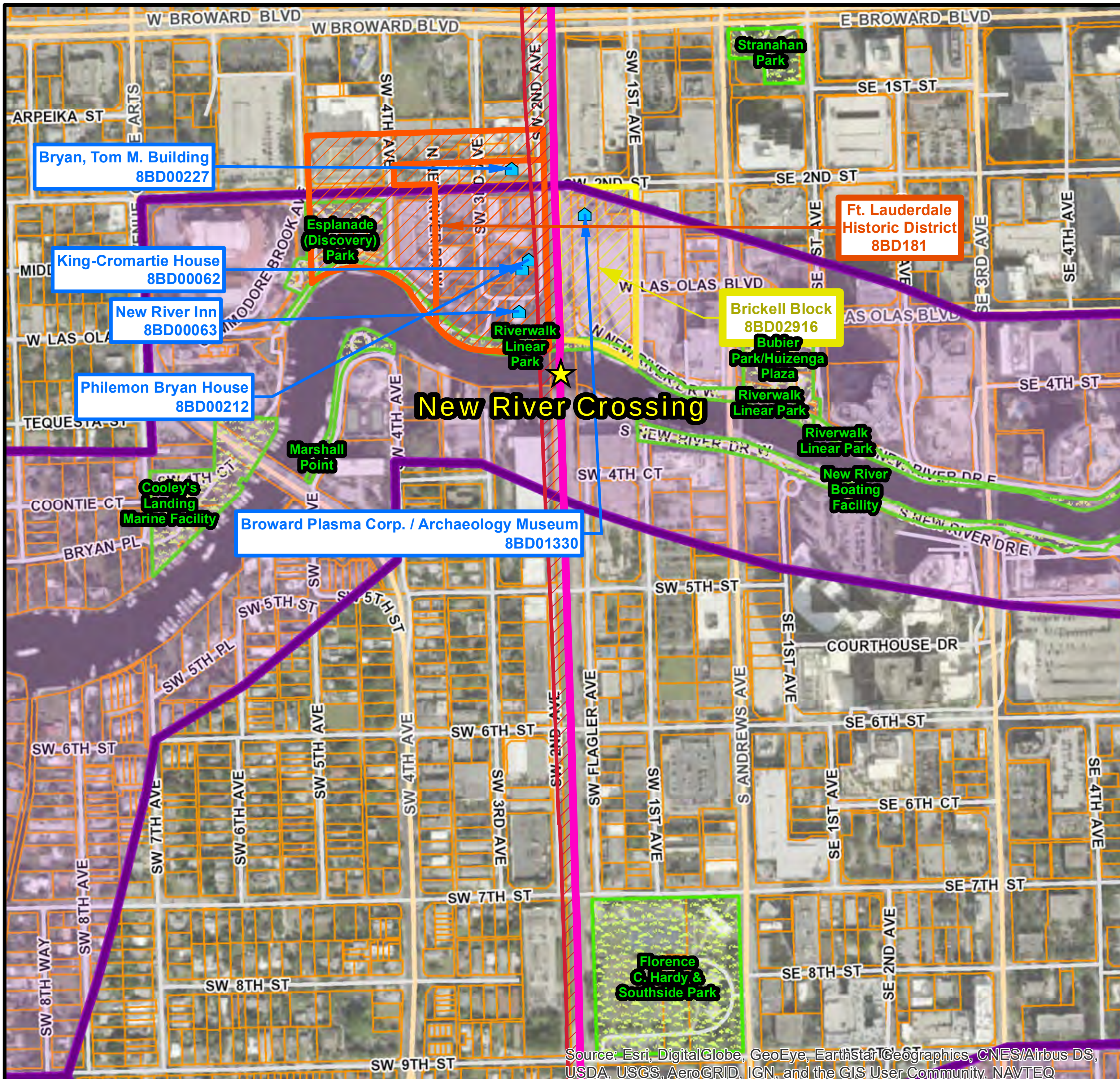
330 Feet

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 49

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 3 High-Level Fixed Bridge - Potential Cultural Resources Considerations

FDOT

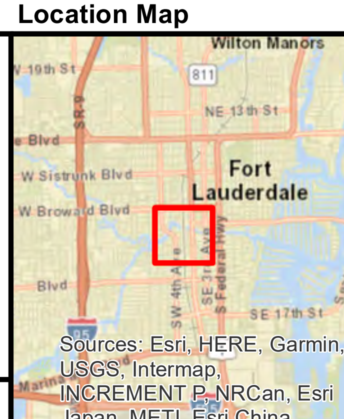
LEGEND

- New River Crossing
- Study Limits
- High-Level Fixed Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

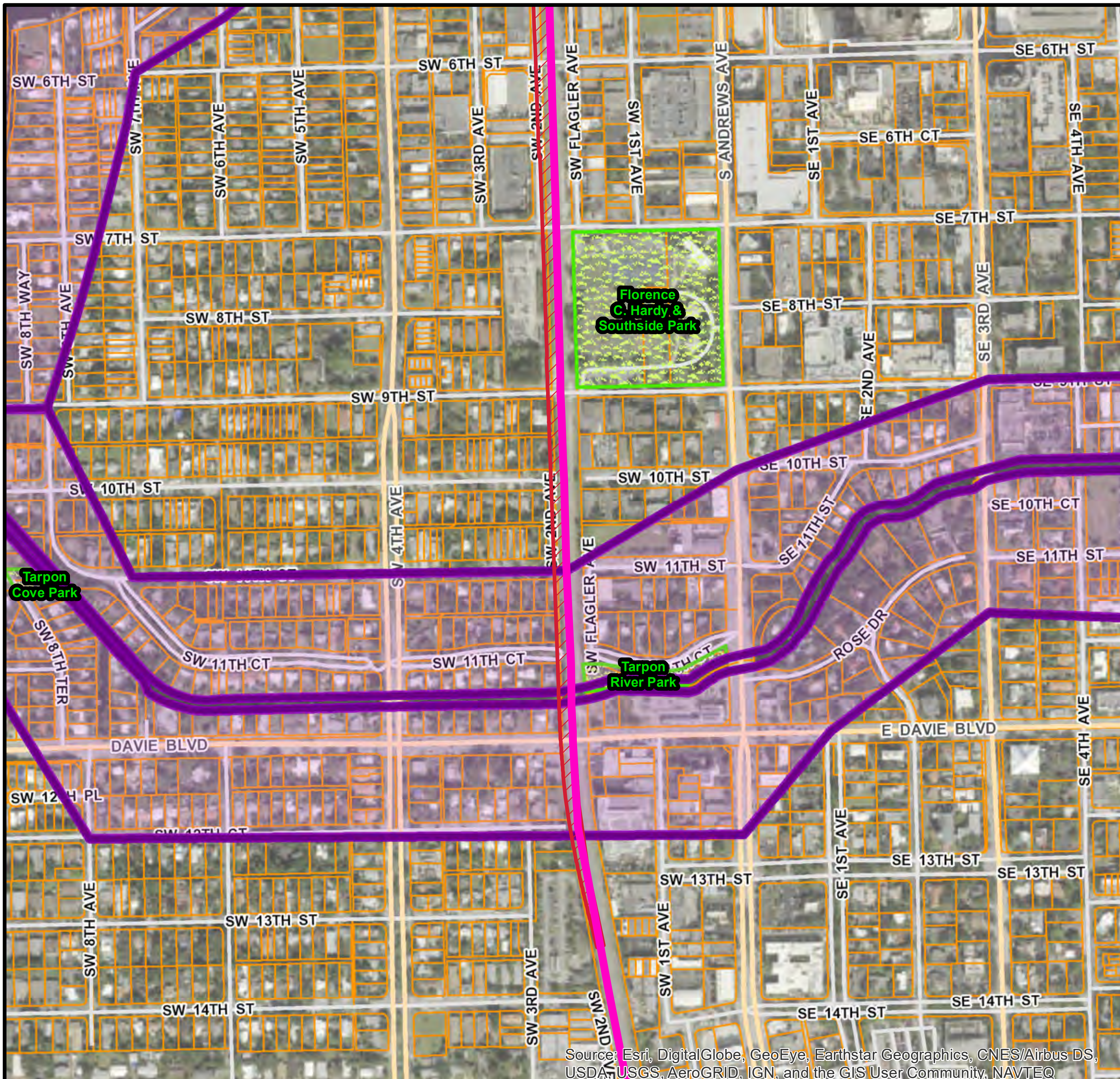


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 50

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 3 High-Level Fixed Bridge - Potential Cultural Resources Considerations

LEGEND

- New River Crossing
- Study Limits
- High-Level Fixed Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 51

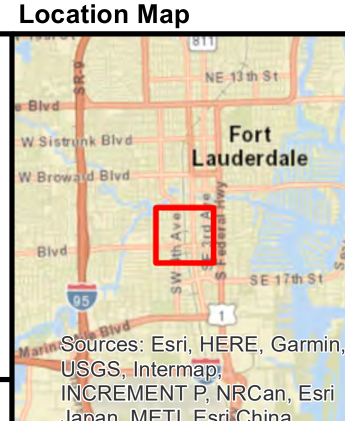
Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

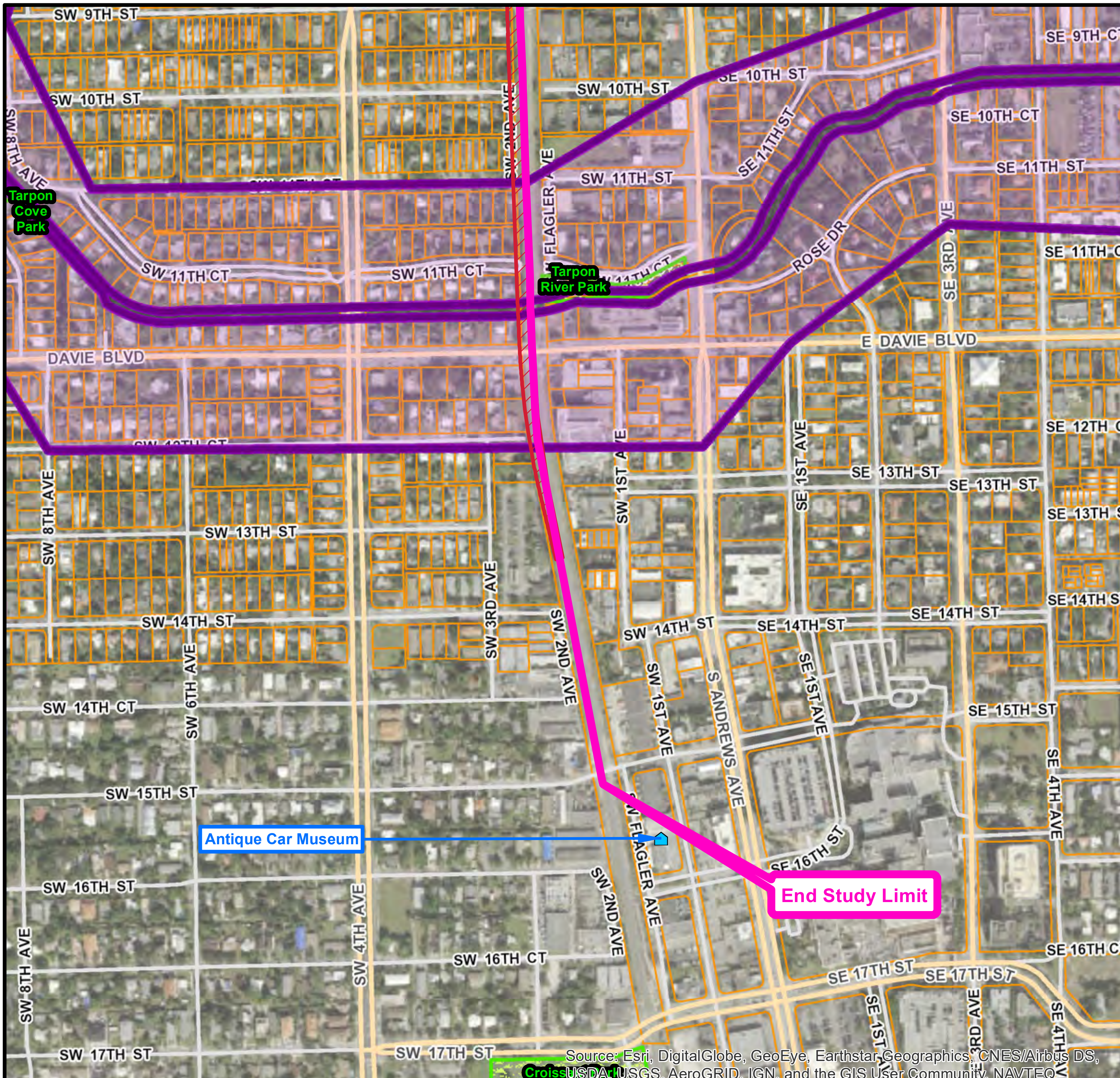
Location Map

N

330 Feet

Broward County





New River Bridge Feasibility Study

Alternative 3 High-Level Fixed Bridge - Potential Cultural Resources Considerations

FDOT

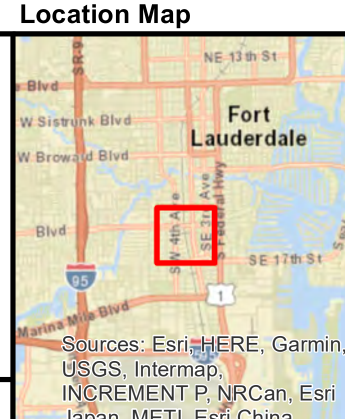
LEGEND

- New River Crossing
- Study Limits
- High-Level Fixed Bridge
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

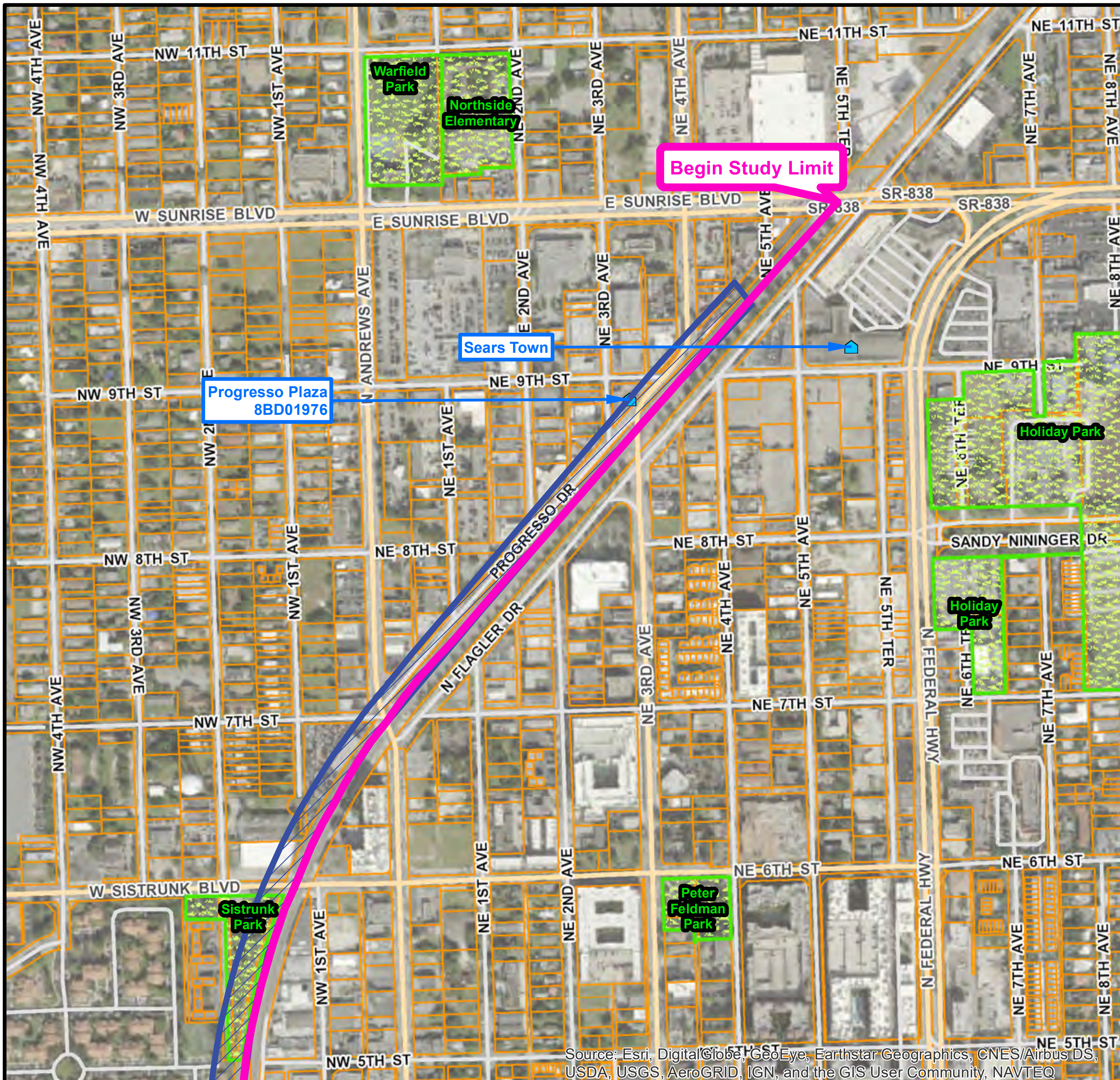


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 52

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 4 Tunnel - Potential Cultural Resources Considerations

FDOT

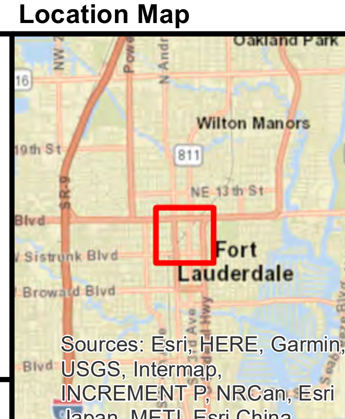
LEGEND

- New River Crossing
- Study Limits
- Tunnel
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

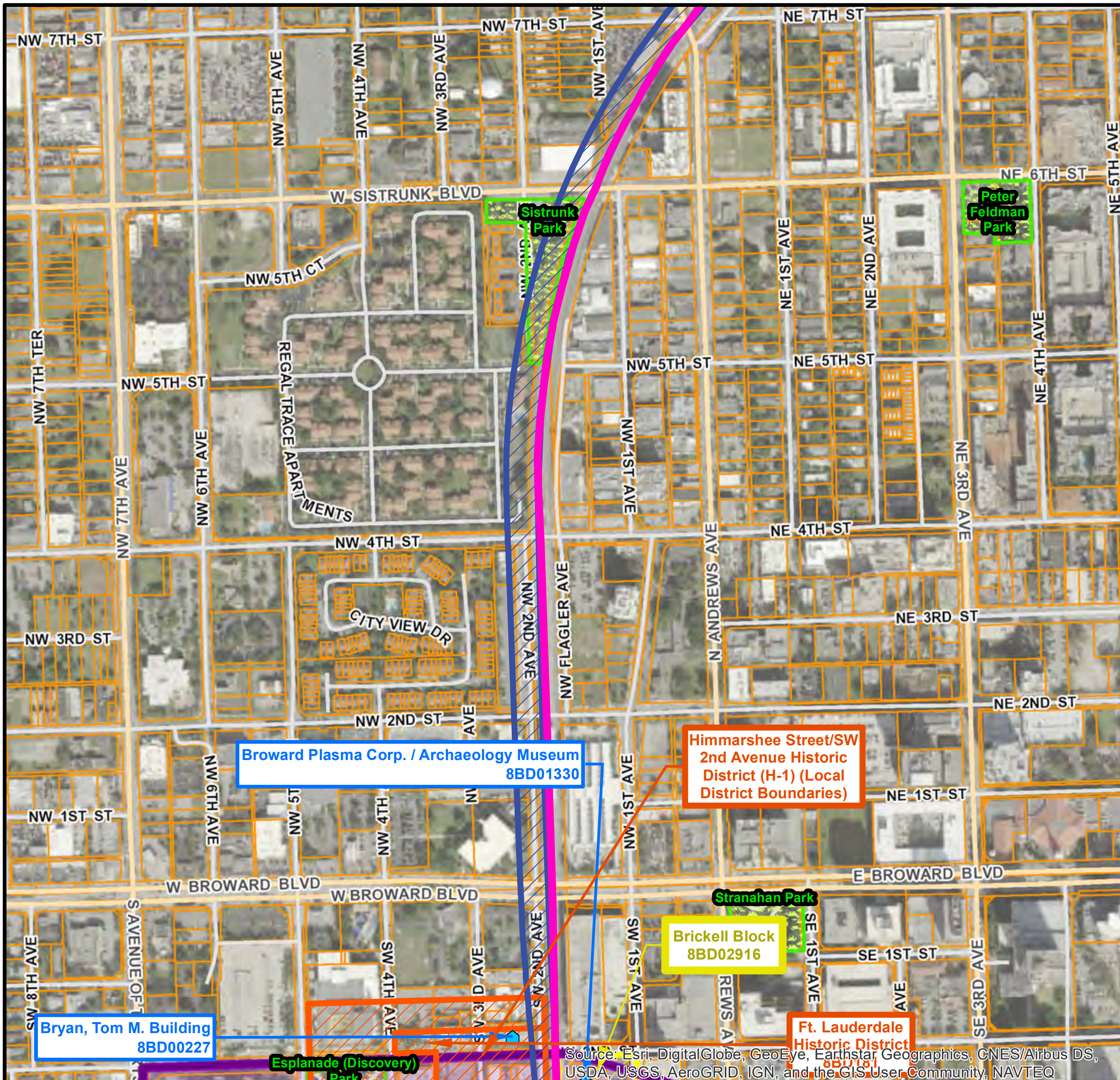


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 53

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 4 Tunnel - Potential Cultural Resources Considerations

FDOT

LEGEND

- New River Crossing
- Study Limits
- Tunnel
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 54

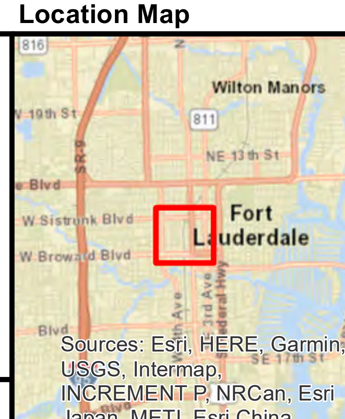
Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

N

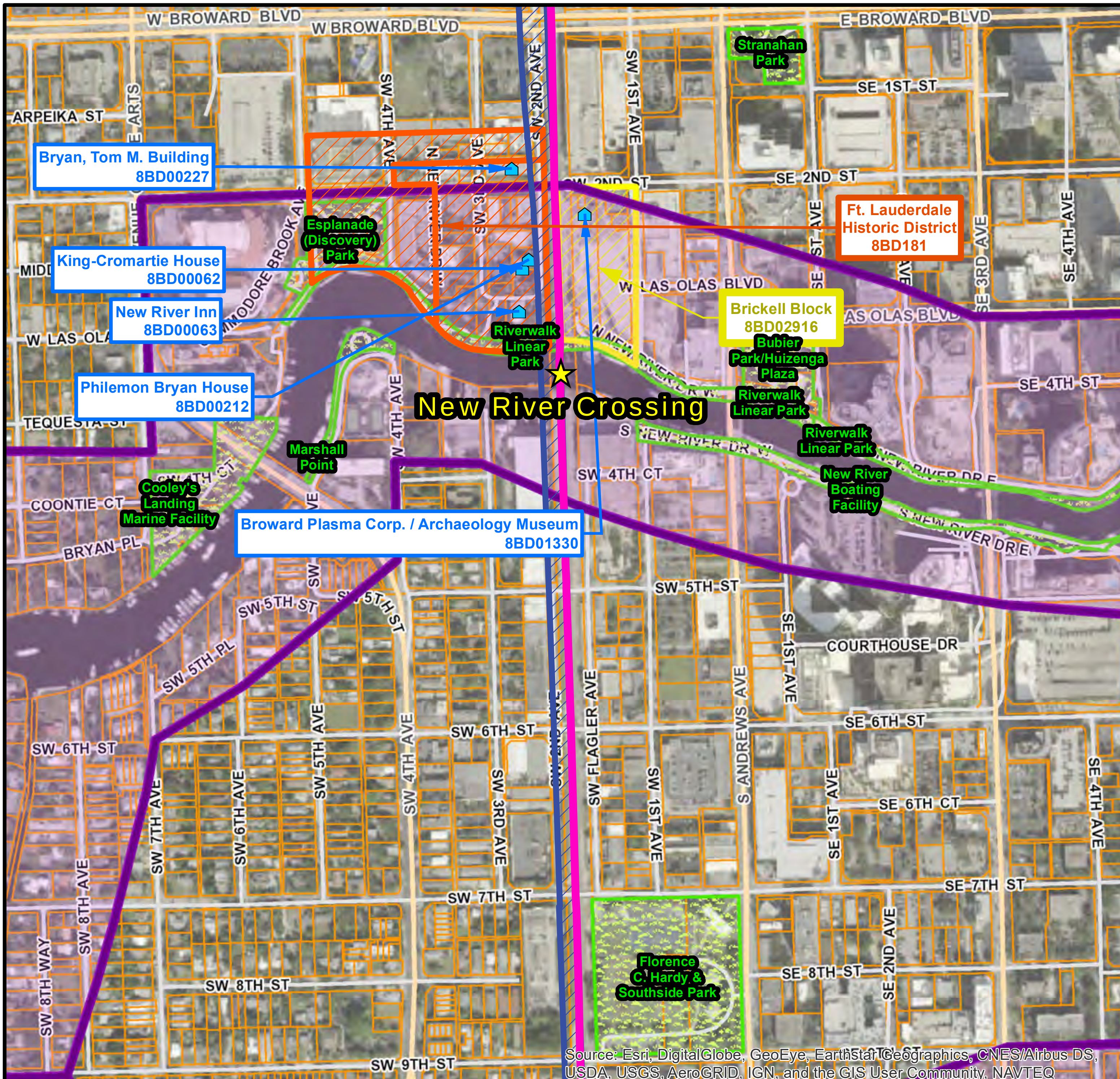
330 Feet

Broward County

Location Map



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China



New River Bridge Feasibility Study

Alternative 4 Tunnel - Potential Cultural Resources Considerations

FDOT

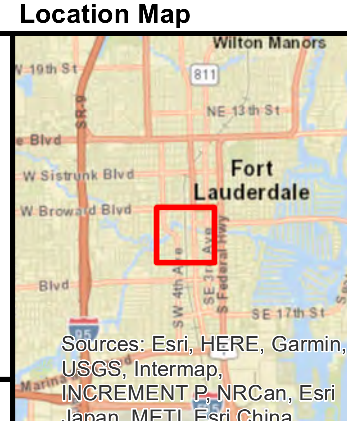
LEGEND

- New River Crossing
- Study Limits
- Tunnel
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

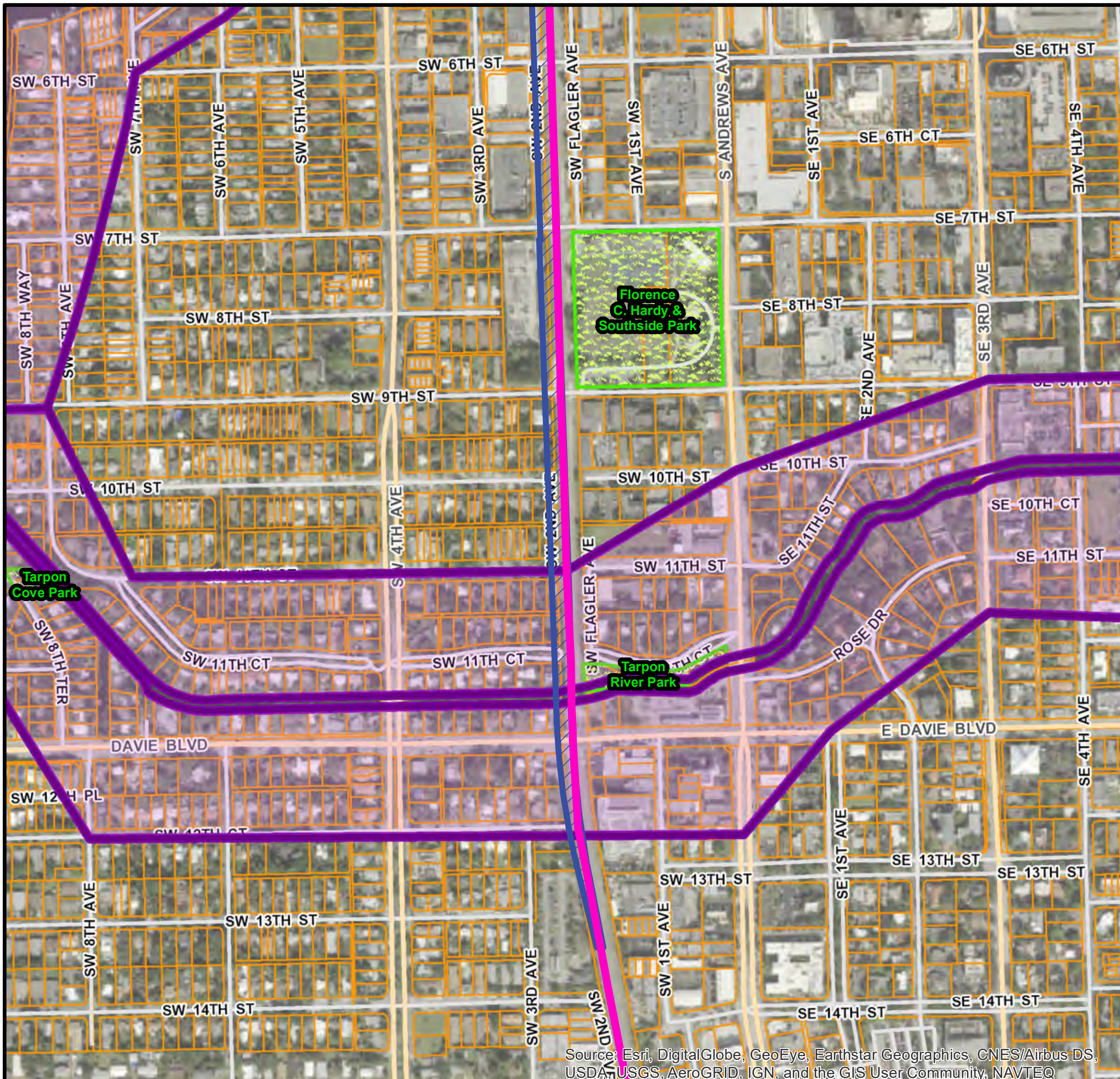


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 55

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 4 Tunnel - Potential Cultural Resources Considerations

FDOT

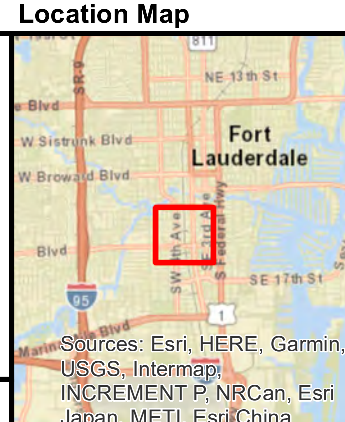
LEGEND

- New River Crossing
- Study Limits
- Tunnel
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet

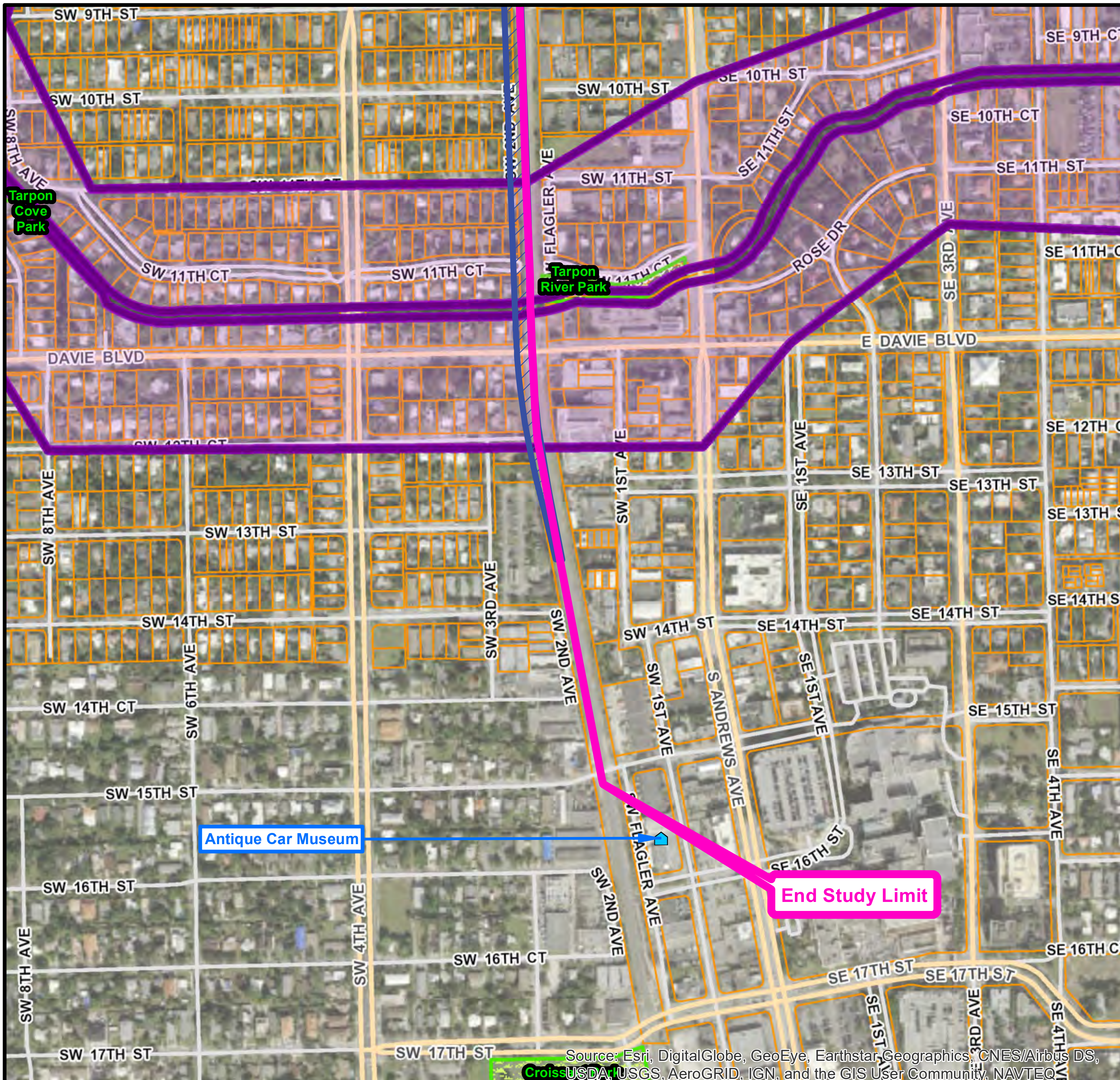


Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 56

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County



New River Bridge Feasibility Study

Alternative 4 Tunnel - Potential Cultural Resources Considerations

FDOT

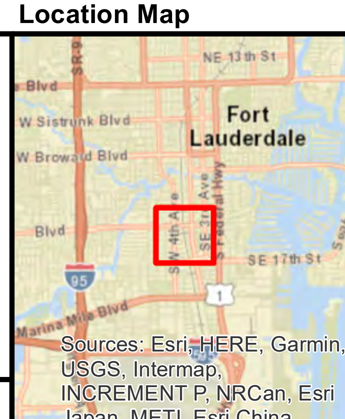
LEGEND

- New River Crossing
- Study Limits
- Tunnel
- Historic Structures
- Historic Stations
- Historic District
- Archaeological Zones
- Archaeological Sites
- Recreation/Park
- Parcels

Location Map

N

330 Feet



Note: The data shown on this map depicts the available information available at the time of the development of this Feasibilty Study. Data to be collected and updated in the Project Development& Environment (PD&E) phase.

Figure 57

Project Development & Environment (PD&E) Services for Tri-Rail Coastal Link (TRCL)
FPID: 417031-5-22-01; 417031-6-22-01; 417031-7-22-01

Broward County

9.3 Constructability

A constructability review is a process that reviews and ensures that a project is buildable, while also being cost-effective, biddable, and maintainable. It is important to note that a constructability review in the early stages of a project has the best potential for providing meaningful benefits without having an adverse effect on project schedules. Conducting constructability reviews early and consistently throughout the project's life can also avoid potential project delays, increased costs, construction claims, and delays and/or disruptions to the public. As part of this study, construction factors were considered during the development of the alternatives. This includes identification of potential challenges, assumptions, sequencing, temporary conditions, etc. As project development continues, further constructability reviews will need to be conducted during the PD&E and subsequent phases. The following lists preliminary constructability considerations for the alternatives.

Alternative 1: Low-Level Bascule Bridge

- The offset of the new bridge will allow for current freight and passenger traffic to remain operational on the existing FEC Railway Bridge throughout the construction phase of the new bridge.
- Due to the limited right of way, the portion of the new bridge within the river, will be constructed utilizing barges. Work from the barges will include all aspects of construction but not limited to foundations, piers, main span, fender system for the moveable span.
- Temporary track and train signals will need to be provided on the north approach prior to start of the construction of the new bridge approach spans and retaining wall sections. Permanent track and signals for freight and passenger trains will be constructed after the new bridge and approaches are built.
- For the bridge approach spans (foundation, piers, and superstructure) and retaining wall approaches to the bridge, construction will require the permanent closure of sections of SW 2nd Avenue (north and south of the river) for both approaches. Note: All foundation work will require vibration monitoring of all the existing structures according to the FDOT requirements.
- On the north approach, the existing mechanical buildings, adjacent to the most western existing track, will have to be relocated prior to the construction of the approach spans and retaining wall sections. Additionally, the Himmarshee crossing will be permanently closed for pedestrians and vehicle traffic. On the south approach, the SW 5th street crossing will be permanently closed to pedestrian and vehicular traffic.

Alternative 2 & 3: Mid-Level Bascule Bridge & High-Level Fixed Bridge

- The offset of the new bridge will allow for current freight and passenger traffic to remain operational on the existing FEC Railway Bridge throughout the construction phase of the new bridge.
- In order to construct the main span over the river, it is anticipated that the bridge approach spans (foundation, piers, and superstructure) and retaining wall approaches will be constructed prior to the main span for construction access. On the north approach, construction will require the temporary closure of NW 2nd Avenue for construction of the bridge spans. Construct the platform bridge section adjacent to the existing station to allow for the new elevated station. On the south approach, the SW 7th Street crossing will be permanently closed to pedestrian and vehicular traffic.
- The foundations and portions of the bridge piers within the river will be constructed utilizing barges. The remaining portion of the main span will be constructed from the recently built approach spans (north and south). Note: All foundation work will require vibration monitoring of all the existing structures according to the FDOT requirements.
- Elevated train station platform will need to provide vertical circulation (elevators, escalators, and stairs), and connection to the existing station.
- Temporary track and train signals will need to be provided on the north approach prior to starting the construction of the new bridge approach spans and retaining wall sections. Permanent track and signals for freight and passenger trains will be constructed after the new bridge and approaches are built.

Alternative 4: Bored Tunnel with Cut/Cover at Station

- The tunnel will allow for existing freight and passenger service to remain operational on existing tracks and the FEC Railway Bridge throughout construction.
- The underground station area will be implemented using constructed with conventional cut and cover techniques allowing for restoration of street traffic after completion of construction. The width of the underground station is 70 feet.
- The tunnel with track centers of 14 feet will be a single Tunnel Boring Machine (TBM) bore that is 40 feet in diameter.
- Depth of cut and cover and TBM will be approximately 75 feet below existing track.
- No geotechnical data was collected for this feasibility assessment. Existing conditions similar to Port Miami tunnel was assumed for constructability and cost estimating, which assumes a need for injected grout to fill lime rock voids prior to TBM boring.
- Length of open cut for construction of tunnel expected to extend from south of Broward Boulevard to south of NW 6th Street. Open cut will include use of sheet piles cofferdams, dewatering or impermeable wall systems and support of/relocation of existing utilities.

- Temporary bridge crossings at Broward Boulevard and Himmarshee Street and/or NW 4th Street will be required to maintain acceptable circulation of surface street movements. Station construction will be possible in incremental lengths to minimize disruption to traffic flows.
- With completion of the station box, backfill above the structure including placement of utilities impacted by the construction will be placed.
- Deep excavation construction methods may be used for underground ventilation buildings at the portal areas and mid-point, and for any shaft construction. For these structures, the excavation's initial support systems could include reinforced concrete drilled-in-place piles, soldier piles and lagging, and tied-back excavations. This allows support of the ground while soil is removed from the interior excavation. Final support includes the concrete slabs, walls, and walkways.
- Pre-drilling of holes may be necessary to eliminate pile driving and reduce project noise and vibration levels that would otherwise occur with pile driving.
- TBM requires that the face of the tunnel excavation and its full perimeter are tightly controlled to minimize ground losses, soil movement toward the tunnel shield and movements of the overlying ground and ground surface typical of lime rock strata. The primary underground construction methods considered for the tunnel is mechanized excavation with a Main Beam or Shielded Tunnel Boring Machine dependent on the geologic features revealed in the detailed geotechnical investigations. The Main Beam TBM or its Shielded counterpart, both excavate the rock with a rotating cutter equipped with special rock cutting tools located around the head of the machine. The excavated rock is typically removed from the invert of the cutter head and transported by conveyor or muck trains from the tunnel heading to the ground surface for disposal. Behind the TBM a support system to forestall the movements of the soil/rock around the excavated perimeter is required to maintain the safety and stability of the opening during construction and for the service life of the structure. The open main beam machine requires support of the excavated rock perimeter typically with rock bolts, shotcrete and lattice girders and similar support installed behind the cutter head. The shielded machine typically installs precast segmental lining ring elements behind the shield hood of the machine, then they are grouted into place.
- A length of tunnel may be conventionally mined at the transition between the open cut station and the 40-foot diameter TBM. In conventionally mined tunnels, initial support is followed by a final cast-in place lining.
- A waterproof membrane may be required behind the concrete lining against the soil/rock surface to minimize long-term leakage of groundwater into the tunnel that may cause deterioration of the lining and affect the electrical and signaling systems in place in the tunnel.
- Fire and Life Safety Measures require means of safe egress in the event of a fire or other emergency within the tunnel. Meeting appropriate national standards for passenger transit tunnels will be required.

- During tunneling, some ground movements may produce surface settlement. The amount of settlement measured at the surface will be a function of the tunnel depth, size, tunneling equipment and techniques, and most importantly the geology conditions in which the tunnel is driven. To reduce surface settlement and the potential for ground loss and soil instability (raveling and fallout, caving) at the tunnel face, temporary support is installed immediately behind the TBM.
- During design of the project, buildings and other structures along the alignment will be evaluated considering the local geology, their proximity to the tunnel or open cut section and the tunneling methods to be employed. Additional settlement mitigation may be recommended.
- Critical to implementation of construction is acquisition of suitable work and laydown sites for construction of both the tunnels and station, typically large enough to allow for the construction activities, removal of spoil, shops, offices, etc. while providing adequate street access for construction traffic. These areas are typically adjacent to or where possible along the alignment. These areas have not been identified as a part of this study.

9.4 Cost Estimate

A preliminary order of magnitude cost estimate was developed for each alternative. Cost components associated with improvements include bridge structures, track, tunnel, stations, roadway, sitework, special conditions, rail signals/communications, construction, right of way, professional services, and operations & maintenance (O&M).

O&M estimates based on life cycle costs for each of the bridge alternatives and are derived from reasonable costs to operate, maintain, repair, and rehabilitate the fixed and movable span portions of the bridge over a period of 75 to 100 years (Tunnel life cycle calculations were based on a 20-year period). Activities considered for each alternative include annual maintenance, routine inspection, infrequent minor repairs and one major rehabilitation. Regular costs for the structures also include annual maintenance and routine inspection of the structural, mechanical/pump equipment, ventilation, safety and electrical systems, as well as bridge operators' salary and utility service. Minor and major repairs are considered at shorter intervals due to the anticipated service life of the mechanical, electrical and controls components. Life cycle costs are discounted and annualized in present-day values. Estimated O&M cost does not include the stations, as that cost is already being incurred by Brightline/Virgin Trains.

Table 16 shows the preliminary costs associated with each alternative. Refer to **Appendix F** for the basis of estimate and **Appendix G** for a detailed summary of costs.

Table 16: Preliminary Cost Estimate

Construction Costs	Alternative 1 Low Level Bascule Bridge (21 feet)	Alternative 2 Mid-Level Bascule Bridge (55 feet)	Alternative 3 High-Level Fixed Bridge (80 Feet)	Alternative 4 Tunnel
Structures	$50,170,640	$214,940,440	$245,477,908	$1,714,960
Track	$12,074,010	$15,402,114	$15,402,114	$15,409,030
Tunnel (including track, ventilation, emergency evacuation, fire suppression)	N/A	N/A	N/A	$2,315,256,047
Stations	N/A	$23,378,228	$23,378,228	$49,632,656
Roadway	$399,100	$2,772,900	$2,772,900	$1,078,350
Sitework and Special Conditions	$3,182,362	$10,207,549	$9,962,674	$8,909,927
Utility Relocation Allowance	$1,000,000	$2,800,000	$3,100,000	$8,000,000
Rail Signals/ Communications	$16,587,901	$17,430,183	$16,191,787	$17,357,371
Construction Cost	$83,414,013	$286,931,414	$316,285,611	$2,417,358,341
Right of Way Costs	$21,100,000	$54,200,000	$48,600,000	$53,400,000
Professional Services	$29,820,510	$102,577,980	$113,072,106	$864,205,607
Total Project Costs	**$134,334,523**	**$443,709,394**	**$477,957,717**	**$3,334,963,948**
Operations and Maintenance Cost ($/Year)	**$1,900,000**	**$3,300,000**	**2,400,000**	**$8,200,000**

9.5 Qualitative Analysis Matrix

A qualitative analysis was conducted to assess the alternatives; ranging from low, medium, medium-high, and high impacts. The qualitative analysis evaluated the following criteria:

1. Corridor considerations such as length of track improvements, length of bridge structures, and number of street closures.
2. Constructability considerations that may impact construction staging, duration, freight and passenger train operations, businesses, and cross streets during construction.
3. Right of Way impacts.
4. Environmental considerations for:
    a. Cultural resources such as Section4(f)/Section 106 (parks, recreation areas, historic and archaeological sites);
    b. Physical resources such as noise;
    c. Social resources such as visuals and aesthetics.
5. Maritime operational impacts.

The summary of the qualitative analysis is presented in **Table 17**. All alternatives are considered feasible for evaluation in the subsequent PD&E phase.

Table 17: Qualitative Analysis Matrix

Evaluation Criteria	No Build Alternative	Alternative 1 Low Level Bascule Bridge (21 feet)	Alternative 2 Mid-Level Bascule Bridge (56.5 feet)	Alternative 3 High-Level Fixed Bridge (80 Feet)	Alternative 4 Tunnel
Corridor Considerations					
Length of Track Improvements	○	◔	◑	◑	●
Length of Structure	○	◔	◑	◕	●
# of Street Closures	○	◑	◔	◔	◔
Constructability					
Construction Staging	○	●	◕	◕	●
Freight Operational Impacts	○	◑	◑	◑	◔
Passenger Operational Impacts	○	◔	◑	◑	◕
Impacts to Business	○	◕	◑	◑	●
Cross Street Impacts (During Construction)	○	●	◕	◕	●
Construction Duration	○	◔	◕	◕	●
Right of Way					
Impacts	○	●	◕	◕	●
Environmental Issues					
Cultural Resources	○	◕	◕	◕	◕
Noise	◕	◕	●	◕	◔

Evaluation Criteria	No Build Alternative	Alternative 1 Low Level Bascule Bridge (21 feet)	Alternative 2 Mid-Level Bascule Bridge (56.5 feet)	Alternative 3 High-Level Fixed Bridge (80 Feet)	Alternative 4 Tunnel
Visual / Aesthetics	◯	◑	◕	●	◔
Martime Impacts					
Maritime Operations	●	◕	◑	◯	◯

Legend:

◯ *None* ◔ Low ◑ Medium ◕ Medium-High ● High

10.0 FUNDING SOURCES

For FDOT to advance the New River Crossing Feasibility Study into future project phases, two criteria must be coordinated including commitments for public use from the private owners of the rail corridor, any users with financial commitments within the corridor, and commitments from public agencies to fund future operations and maintenance costs of potential public transit use within the corridor. The criteria are as follows:

- Public access to the private freight corridor, an agreement must be developed that allows public transit to operate within the freight corridor.
- Operations and maintenance (O&M) costs must be identified and locally funded
.

Once these two issues resolved, the range of alternatives and associated costs are significant in order to identify potential funding sources. Currently the project is funded for the next phase, the Project Development and Environment (PD&E) study. Potential Sources for the project design, right of way acquisition and construction phases will be dependent on the type of project delivery system that will be utilized; a standard design, bid, build approach, design-build or a Public, Private Partnership (P3).

The following is a list of the general funding program (grant and loan) options to consider in advancing this project:

- Better Utilizing Investments to Leverage Development (BUILD). Federal Grant from the U.S. Department of Transportation (USDOT) for investment in surface transportation infrastructure.
- Infrastructure For Rebuilding America (INFRA). Federal Grant from the USDOT, Federal Railroad Administration (FRA) to highway and railroad projects of national or regional significance.
- Consolidated Rail Infrastructure and Safety Improvements (CRISI) and Federal-State Partnership for State of Good Repair Programs Benefit-Cost. Federal Grant from the USDOT, FRA.
- Rail Safety IDEA Program. Federal Grant from the USDOT, FRA to promote innovative approaches to improve railroad safety or performance.
- Transportation Infrastructure Finance and Innovation Act (TIFIA). USDOT direct loans, loan guarantees, and standby lines of credit designed to fill market gaps and leverage substantial private co-investment.
- Railroad Rehabilitation and Improvement Financing (RRIF). USDOT direct loans and loan guarantees to finance development of railroad infrastructure.
- New Starts/Small Starts, USDOT Federal Transit Agency (FTA) competitive funding of rail, fixed guideway projects:
    - New Starts – project costs equal to or greater than $300 million or total New Starts funding equals or exceeds $100 million.

  - Small Starts – project costs less than $300 million or total Small Starts funding less than $100 million.
  - Core Capacity – substantial corridor-based investment in corridor near or over capacity within five years; increase capacity by 5%.
- Private Activity Bonds (PAB). USDOT tax exempt bonds to increase private sector investment.
- State Infrastructure Bank (SIB). Revolving loan and credit enhancement program with federally funded account capitalized by federal monies matched with state money and state-funded account capitalized with state money and bond proceeds.
- State and Local Funding options vary with state/local constitutional, legislative, and local government requirements:
  - Motor fuel taxes
  - Optional sales taxes
  - General government contributions
  - Local fees
- Public-Private Partnerships (P3) – Various types including Build Finance; Design Build Finance; Design Build Finance Operate Maintain
  - The use of P3 delivery system will require identification of partners that can meet the public process requirements and identify the risk and equity return to a private partner. Given the number of crossing alternatives and associated potential costs, a range of P3 arrangements are possible.

Federal or state projects to be eligible for assistance under various statutes/codes potentially include Title 23, United States Code (USC) or capital projects as defined in Section 5302 or title 49 USC, projects of the Transportation Regional Incentive Program (TRIP) per Section 339.2819(4), F.S. These projects must be consistent, to the maximum extent feasible, included in the adopted plans of the Broward Metropolitan Planning Organizations (MPO) and local government comprehensive plans and must conform to policies and procedures within applicable Florida Statutes and other appropriate state standards for the transportation system.

11.0 IMPLEMENTATION PLAN

Upon completion of this feasibility study, the next phase in project implementation is the Project Development & Environment (PD&E) Study. In order to advance into the PD&E phase, the following needs to be completed:

- An agreement must be developed that allows public transit to operate within the rail corridor.
- Local funding sources must be identified to cover annual operations and maintenance cost.

The following describes the estimated implementation schedule for all the phases required. The total implementation schedule for the New River Crossing is estimated to range from 9 – 17 years, depending on the alternative selected for construction. See **Table 18** for the implementation timeline for the alternatives.

1. **PD&E Study**

The subsequent phase of the project is the Project Development and Environment (PD&E) Study. The expected environmental documentation level is an Environmental Impact Statement (EIS), which would require 36 – 48 months to complete.

2. **Final Design**

The next phase of the project will be the development of the final design plans. This phase is estimated at 18 – 36 months to complete, depending on the alternative selected for construction.

3. **Right-of-Way Acquisition**

The project will require the acquisition of right-of-way. Depending on the extent of right-of-way needed, this phase could be expected to take 24 - 36 months to complete and can be accomplished in conjunction with the final design phase.

4. **Construction**

Depending on the alternative selected for construction, the total construction time is estimated to range from 30 – 84 months. The above implementation timeline is based on a standard design, bid, build delivery system. Depending on the selection of a possible alternative delivery system, a Design-Build or potential Public-Private Partnership (P3), the overall timeline may be reduced by one to three years.

Table 18: Implementation Plan Timeline

Phase Timeline	No Build	Alternative 1 Low Level Bascule Bridge (21 feet)	Alternative 2 Mid-Level Bascule Bridge (55 feet)	Alternative 3 High-Level Fixed Bridge (80 Feet)	Alternative 4 Tunnel
PD&E Study	-	36 to 48 months	36 to 48 months	36 to 48 months	36 to 48 months
Final Design	-	18 to 24 months	24 to 36 months	24 to 36 months	24 to 36 months
Right of Way Acquisition	-	24 to 36 months	24 to 36 months	24 to 36 months	24 to 36 months
Construction	-	30 to 36 months	48 to 60 months	48 to 60 months	72 to 84 months
Total Anticipated Implementation Schedule	-	9 to 11 years	11 to 15 years	11 to 15 years	13 to 17 years

12.0 CONCLUSION

12.1 Conclusions

The following are the consensus of the conclusions reached by the FDOT as part of this study:

- All alternatives were determined to be feasible and should be further developed and evaluated in the PD&E phase.
- Potential Section 4(f) and Section 106 resources will need to be further evaluated in the PD&E phase. At this time, this study did not determine a fatal flaw, however, additional coordination with the FDOT, FTA, stakeholders, and consultation parties will be needed as part of the PD&E study to provide appropriate documentation of identified environmental resources and whether there any adverse effects to environmental resources.
- Appropriate level of documentation to meet NEPA requirements will be on going and will be part of the PD&E phase.
- An in-depth traffic analysis should be conducted as part of the PD&E study to determine how local downtown Fort Lauderdale traffic will be impacted by the various bridge crossing alternatives.
- A vessel survey update will need to be conducted as part of the PD&E study.
- A benefit cost analysis should be conducted as part of the PD&E phase to determine the life cycle benefits to the initial capital cost investment of the project.

12.2 Additional Considerations

Prior to initiation of a PD&E study, an agreement between the railroad owner and the public sector for public access and use of the rail corridor is required. The potential for the addition of a freight track to the east of the existing freight track alignment, and a review of the remaining lifespan of the existing freight bascule bridge should be considered. This will allow for an environmental assessment (PD&E) to minimize right of way impacts and costs, business damages and potential relocations, access impacts within the immediate river crossing vicinity, impacts to recreational or historic properties (Section 4(f) & Section 106) and potentially extend the life cycle of the existing freight bascule bridge. This study identified additional options that should be considered as part of the PD&E phase.

<u>Option 1:</u>

To achieve a shorter construction duration impact on freight and passenger operations, the existing bascule bridge could be relocated to the east within the railroad right of way with the construction of new foundations and a lifting and resetting of the existing bascule bridge mechanical equipment and bridge deck. This will allow 13 to 15 feet of additional horizontal distance for the construction of any of the bridge alternatives examined in this study.

Option 2:

A second option would be the addition of a new freight track to the east of the existing Track 2, and re-construction of the bascule bridge, thereby reducing the footprint of the new bascule bridge serving freight operations. This allows for additional horizontal space to locate the new passenger tracks and bridge structures within the existing right of way. This additional right of way will potentially allow the proposed Low-Level Bascule Bridge alternative 5 to 11 feet of additional space for improvements, resulting in minimal impact to the existing angle parking on SW 2nd Avenue, and maintain access to the businesses and Historic Society buildings north of the river and have no impacts to the existing boat storage facility on the river's south bank. For the Mid-Level Bascule Bridge and High-Level Fixed Bridge alternatives, the new freight track will provide additional right of way to construct the foundations and support columns for the bridge alternatives and will maximize the use of the existing right of way while minimizing impacts to parking along SW 2nd Avenue north of the river.

The limits of the additional freight track to the east of the existing freight Track 2, will be consistent with the limits of the track impacts identified for each of the bridge alternatives. These limits range from approximately 5,740 feet (1.1 mile) for the Low-Level Bascule Bridge alternative to approximately 13,215 feet (2.5 miles) for the Mid-Level Bascule and High-Level Fixed Bridge alternatives.

Appendices

Appendix A – Phase 2 Navigable Waterway Analysis Technical Memorandum Dated November 2009

SOUTH FLORIDA EAST COAST
CORRIDOR TRANSIT ANALYSIS STUDY

www.sfeccstudy.com

Phase 2 Navigable Waterway Analysis Technical Memorandum

Prepared by:

Gannett Fleming

November 2009

MEMORANDUM

To: Scott Seeburger

From: Jim Schwarzwalder

Date: May 7, 2009

Subject: South Florida East Coast Corridor Transit Analysis (SFECCTA) Study - Phase 2 Navigable Waterway Analysis Technical Memorandum

This memorandum summarizes preliminary navigational data collected on bridge operations along the New River for the Andrews Avenue and Florida East Coast (FEC) Railway Bridges in Broward County as well as information collected during field interviews. Ultimately, this and other information collected in subsequent phases of the study will be used to establish the reasonable needs of navigation in this section of the New River. This work has been completed per scope of work item number 3.1.6.4.1, Navigable Waterway Analysis/Vessel Survey, Regional Analysis.

Introduction:

The New River is a major waterway that winds through Ft. Lauderdale' central business district (CBD) in Broward County. West of the CBD, the river splits into the North and South Forks. The North Fork is a shallow meandering tributary of the New River and is bordered primarily by residences with private docks. The South Fork of the River is deeper and can accommodate larger vessels. In addition to residences, the South Fork is also bordered by commercial marine industries (see attached map).

Several bridges, including a FEC Railway Bridge, cross the New River. These bridges are movable (e.g., bascule) and either open upon request or on a specified schedule. The exception to this type of operation is the FEC Railway Bridge that remains in the open position offering virtually unlimited clearance until a freight train approaches. In the down position, the FEC Railway Bridge has a vertical clearance of 4 feet (ft). The United States Coast Guard (USCG) has established a guide vertical clearance of 21 ft for movable and 55 ft for fixed bridges over the New River. West of the FEC Railway Bridge, navigational vertical clearance is limited by two features along the South Fork of the New River, overhead power cables with a height of 80 ft and Interstate 95 (I-95) with a vertical clearance of 55 ft (see attached map). Vertical clearances refer to the distance from Mean High Water to the lowest member of a bridge's underside.

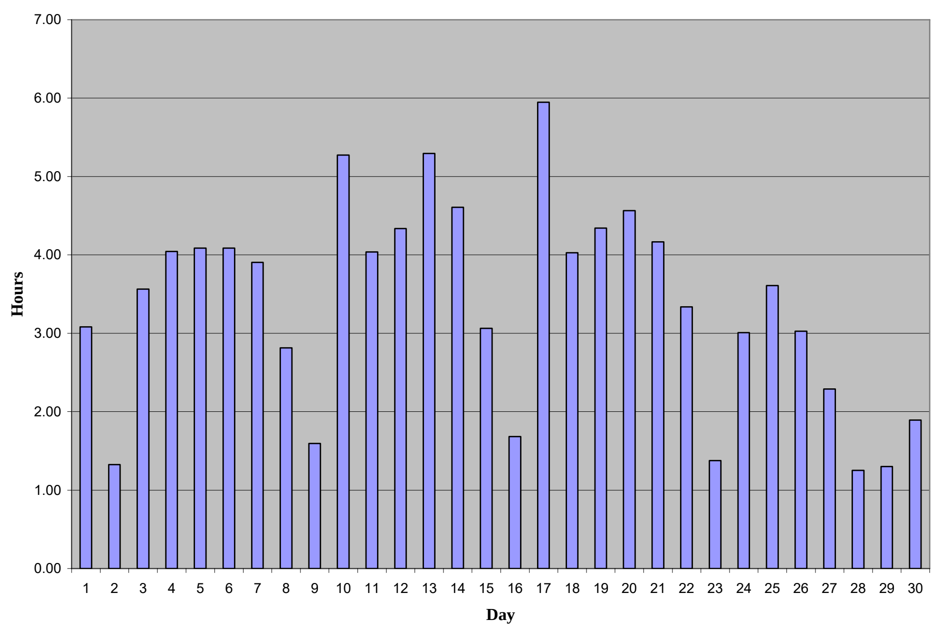
Methodology:

Data Collection

FEC Railway Bridge Closure Log over the New River, Ft. Lauderdale:

An FEC Railway Bridge log was obtained for November 2008 to serve as a sample of freight train activity for the New River crossing. The log served to calculate the average number of freight trains crossing the New River daily and the duration of those bridge closures. As noted above, the FEC Railway Bridge generally remains in the open or up position and closes when a train approaches. The duration of bridge closures was calculated by employing a macro[1] that was written specifically to calculate time differences for this study from an Excel spreadsheet. Calculations, based on the November 2008 bridge log, indicated an average of 11 freight trains crossed the New River daily, which accounts for the bridge being closed an average of 3.4 hours per day. According to the bar graph below, the FEC Railway Bridge may close from about 1.5 hours to almost 6 hours per day depending on the number of freight trains and their length.

Sum – Weekday Closures (hrs)	*Average – Weekday Closures (hrs)*	*Sum – Weekend Closures (hrs)*	*Average – Weekend Closures (hrs)*	*Total Time in the Closed Position(hrs)*	*Daily Average for Month (Nov 2008) (hrs)*
79.5	4.0	21.5	2.0	101	3.4



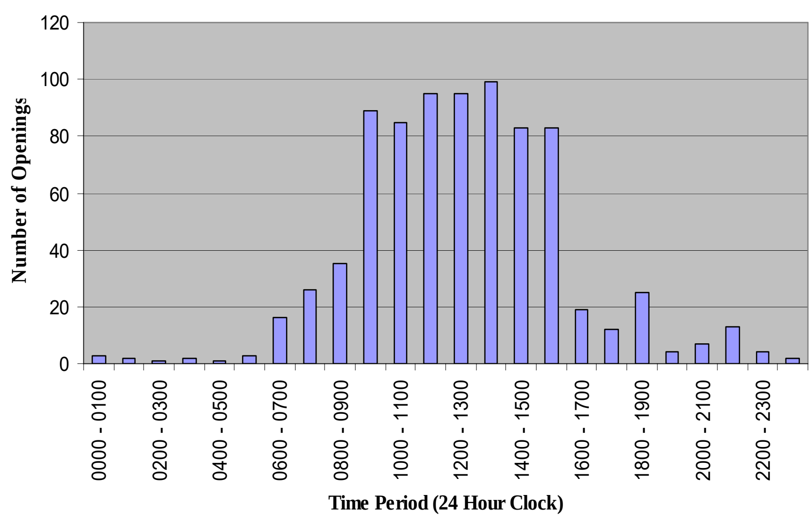
Bar Graph of FEC Railway Bridge Closures over the New River

[1] "A macro is a series of commands that are stored in Microsoft Visual Basic software to be used whenever needed to perform the task." (http://office.microsoft.com/en-us/excel/HP052012011033.aspx)

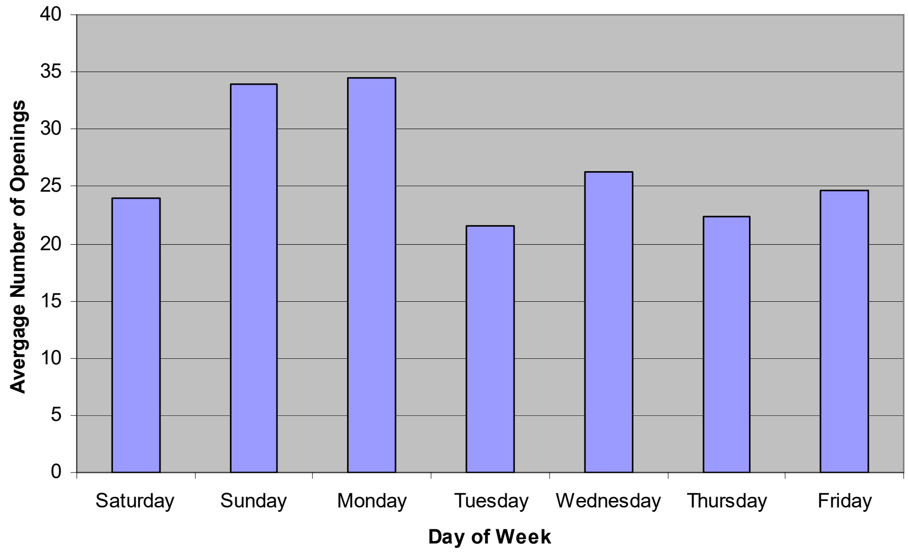
A regression analysis was performed in an effort to predict how many hours the bridge would be in the closed position for a specified period since this is when navigational traffic would be affected by the bridge. However, the correlation between the two variables (R^2), time of closures and day of month, was too low to be of any statistical value given the limited data (i.e., 30 days). Predicting trends of how FEC Railway Bridge closures may affect navigational traffic would require a detailed study beyond the scope of this technical memorandum. Variables or factors such as the cost of fuel, availability or demand for building materials and general goods (e.g., "supply and demand") would have an influence on freight movement and would necessitate consideration in a trend analysis.

Andrews Avenue Bridge Log:

In order to gain a perspective on boating traffic requiring a bridge opening near the FEC Railway Bridge, the Andrews Avenue Bridge log for the month of November 2007 was obtained for evaluation. The Andrews Avenue Bascule Bridge is located approximately 240 yards east of the FEC Railway Bridge and has a vertical clearance of 21 ft. Twenty-one ft is the minimum guide vertical clearance established by the USCG for movable bridges over the New River and therefore establishes the minimum vertical clearance required for a movable transit bridge over the New River. From this bridge log, the number of openings in one-hour periods throughout the day as well as the average number of openings per day of the week was calculated for the month of November 2007. The bar graphs reveal the majority of navigational activity occurred from approximately 10 a.m. to 4 p.m. with the greatest number of bridge openings (34 openings) taking place on Sundays and Mondays. The hourly average was approximately one opening per hour.



Bar Graph of Total Bridge Openings for the Andrews Avenue Bascule Bridge per One-Hour Periods for Nov. 2007



Plot of Average Number of Bridge Openings for the Andrews Avenue Bascule Bridge

Based on a phone interview conducted on March 10, 2009 with Mr. Sam Sohad of the Broward County Streets and Highway Division, the Andrews Avenue Bridge opens an average of 30 times per day for vessels having a vertical clearance greater than 21 ft. This average number of openings is based on 800 to 1000 bridge openings per month throughout a year.

A field visit to the New River revealed approximately 500 ft of privately owned mooring or dock space on both sides of the New River between the Andrews and FEC Railway Bridges.

Given the number of vessels requiring an opening at the Andrews Avenue Bridge and the lack of large marinas before reaching the FEC Railway Bridge, one could assume 80% - 90% of those vessels are also traveling past the FEC Railway Bridge either upstream or downstream.

FEC Railway and Andrews Avenue Bridges

1999 Vessel Survey:

A vessel survey conducted on January 14 and 17, 1999 at the CSX Railway crossing of the South Fork of the New River counted 170 boats with the tallest vessel height measured at 48 ft. The CSX Railway is an at-grade bridge approximately 2.7 miles west of the FEC Railway Bridge and remains in the open or up position similar to the FEC Railway Bridge. The CSX Railway Bridge is paralleled by a high-level Tri-Rail bridge at this point and both of these bridges are west of I-95, which restricts vertical clearance in the western reaches of the South Fork of the New River to 55 ft.

Field Measurements:

A field visit was conducted on March 13, 2009 from approximately 3:00 p.m. to 5:00 p.m. to approximate vertical clearance needs west of the FEC Railway Bridge. Vertical heights of what appeared to be the tallest sailing vessels, moored along the New River between Andrews Avenue and FEC Railway Bridges, were measured from the waterline to the top of mast using a digital, laser-equipped range finder. The instrument utilizes a built-in triangulation feature to calculate the heights or vertical clearance. These measurements are approximate values since readings had to be taken below the very top of the masts so that the instrument could obtain a reading. This site was selected for its accessibility to the New River. Additional measurements were taken at the River Bend Marine Center located on the South Fork of New River west of the FEC Railway and just east of I-95. Measurements taken from both locations are listed below (see inserts on attached map).

Measured Vertical Heights (ft)				Average Height (ft)
52	47	67	52	54.5

Interviews:

Two interviews were conducted during March 2009 to collect information on the range of vertical heights of vessels coming to the River Bend Marine Center. The first interview was conducted on March 13, 2009 with Mr. Ed Brown of the River Bend Marine Center. According to Mr. Brown, the average vertical height of sailing vessels coming for service was approximately 60 ft. The average field measurement calculated for this area was relatively close to Mr. Brown's observations given the inability to take readings at the very tops of masts.

A second interview was conducted on March 16, 2009 by phone with Mr. Brad Storm of Storm Rigging who operates out of the River Bend Marine Center. Mr. Storm indicated that he services about two sailing vessels a month that require a vertical clearance between 80 ft and 85 ft and "on occasion", he receives vessels that reach 90 ft to 95 ft in height.

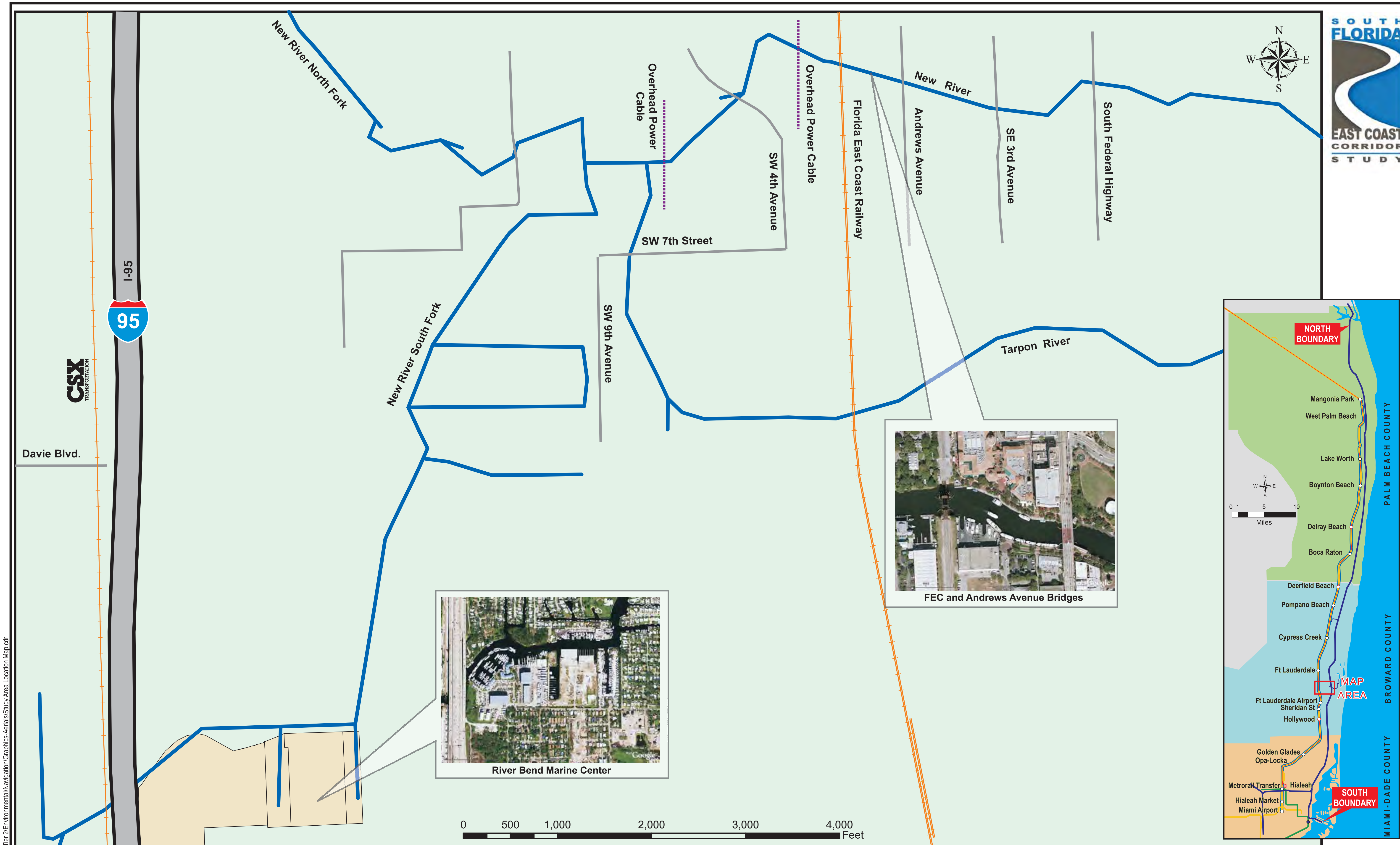
The taller vessels time their trip up the New River to arrive at the overhead power cables at low tide to increase their clearance under the wires. Although the charted clearance for the power cables is listed as 80 ft, Mr. Storm indicated the cables are actually at 105 ft. According to Mr. Storm, 63.5 ft is the most common vertical height of sailing vessels coming for service. He explained that the 63.5 ft height is an intentional design criterion for many sailboat manufactures that is driven by the 65 ft vertical clearance of fixed bridges along the Atlantic Intracoastal Waterway.

Conclusion:

Several navigable waterways have been identified along the project corridor including the River, Hillsboro Canal, Cypress Creek, New River, and Dania Cut-off Canal. Of these navigable waterways, the New River is the only one that is crossed by a movable FEC Railway Bridge. Currently the FEC Railway Bridge remains in the open position until a train approaches. However, this approach would not likely be an option for passenger transit given the greater number and frequency of passenger trains crossing the New River compared to freight trains.

The USCG has provided a guide vertical clearance of 55 ft for a fixed bridge over the New River but the preliminary survey conducted for this technical memorandum indicates that sailing vessels with a vertical clearance of 63.5 ft, and occasionally taller, routinely travel past the FEC Railway Bridge to reach the River Bend Marine Center for service. An alternative to a high-level fixed bridge could include a bascule bridge designed with the necessary vertical clearance to accommodate a satisfactory percentage of the boating traffic, and open for taller vessels on an established schedule, while meeting the operational needs of future passenger and freight trains along this section of the New River. Bridge operations could be managed to accommodate passenger transit and vehicular traffic by scheduling times when the bridge would not open during morning and evening commuter "rush hours" for boating traffic.

Additional information will be collected in Phase 3 of the SFECCTA study to build upon this preliminary assessment. It is anticipated that a detailed vessel survey will be conducted in Phase 3 of the study to represent navigational activity at the FEC Railway Bridge crossing. In addition, detailed freight train information will be obtained and a more defined service plan for passenger transit will be developed. Combined, this information will allow for the development of a crossing solution that meets the reasonable needs of navigational traffic, freight trains, and passenger transit for the New River crossing.

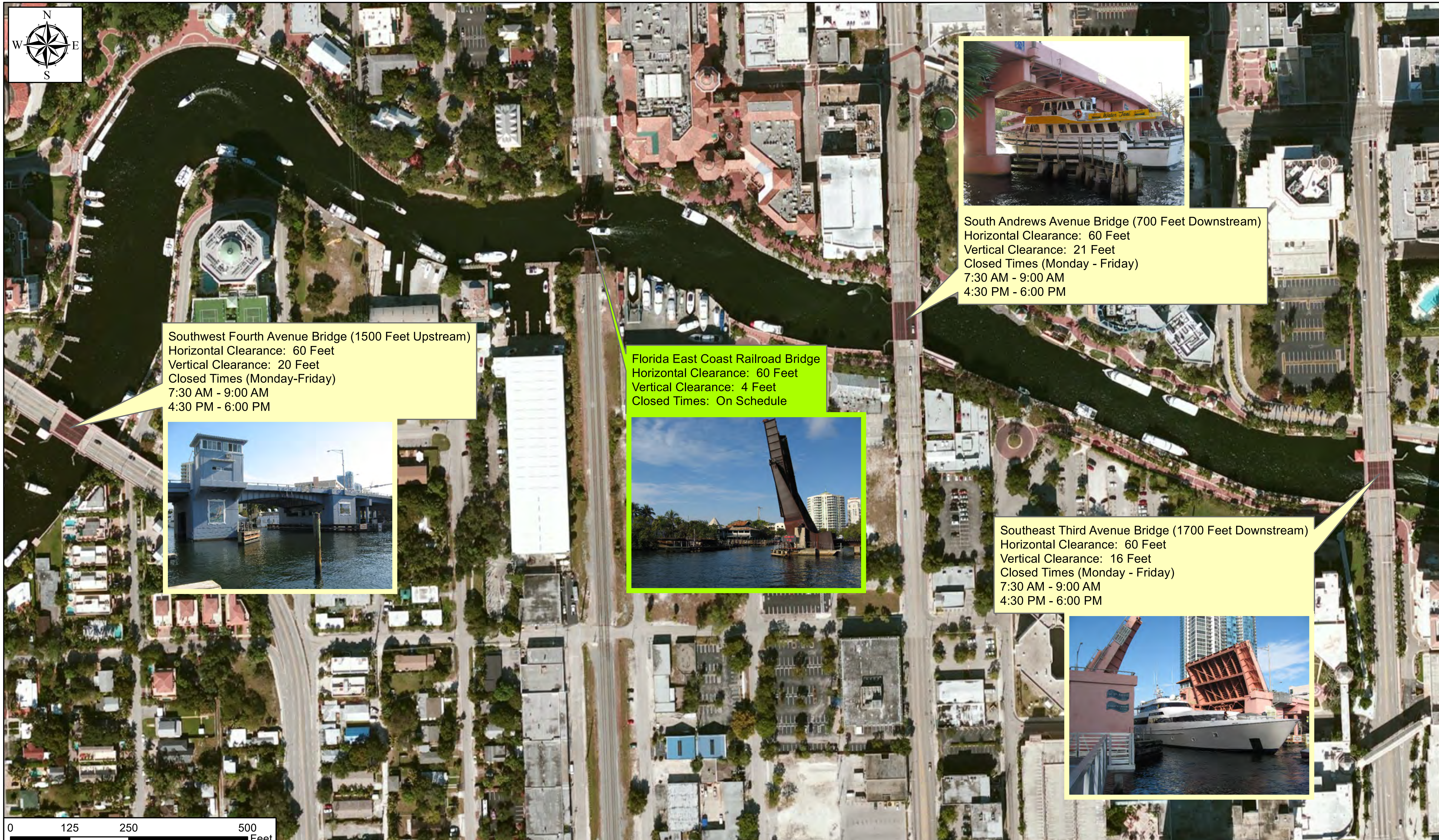


G:\PROJECTS\49747 - FEC Tier 2\Environmental\Navigation\Graphics-Aerials\Study Area Location Map.cdr

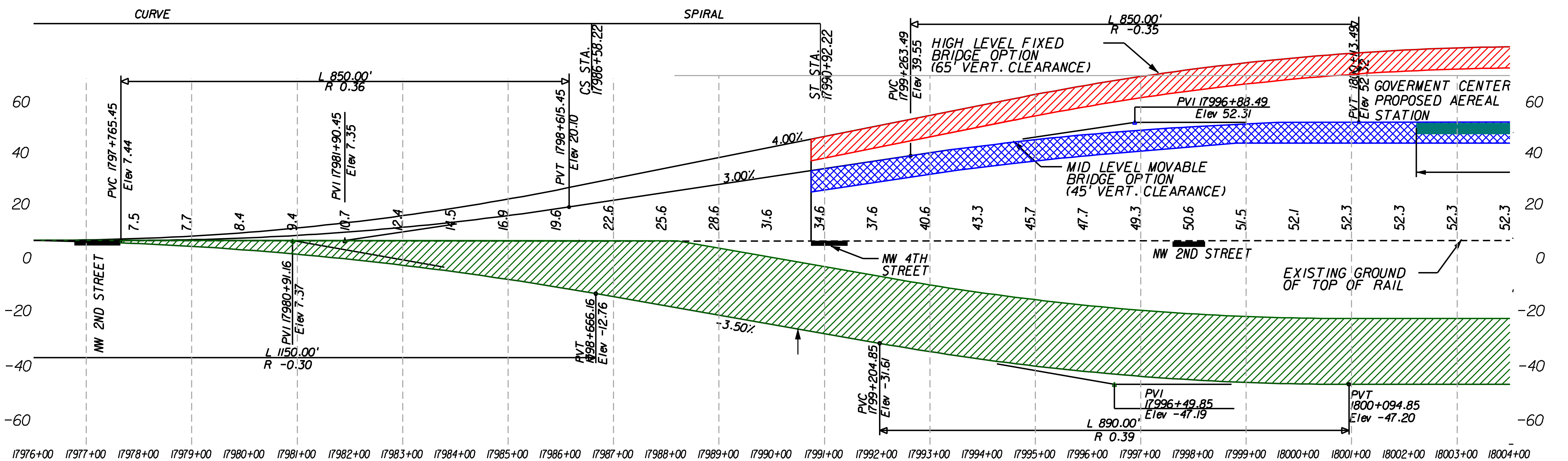
Gannett Fleming

South Florida East Coast Corridor Transit Analysis (SFECCTA) Study:
Phase 2 Navigable Waterway Analysis Technical Memorandum

New River Study Area Location Map



South Florida East Coast Corridor - New River Bridges near Florida East Coast Railroad Bridge



NOTE: PROPOSED VERTICAL PROFILE REPRESENTS HIGH LEVEL, MID LEVEL & TUNNEL CROSSING AT NEW RIVER

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD :
Gannett Fleming
7300 CORPORATE CENTER DRIVE, SUITE 701
MIAMI, FLORIDA 33126
(786) 845-9540 FAX (786) 845-6802

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	- - -

SOUTH FLORIDA EAST COAST CORRIDOR CONCEPT PLANS PLAN & PROFILE SHEETS

SHEET NO. 126

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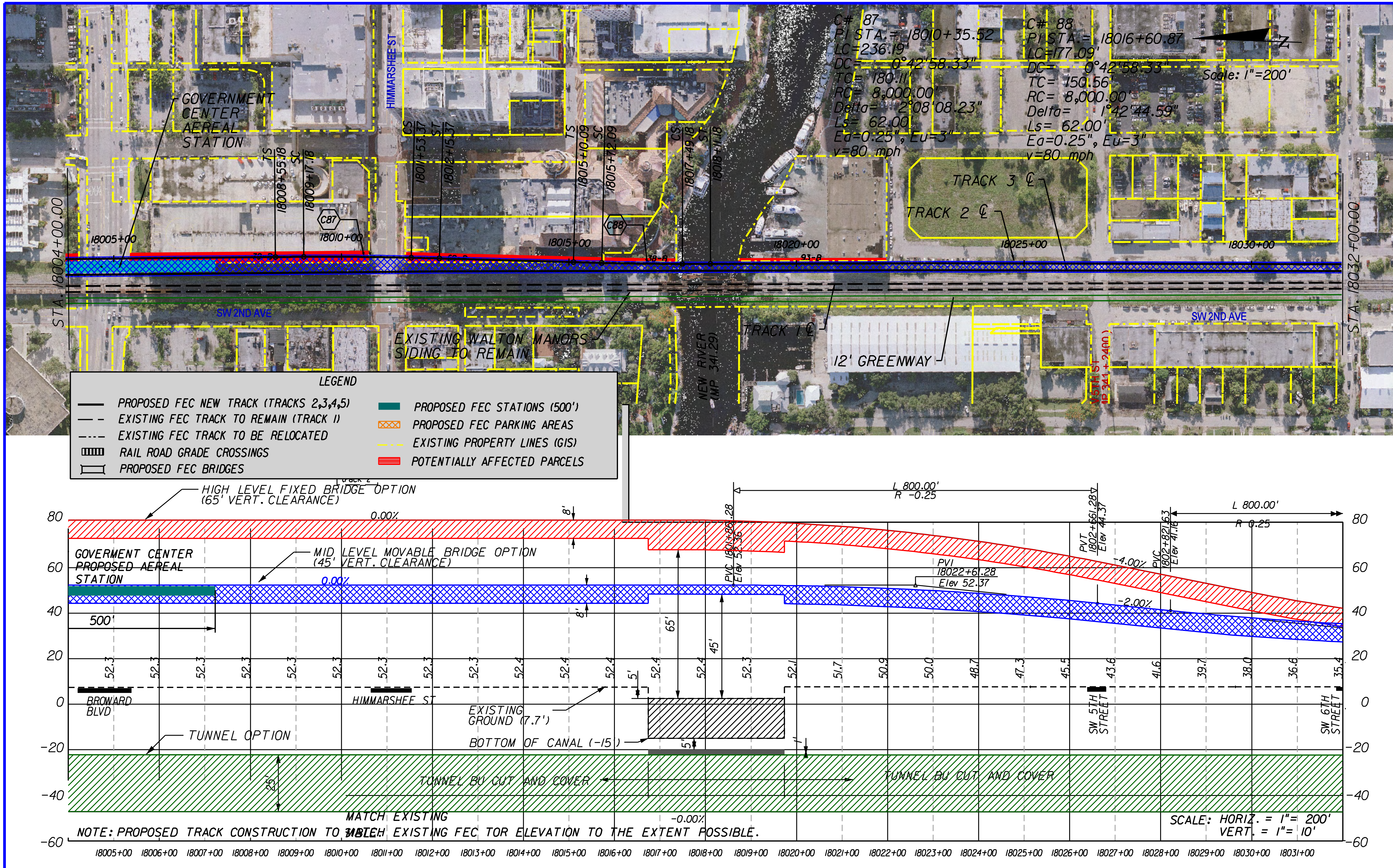

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD:
Gannett Fleming
7300 CORPORATE CENTER DRIVE, SUITE 701
MIAMI, FLORIDA 33126
(786) 845-9540 FAX (786) 845-6802

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	- - -

SOUTH FLORIDA EAST COAST CORRIDOR CONCEPT PLANS
PLAN & PROFILE SHEETS

SHEET NO. 127

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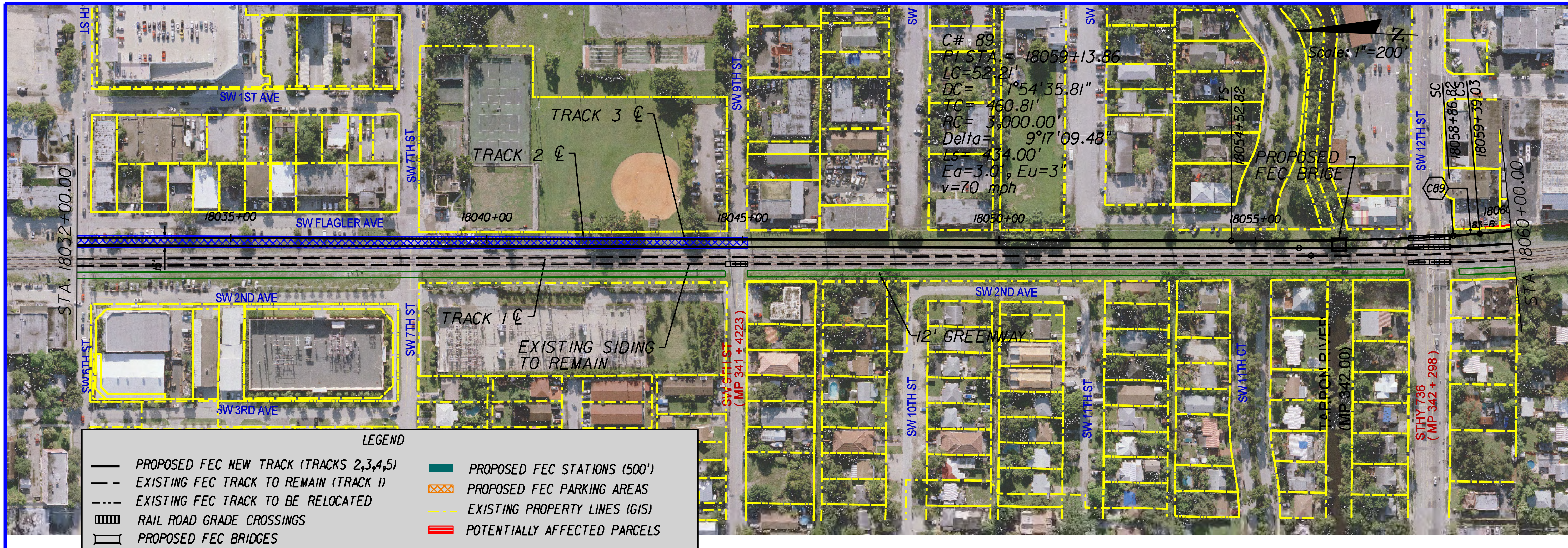

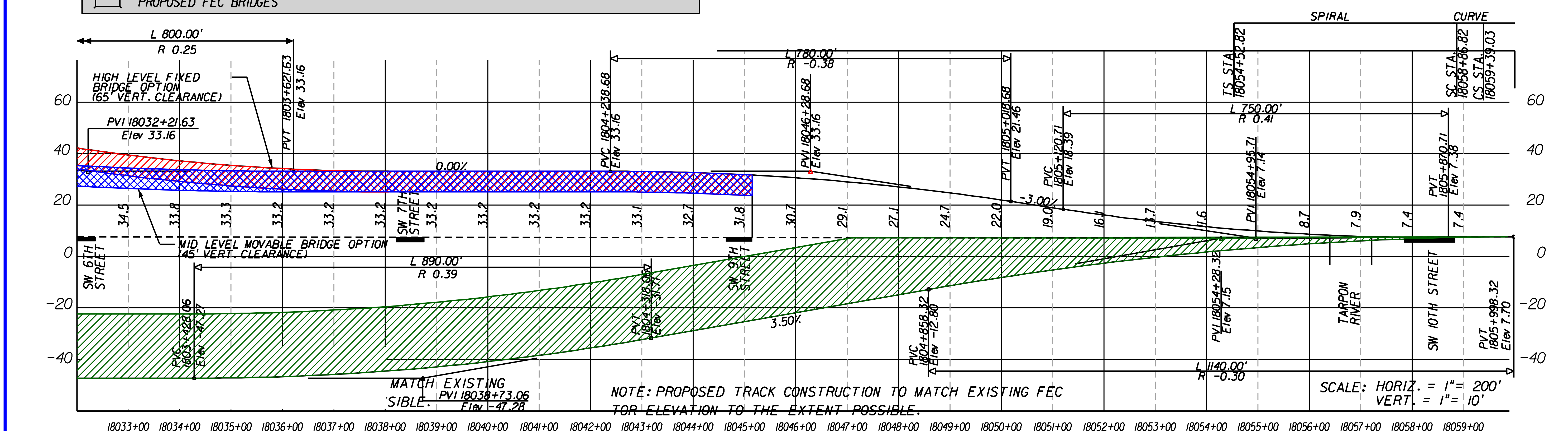

REVISIONS			
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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	- - -

SOUTH FLORIDA EAST COAST CORRIDOR CONCEPT PLANS
PLAN & PROFILE SHEETS

SHEET NO. 128

128

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Appendix B – Stakeholder Coordination Meeting Notes

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
Project Overview and Coordination
Virgin Trains (aka Brightline)
August 14, 2019; 1:30 pm

Attendees: Husein Cumber, FECI; Ben Porritt, Brightline; Myles Tobin, Brightline; Howard Newman, HDR; Todd Riley, HDR; Jeff Bowen, Hanson

Teleconference: Alexander Barr, FDOT; Marjorie Hilaire , FDOT; Mike Ciscar, TCG

1) Introductions (Sign-In Sheet)

- *Introductions provided and the roles of the consultant Teams described.*
- *Ben Porritt was identified as the Brightline point of contact for this study.*
- *Sign in sheet attached.*

2) Brief Overview of New River Crossing Feasibility Study

- *Feasibility study is to examine potential alternatives to improve maritime operations on the river and maintain freight and passenger rail operations.*
- *Initial alternatives will include low/medium/high level bridges and cut and cover and direct bore tunnels.*
-

3) Discussion of Project Goals and Technologies

The results of the study will be included in a technical memorandum and submitted to the Florida Legislature in January 2020. A final draft for review is targeted to be complete by Christmas this year.

This report will identify a timeline for next steps including, but not limited to, a project development and environment study, preliminary engineering and construction, the alternatives recommended to move forward, and the next steps.

Discussions included:
- *The public involvement effort will not include property owners or any general public involvement effort for this study. Coordination meetings will be conducted for review/comment of information as it is developed from the City of Fort Lauderdale, Broward County, Broward MPO, the maritime community, USCG, the rail operators - Brightline and FEC.*
- *Potential funding sources are a part of the report.*
- *The evaluation of the alternatives will include the following:*
    - *Costs (design and construction)*

- *FECRWY freight and passenger track geometry criteria for the current and proposed track speeds*
- *Effect on current rail operations and maintaining rail operations throughout construction*
- *Effect on existing and adjacent (rail and private) structures*
- *Effect on existing and future marine traffic*
- *Superstructure and substructure replacement types – different types of bridge structures*
- *Identification of potential Permits*
- *Constructability to include staging concepts and possibly temporary bridges to maintain rail traffic*
- *Adjacent real estate access and impacts*
- *Land use impacts, existing and future*
- *Identify crossroad impacts, potential closings, identify daily volume of traffic impacted at closure, potential ROW impact with closure Potential utility impacts*
- *Right of way impacts and coordinate data for costs to be provided by DEPARTMENT.*

- *Additional costs need to identify the cost to replace/modify existing Brightline Broward Boulevard station.*
- *Will the level of environmental analysis be determined for this report? The Class of Action determining the level of environmental report/analysis will be included in the next phase (PD&E Study) of the proposed improvements to the crossing.*

4) Coordination with Virgin Trains

a. Passenger Operations
   i. Future Operations with Orlando Extension
   ii. Boca Raton
   iii. FLL

- *With any other extension of the Brightline service, the operations plan will likely change possibly impacting the current timing of the New River crossing occurring at the same time in both directions.*
- *The Broward Blvd. station will remain open and operational during any improvements at the river.*
- *Any track revisions cannot affect train times or extend train travel times.*

b. Design Criteria

- *For the current Brightline design criteria, contact Josh Bair, HNTB. Ben Porritt of brightline was to contact HNTB and provide info to feasibility study team.*
- *Contact FECRWY for design criteria and to verify need to address freight operations on proposed alternatives other than on existing tracks/bridge.*

c. Track Alignment
   i. Passenger
   ii. Freight

- *FECRWY has access to all current (3) tracks. Any additional track would likely have to provide access for freight either crossovers or potential diamond crossing.*
- *Note that Brightline identifies that with the potential/future commuter rail service a third passenger track would be required. Additional analysis would be required to verify if a two passenger track bridge would accommodate capacity needs.*

- *Any joint use, emergency use of freight tracks by passenger service, or the opposite, would be a negotiation with FECRWY.*

d. Existing Use of Corridor
   i. Existing Freight Bridge
   ii. Utilities

- *Any parallel infrastructure is now under FERRWY jurisdiction. There is existing ductbank through the corridor.*
- *Brightline had additional boat survey completed as part of the previous environmental documentation that is available. The previous boating surveys completed as part of FDOT studies will also be made available to Brightline.*

e. Potential Impacts
   i. Draft Preliminary Profiles (L/M/H River Crossings)
   ii. Tunnel Alternative

- *Preliminary profiles were reviewed for the low/medium/high bridge structures at New River with following discussion;*
  - *Low level bascule bridge provides 21 foot of clearance from bottom of structure to normal waterline. This matched the existing bridge structures upstream and downstream from the New River crossing. The profile matches existing track profile south of Broward Blvd. with closure of Himmarshee Street and SW 5th Street. No impact to Broward Boulevard or facilities north.*
  - *Medium level bascule bridge provides 45 foot clearance to the waterline. This bridge would extend on elevated structure, with the position that retaining wall would not be aesthetically acceptable to the area, from SW 6th Street to north of NW 4th Street. All crossroads with the exception of SW 7th Street would remain open. The Broward Blvd. station platform would be elevated between 30-35 feet.*
  - *High level fixed bridge provides 65 foot clearance to the waterline. This is minimum vertical clearance for an intercoastal waterway and will be coordinated with USCG. This alignment will also be on elevated structure from SW 6th Street to NW 4th Street, however SW 7th Street and SW 9th Street would be closed and minimal regrading of NW 6th Street is required for this crossing to remain open. The Broward Blvd. station platform would be elevated approximately 50+ feet.*
- *Any revisions to the station platform must be on 0% grade.*
- *Information for the existing station platform, the pedestrian crossing and potential loads on the existing canopy – contact Eric Clausen.*

5) Action Items and Next Steps

Updates, meetings, coordination will continue through Ben Porritt.

Action items and next steps are identified in the following Table 1:

Table 1: Summary List of Action Items

Action Item	Responsible Party	Deadline
Provide Brightline with current working Schedule	HDR	8/15/2019
Contact HNTB for current Brightline design criteria	Brightline	8/16/2019
Contact FECRWY for coordination meeting and design criteria	HDR	8/16/2019
Provide FDOT boat survey to Brightline	HDR/CMOC	8/20/2019
Brightline to provide their boat survey data	Brightline	8/20/2019
Continue Coordination	All	On-going

Meeting Sign In

Project: New River Crossing Feasibility Analysis

Date: August 14, 2019

Location: Hanson Offices: 8075 Gate Pkwy W, Jacksonville, FL 32216; Suite 204

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
	Howard Newman	HDR	407 832 2500	howard.newman@hdrinc.com
	Todd Riley	HDR	904 434 4737	todd.riley@hdrinc.com
	Ben Porritt	Brightline	305 521 4801	Ben@gobrightline.com
	Husein Cumber	FECI	904 996 2812	husein.cumber@feci.com
	MYLES TOBIN	BRIGHTLINE	312-485-8557	MYLES@GOBRIGHTLINE.COM
	Jeff Bowen	Hanson	904-737-0090	jbowen@hanson-inc.com
	Alex	By phone		
	Marjorie			
	Oscar			

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
USCG Project Overview and Coordination
USCG District 7
October 11, 2019; 10:00 am

Attendees:

Randal Overton, USCG	Jennifer Zercher, USCG	Howard Newman, HDR
Darayl Tomkins, USCG	Alexander Barr, FDOT-D4	Todd Riley, HDR
Eddie Lawrence, USGC	Jaime Lopez, RS&H	Leo Villalobos, HDR
Alicia Kowalczyk, USCG	Mike Ciscar, Corradino	

1. Around the table introductions.
2. An overview of the project and purpose for the replacement of the New River Bridge was provided. It was also stated that the Feasibility report would include up to the three (3) options, including comparative analysis and cost estimates.
3. USCG discussed previous public meetings. Comments of the public and marine industry described the need for a viable waterway and to improve current boat operations.
4. USCG conducts regular Harbor Safety meetings.
5. The various alternatives were described, including:
    a. Low-level
        i. 27.5 feet(and 21 feet) clearance moveable bridge
    b. Mid-level clearance bridge
        i. 45 feet clearance moveable bridge
    c. High-level
        i. 65 feet clearance fixed bridge
        ii. 80 feet clearance fixed bridge
    d. Tunnel
        i. 40 feet diameter bored tunnel
6. Discussions/comments on the alternatives included:
    a. The 27.5 clearance would provide operations consistent with the existing upstream and downstream bridges.
    b. Clarified that the existing FEC Bridge will remain with freight operations.
    c. USCG confirmed the need for a full time bridge tender house for all moveable bridge options.
    d. For the mid-level option the USCG confirmed that it would be consistent with the 17th Street Bridge.
    e. The mid-level option height may be adjusted to conform to the proposed elevation of the BrightLine platform provide for a proposed Broward Blvd. East-West premium transit corridor to cross over the existing tracks (freight).
    f. Reviewed of the 65 feet clearance fixed bridge: The current clearances along the river were discussed and USCG highlighted the existing 80 feet clearance of the

power lines. USCG indicated that the 80 feet clearance fixed bridge will be consistent with the maximum height currently provided on the river. The 80 feet fixed bridge profile was reviewed.

   g. The tunnel plan and profile were discussed, including constructability. USCG verified the need to maintain a horizontal channel width to allow for boat navigation. The cut and cover method at the river would not be a viable option.
   h. It was stated that the tunnel option would not have any impacts on the navigational operational of the river.

7. USCG indicated that any of these bridge or tunnel options could be permitted.
8. Regarding the application process:
   a. Will need environmental, administrative, and navigational requirements
   b. FDOT will be the lead permitting agency
   c. NEPA documentation noted that EA could be process through the District 7 Office, any EIS would be process through USCG Washington DC office.

HDR

Meeting Sign In

Project: New River Crossing Feasibility Study: USCG Coordination Meeting

Date: October 11, 2019

Location: USCG District 7 Offices 10 AM 909 SE 1st AVE, MIAMI, FL

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
	Howard Newman	HDR	407 832 2500	howard.newman@hdrinc.com
	Randall OVERTON	US Coast Guard	(305)415-6736	Randall.D.OVERTON@USCG.mil
	DARAYL TOMPKINS	USCG	305-415-6766	DARAYL.Tompkins@uscg.mil
	Lisia Kowalczyk	USCG	305-415-6932	lisia.j.kowalczyk@uscg.mil
	EDDIE LAWRENCE	USCG	305-415-6946	EDDIE.K.LAWRENCE@USCG.MIL
	MIKE CISCAR	CORRADINO GROUP	305-586-7107	mciscar@corradino.com
	Leo Villalobos	HDR	954-610-2635	lvillalobo@HDRINC.com
	JAIME LOPEZ	RS+H	786-588-0234	JAIME.LOPEZ@RSandH.com

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
Marine Industry Association of South Florida (MIASF)
Project Overview and Coordination
October 15, 2019

Attendees:

Patience Cohn, MIASF
Ben Rogers, City of FLL
James Maitland, MIASF
Philip Purcell, MIASF
Alexander Barr, FDOT-D4
Bill Walker, Water Taxi
Howard Newman, HDR
Jim Naugle, Lauderdale Boat Yard
Mike Ciscar, Corradino
Leo Villalobos, HDR

1. Around the table introductions.
2. Phil Purcell provided an overview of the MIASF and some factoids about the marine industry in Ft. Lauderdale.
3. An overview of the project and purpose for the replacement of the New River Bridge was provided. It was also stated that the Feasibility report would include up to the three (3) options, including comparative analysis and cost estimates.
4. The various alternatives were described, including:
    a. Low-level
        i. 27.5 feet clearance moveable bridge
    b. Mid-level clearance bridge
        i. 45 feet clearance moveable bridge
    c. High-level
        i. 65 feet clearance fixed bridge
        ii. 80 feet clearance fixed bridge
    d. Tunnel
        i. 40 feet diameter bored tunnel
5. Discussions/comments on the alternatives included:
    a. The 27.5 feet clearance bridge would not provide enough bridge clearance that would minimize the number of bridge openings when compare to the 21.5 feet bridge.
    b. The low bridge option would not improve the surface street traffic operations on Broward Blvd.
    c. Clarified that the existing FEC Bridge will remain with freight operations.
    d. The MIASF stated that the mid-level moveable met their preferences. They expressed the potential of a signature bridge with the city in the background. This option will also improve traffic on Broward Blvd. Need to keep elevation above parking garage next to existing bridge.
    e. Reviewed the 65 feet clearance fixed bridge would not allow for larger vessels to navigate beyond the FEC crossing without removing masts.

f. The 80 feet clearance fixed bridge will provide the max clearance on the river, matching the vertical clearance of the existing power line crossing.

g. The tunnel plan and profile were discussed, including constructability. MIASF expressed the need to have navigation through the river during construction.

h. MIASF asked for the estimated values of each option. Expressed some concern for the price of the tunnel option.

6. Next steps were discussed. It was stated that the PD&E is currently funded. MIASF would contact FDOT to keep the process/study going.

HDR

Meeting Sign In

Project: New River Crossing Feasibility Study - Marine Industries Association of South Florida (MIASF)

Date: October 15, 2019

Location: 221 SW 3rd Avenue, Fort Lauderdale, Florida 33312

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
	Patience Cohn	MIASF	954-524 2733	patience@miasf.org
	BEN ROGERS	CITY OF FORT LAUDERDALE	954.828.3781	BROGERS@FORTLAUDERDALE.GOV
	JIM NAUGLE	LAUDERDALE BOAT YARD	954 632-3636	MAYORJAMES@aol.com
	James Maitland	MIASF	954 524 2733	james@miasf.org
	Philip Purcell	MIASF	" "	Phil@MIASF.ORG
	Leo Villalobos	HDR	954-610-2635	Lvillalobo@HDRINC.COM
	MIKE CISCAR	CORRADINO GROUP	305-586-7107	MCISCAR@CORRADINO.COM
	Bill Walker	Water Taxi	954-467-6677	bwalker@watertaxi.com
ON PHONE	ALEXANDER BARR	FDOT - D-4	954-777-4284	ALEXANDER.BARR@dot.state.fl.us

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
Project Overview and Coordination
FECRWY
October 25, 2019; 11:00 am

Attendees: Charlie Graning, FECRWY; Daniel Briggs, FECRWY; Cory Cutlip, FECRWY; Larry Merritt, FDOT-D4; Alexander Barr, FDOT-D4; Chris Riviere, HDR; Howard Newman, HDR; Todd Riley, HDR; Leo Villalobos, HDR

1. **Introductions (Sign-In Sheet)**
   Sign in sheet attached.
2. **Brief Overview of New River Crossing Feasibility Study**
   Overview of the feasibility study purpose and objective was provided. Noted that freight and passenger services were to be maintained during all phases of the project including construction.
3. **Coordination with FECRWY**
   General discussion of the following issues with notation as applicable:
   a. **Freight Operations**
      i. **Design Speed:** Design speed to be maintained at 40mph. Design criteria and existing plans are not available due to security concerns. AREMA criteria should be followed.
      ii. **Maintain Existing Services:** Existing schedule/service imperative
   b. **Crossing Alternatives for Passenger Service**
      i. **Low-Level:** Discussion on maintaining operations and potential freight track realignment during construction. The retaining wall proposed with the low level bridge requires realignment of both freight a passenger tracks. FEC noted significant signal modifications and the difficulty of adjusting what is an existing restrictive signaling layout with the close proximity of two control points in this vicinity. Overall major concern with the low level alternative.
      ii. **Mid-Level:** Noted freight operations would be located on the two existing far east tracks; passenger service would need a second temporary platform.
      iii. **High-Level:** Same discussion as mid-level alternative.
      iv. **Tunnel: Discussion of any** safety concerns with restricted sight lines – currently FEC has no criteria with no tunnels on their system. Follow AREMA to address.
   c. **Freight Track Alignment**
      i. **Future Track Alignment:** Potential to add a new freight track to the east of the existing track is not a consideration.
      ii. **Potential Operational Considerations during Construction**
   d. **Use of Corridor**
      i. **Existing Freight Bridge:** Only FECRWY will be using the existing bridge with possible track connections for emergency uses.
      ii. **Utilities:** fiber optic duct banks are within the corridor, no specific location was stated.

4. **Questions Provided Before the Meeting for Discussion:**

- **FECR had indicated to FDOT that any TRCL stations would need to be on sidings and not the mainline. Is this still their approach?**
  Yes

- **What is their Operating Plan – both FECR & Brightline?**
  FECR 14 to 16 trains per day, 20—25 minute closures.
  BrightLine 34 trains per day weekdays 5AM to 12Pm, 32 trains per day on Saturday, 24 trains per day on Sunday.
  Existing 50/50 split in a 2 hour window between FEC and BrightLine.

- **Can they provide their as-builts, survey and any geotech reports for the PD&E phase? FDOT requested this information a long time ago. Refer back to the list we talked about in July.**
  AS builts and survey is not available. FDOT will use geometry as determined from existing aerials and in-hand geotechnical information from the original bridge plans.

- **What is the status of access negotiations with the locals?**
  Not aware of status, Bob LeDoux will or equivalent senior staff will have to be contacted.

- **Will freight contemplate using the new bridge?**
  No

- **What are your requirements for line of sight at tunnel portals (Andrews, 3rd Avenue)?**
  Use AREMA criteria.

- **The line of sight question below applies to Brightline as well.**
  Noted

- **Where would temporary track and temporary platform best be located if needed during construction?**
  A layout of interim track with any accommodation of passenger service will be provided.

- **Re temporary single track, how would wide loads be handled?**
  Single track not a consideration.

- **Can we reduce the operational speed during construction? (Current speed is 40 MPH?)**
  No

- **Can we single track during construction?**
  No

- **Can we move crossover north of the Brightline station?**
  Layout with crossovers will be completed. FECRWY stated that double crossovers preferred versus diamond crossovers.

- **Can the tracks south of the river be shifted east to minimize ROW taking?**
  FECRWY would not consider shifting of the existing freight tracks.

- **Operational concerns, ie signals, bridge**
  Operational concerns discussed with review of the alternatives.

5. Additional Comments

- FECRWY is okay with the project as long as the plan maintains two freight tracks, does not impact operations and has no costs to FECRWY.
- FECRWY has strong concerns with operations, signaling during construction on the Low-Level Alternative.
- Consideration of BrightLine abandoning the existing east platform track will be pursued with the consideration of other alternatives beside the Low-Level Alternative.

HDR

Meeting Sign In

Project: New River Crossing Feasibility Study Project Coordination - FECRWY

Date: October 25, 2019

Location: FECRWY [BWD] Operations Conference Room

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
✓	Daniel Briggs	FEC	863-594-0411	Daniel.Briggs@FECRWY.com
✓	Cory Cutlip	FEC	352-638-7515	cory.cutlip@fecrwy.com
✓	Charlie Graning	FEC	540-589-5903	Charles.Graning@FECRWY.com
✓	Howard Newman	HDR	407.832.2509	howard.newman@hdrinc.com
✓	Todd Riley	HDR	404-434-4937	Todd.riley@hdrinc.com
	Larry Merritt	Tele conf.		
	Alex Barr			
	Leo Villalobos			
	Chris Riviere			

Suite 400
315 E. Robinson Street
Orlando, FL 32801-1949

Phone (407) 420-4200
Fax (407) 420-4242
www.hdrinc.com

MARINE ADVISORY BOARD MEETING
NOVEMBER 7, 2019 - 6:00 P.M.
CITY HALL
CITY COMMISSION CONFERENCE ROOM-EIGHTH FLOOR
100 NORTH ANDREWS AVENUE

AGENDA

I. Call to Order/Roll Call

II. Approval of Minutes – October 3, 2019

III. Statement of Quorum

IV. Waterway Crime & Boating Safety Report

V. Presentation – Tri-Rail Coastal Link, New River Bridge Feasibly Study– Mike Ciscar

VI. Reports

VII. Old/New Business

VIII. Adjournment

Purpose of Marine Advisory Board: Study and recommend to City Commission on all phases of operation, activities, regulations, advertising and publicity of the waterways of the City.

Note: If any person decides to appeal any decision made with respect to any matter considered at this public meeting or hearing, he/she will need to ensure that a verbatim record of the proceedings is made, which record includes the testimony and evidence upon which the appeal is to be based. If you desire auxiliary services to assist in viewing or hearing the meetings, or reading meeting agendas and minutes, please contact the City Clerk's Office at 954-828-5002 and arrangements will be made to provide these services for you.

TWO (2) OR MORE FORT LAUDERDALE CITY COMMISSIONERS OR MEMBERS OF A CITY OF FORT LAUDERDALE ADVISORY BOARD MAY BE IN ATTENDANCE AT THIS MEETING

MORE THAN ONE (1) MEMBER OF THE BROWARD COUNTY MARINE ADVISORY COMMITTEE SERVE AS MEMBERS OF THE CITY OF FORT LAUDERDALE'S MARINE ADVISORY BOARD

MAILED ON: Wednesday, October 30, 2019

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
Marine Advisory Board Meeting
City Hall - City Commission Conference Room – Eight Floor
100 North Andrews Avenue
Thursday, November 7, 2019; 6:00 PM

Agenda

1. Call to Order/Roll call
   - *Board Meeting starts at 6:10 PM with roll call.*
2. Approval of Minutes – October 3, 2019
3. Statement of Quorum
4. Waterway Crime & Boating Safety Report
5. Presentation – Tri-Rail Coastal Link, New River Bridge Feasibility Study – Mike Ciscar
   - *Consultant team begins presentation at 6:23 PM with introductions of the Study Team (Larry Merritt – FDOT, Howard Newman – HDR, Leo Villalobos – HDR, and David Mairena – Corradino).*
   - *Board member asked if the team expanded the low level alternative past Broward Blvd. The Consultant team clarified that this would be addressed by the other feasibility alternatives.*
   - *Board member asked why a 21-foot bridge could not be carried across Broward Blvd. It was stated that there is some roadway traffic issues in the area. Consultant team clarified that this would require the bridge to clear a potential transit envelope currently being studied along Broward Blvd; which would increase the impacts to the North.*
   - *Board member asked if a B/C Analysis has been conducted. The Consultant team advised that preliminary analysis is underway as part of the Feasibility Study.*
   - *Board member asked if Marine Industries had a preference. The Consultant team advised that the only the low-level bascule was not a desired option.*
   - *Board member asked if any of the alternatives minimize impacts. The Consultant team advised the mid-level and high fixed bridge offer less impacts to surrounding community and businesses.*
6. Reports
7. Old/New Business
8. Adjournment

MEETING MINUTES
100 NORTH ANDREWS AVENUE
COMMISSION CONFERENCE ROOM – EIGHTH FLOOR
FORT LAUDERDALE, FLORIDA
THURSDAY, NOVEMBER 7, 2019 – 6:00 P.M.

CITY OF FORT LAUDERDALE

		Cumulative Attendance May 2019 – April 2020	
Grant Henderson, Chair	P	5	1
Ed Strobel, Vice Chair	P	5	1
Cliff Berry II	A	4	2
Robyn Chiarelli	P	3	3
James Harrison	A	1	2
Rose Ann Lovell	P	6	1
Kitty McGowan	A	3	3
Ted Morley	P	1	0
Norbert McLaughlin	P	7	0
Curtis Parker	P	3	3
Rossana Petreccia	A	4	2
Roy Sea	P	6	0
Randy Sweers	A	1	4
Bill Walker	A	5	1

As of this date, there are 14 appointed members to the Board, which means 8 would constitute a quorum.

<u>Staff</u>
Andrew Cuba, Manager of Marine Facilities
Jonathan Luscomb, Marine Facilities Supervisor
Sergeant Todd Mills, Fort Lauderdale Police Department
Brigitte Chiappetta, Recording Secretary, Prototype, Inc.

<u>Communications to City Commission</u>

None.

I. Call to Order / Roll Call

Chair Henderson called the meeting to order at 6:10 p.m.

II. Approval of Minutes – October 3, 2019

This Item was deferred.

III. Statement of Quorum

IV. Waterway Crime & Boating Safety Report

Sergeant Todd Mills of the Fort Lauderdale Police Department reported the following Marine Unit activity from October 2019:

- 14 citations
- 71 warnings
- 28 safety inspections
- 2 boating accidents
- 15 incidents, including 9 electronic thefts

Sgt. Mills stated that the recent Fort Lauderdale International Boat Show was a success, with no major incidents or accidents. The next major event is the Winterfest Boat Parade, which is scheduled for December 14, 2019.

Suzee Bailey, president of the Nurmi Isles Homeowners' Association, reported that boats are running into a sand bar in that neighborhood, resulting in damage. Sgt. Mills replied that he had seen no reports on this issue but would look into it. He recommended that individuals reporting conditions such as this call the City's non-emergency Broward Sheriff's Office (BSO) dispatch number, as this would result in quicker action. He noted, however, there may be little the Marine Unit can do to address the situation.

V. Presentation – Tri-Rail Coastal Link, New River Bridge Feasibility Study – Mike Ciscar

Larry Merritt, representing the Florida Department of Transportation (FDOT), and Howard Newman, Leo Villalobos, and David Mairena, consultants, presented an initial feasibility study on freight and passenger rail crossing the New River. The study's directive was a specific appropriation passed in summer 2019. Its intent is to provide a solution that meets reasonable needs for marine navigation as well as freight and passenger train services. It will identify three alternatives that will be moved into the project development and environmental (PD&E) phase, which provides more details as well as a time frame for design.

Another part of the study's directive is the identification of potential funding sources and an implementation plan incorporating both timeline and funding elements. It will also include a comparative analysis that looks at environmental and engineering factors, as well as costs.

The study has identified four alternatives thus far in coordination with agencies and users of the corridor:

- A low-level bascule bridge with 21 ft. clearance from mean high water to the bottom of the structure
- A medium-level bascule bridge with 56 ft. clearance and the ability to open

- A high-level fixed bridge with 80 ft. clearance
- A tunnel with construction of actual approaches to the station

These and other alternatives have been coordinated with the U.S. Coast Guard. The study team has held meetings with the Coast Guard, Brightline, the FEC Railway, and the Marine Industries Association of South Florida (MIASF), and plans to meet with Fort Lauderdale's Downtown Development Authority (DDA) as well. The study will also allow for the possibility of future light rail train or premium transit service over the existing FEC tracks.

Mr. Newman provided a schematic overview of the four alternatives, noting that the low-level bascule bridge would include roughly 1.1 mile of track improvements. The bridge would be approximately 1020 ft. in distance and would include retaining walls from the end of the structure down to grade. This concept would result in the closing of portions of Himmarshee Street and 5th Street to accommodate the retaining walls. The bridge would also affect 2nd Avenue as it returns to grade and the existing tracks.

Pros and cons for the low-level alternative include:

- No impact on Broward Boulevard or the Brightline station
- Maximizing the use of the existing track configuration
- Closure of multiple streets
- Creation of temporary tracks and signalization during construction
- Access issues to nearby historic sites

The medium-level bascule bridge would provide 56 ft. of clearance and would open to accommodate taller vessels. The Brightline station would be raised approximately 55 ft. The structure would be roughly 7000 ft. in distance and would affect access across the corridor. Its implementation would result in closure of the 7th Street crossing. A transit envelope would provide for east-west crossing over the tracks along Broward Boulevard with a clearance of 47 ft. over the existing track.

Pros and cons include:

- Increased maritime navigations for high-mast boats
- Passenger rail crossings that extend from Andrews Avenue across SW 6th Street, while freight would remain at grade
- Closure of 7th Street
- Significantly elevated Brightline station
- Effects on the right-of-way, and additional historic site, visual, noise, and environmental considerations

The high-level bascule bridge would be approximately 1.5 mile in length, with a 68 ft. platform and an impact of roughly 2.5 miles to the tracks themselves. Mr. Newman compared this alternative to an existing bridge across the Miami River with 80 ft. clearance.

Pros and cons include:

- Elevating over cross streets from Andrews Avenue to 7th Street
- No bridge openings required due to 80 ft. clearance
- Consistency with existing fixed vertical elevation along the corridor
- Closure of 9th Street
- Elevated platform
- Environmental, noise, historic site, and right-of-way impact considerations

The tunnel alternative would be 63 ft. below the existing track due to the depth of the New River. A 40 ft. bore would be used to create the tunnel in order to accommodate double-tracking and pedestrian safety access. Portals would be roughly 1.34 mile apart, with touchbacks to existing tracks at 1.85 mile and tie-in at 2.5 miles. The station would be "cut and covered" at a width of roughly 75 ft. with a center platform. There would be no changes to freight service.

Mr. McLaughlin observed that there has been discussion of moving Tri-Rail service onto the same tracks as Brightline. Mr. Villalobos advised that this would need to be discussed between FDOT and the owners of the rail corridor, as Tri-Rail is public transit, while Brightline service is private.

Pros and cons include:

- Significant effects from construction of the cut and covered station, including a temporary bridge over the cut on Broward Boulevard
- A construction timeline of five to six years
- Disruption of Downtown traffic circulation and businesses
- Accommodation of life/fire safety issues inside the tunnel

The next phase of the study includes comparative evaluation, development of cost/benefit analysis, and identification of initial alternatives and future phases. The report must be finalized and submitted to the Florida Legislature by January 2, 2020. Stakeholder coordination will continue into the future. The project team will return to the Marine Advisory Board at their December 2019 meeting to further discuss recommendations. The PD&E phase will include a full public involvement effort once alternatives have been recommended.

VI. Reports

None.

VII. Old / New Business

Chair Henderson recalled there was discussion of how the City addresses sewage in waterways at the October 2019 meeting. Mr. Cuba advised that he hoped to have a water quality report to present to the Board at a subsequent meeting. While sewage is never supposed to be released into the water, pump-outs can be an issue, although free pump-outs are available at all City marinas.

VIII. Adjournment

There being no further business to come before the Board at this time, the meeting was adjourned at 7:03 p.m.

Any written public comments made 48 hours prior to the meeting regarding items discussed during the proceedings have been attached hereto.

[Minutes prepared by K. McGuire, Prototype, Inc.]

NEW RIVER CROSSING FEASIBILITY STUDY
Meeting Notes
Broward County Commission Office
115 South Andrews Avenue, Suite 409G
Fort Lauderdale, FL 33301
November 14, 2019 at 4:00 PM – 5:00 PM

Attendees

Amie Goddeau, FDOT-D4	Mike Ciscar, Corradino	David Mairena, Corradino
Jaime Lopez, RS&H	Howard Newman, HDR	Leo Villalobos, HDR
Tony Hui, Broward County	Derrick Chan, Broward County	Richard Tornese, Broward County
Bertha Henry, Broward County	Chris Walton, Broward County	

Meeting Notes

- *Mr. Mike Ciscar introduces the study by introducing the Legislative Mandate that initiated the feasibility study.*
- *Ms. Bertha Henry asked if the team met with Broward MPO. The study team stated that attempts to schedule a coordination meeting with Broward MPO has been ongoing, however a meeting has not yet been conducted.*
- *Mr. Derrick Chan asked if the study team investigated building a temporary bridge and improving the existing bridge. The consultant team advised that FEC does not want the team to impact the freight bridge and tracks.*
- *Ms. Bertha Henry stated that they do not see the tunnel being a feasible alternative due to funding. Ms. Bertha Henry also states based on lessons learned, permitting is an issue; and Broward County expects permitting will delay the tunnel alternative, if selected, making it impractical and unfeasible solution.*
- *Ms. Bertha Henry states that the Mid-Level seems to be the most feasible because of the parameters that the FEC has imposed on the study team.*
- *Ms. Bertha Henry states that the Low-Level provides no benefits and high impacts. And believes the Tunnel should be discarded since it would not be feasible to construct within our lifetime.*
- *Ms. Amie Goddeau stated that there needs to be an access agreement with FEC for passenger rail and an O&M plan before the State provides funding to construct a bridge crossing.*
- *Ms. Bertha Henry believes that quantifying the benefit for the Mid-Level would probably provide a good indication of it being the most feasible alternative.*
- *Mr. Derrick Chan believes that the study team should still maintain the dialogue to request to replace the FEC bridge which could make the 21-foot low-level bridge a more desirable & feasible option. This would involve construction of a temporary bridge.*
- *Ms. Amie Goddeau requested some feedback regarding closure of Himmarshee Street. Ms. Bertha Henry states that this is a challenge and would probably be a severe issue for City of Fort Lauderdale.*
- *Ms. Amie Goddeau clarifies that the PD&E is funded, however, it was put on hold in 2015 due to the access agreement for passenger rail and O&M plan as previously stated.*

Meeting Sign In

Project: New River Crossing Feasibility Study

Date: November 14, 2019

Location: Broward County

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
	David Mairena	Corradino	305-594-0735	dmairena@corradino.com
	MIKE CISCAR	CORRADINO	305-586-7107	MCISCAR@CORRADINOINC.COM
	JAIME Lopez	RS & H	7/388-0234	JAime.Lopez@RSandH.[illegible]
	LEO Villalobos	HDR	954-610-2635	Leonardo.villalobos@HDRINC.com
	Howard Newman	HDR	407 832 2500	howard.newman@hdrinc.com
	Amie Goddeau	FDOT-District 4	954-777-4343	amie.goddeau@dot.state.fl.us
	Tony Hui	BC-PWD	(954)357-6308	thui@broward.org
	Derrick Chan	BCT	9542324330	dechan@broward.org
	Richard Tornese	BC-HCED	954-577-4579	rtornese@broward.org
	Bertha Henry	Broward Cnty	9/357-7362	bhenry@broward.org
	CHRIS WALTON	BCT	954-357-8361	CWalton@broward.org

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes

City of Fort Lauderdale/ Downtown Development Authority (DDA)

Transportation and Mobility

290 NE 3rd Ave, Fort Lauderdale, FL 33301

November 14, 2019 at 1:00 PM – 2:00 PM

Attendees

Alex Barr, FDOT-D4	Mike Ciscar, Corradino	David Mairena, Corradino
Howard Newman, HDR	Leo Villalobos, HDR	Ben Rogers, City of Fort Lauderdale
Karen Warfel, City of Fort Lauderdale	Marlon Lobban, City of Fort Lauderdale	Christine W. Fanchi, City of Fort Lauderdale
Jenni Morejon, DDA	Elizabeth Van Zandt, DDA	

Meeting Notes

- *Mr. Ben Rogers provided a brief introduction to the purpose of the meeting.*
- *Mr. Howard Newman provides a presentation to attendees regarding project status.*
- *City of Fort Lauderdale inquired if there was a project which proposes moving freight away from the Downtown area. It was stated that it was part of a new maintenance yard project. The Consultant team clarified that the only alignment studied is along the west side of the existing FEC tracks.*
- *City of Fort Lauderdale would like the tunnel to be carried into the PD&E.*
- *City of Fort Lauderdale posed the question: Why does the freight have to run within Downtown Fort Lauderdale, why not adjacent to I-95?*
- *City of Fort Lauderdale inquired what type of questions the team has encountered with other stakeholders. The team stated that various other alternatives were evaluated including a 27-foot and 65-foot clearance bridge, however, Maritime Industries did not see the benefits of a 27-foot bridge, and USCG prefers the 80-foot clearance bridge for consistency with existing crossing with FPL transmission lines.*
- *City of Fort Lauderdale stated there are existing issues with providing pedestrian access across New River. Can a pedestrian bridge/crossing be integrated with any of the bridge crossings?*
- *City of Fort Lauderdale believes that Brightline has lobbied to obtain funding to upgrade the existing FECR bridge.*
- *City of Fort Lauderdale expresses concerns regarding providing legislature a report without providing some sort of community awareness for the impacted public. The Consultant team clarified that no preferences are decided at this phase, only determination of a range alternatives, potential costs, potential impacts, and potential timelines for each alternative are determined at the feasibility study phase.*
- *Ms. Jenni Morejon requested a copy of the presentation so the DDA board can be briefed.*

HDR

Meeting Sign In

Project: New River Crossing Feasibility Study

Date: November 14, 2019

Location: City of Fort Lauderdale

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
	Karen Warfel	City of Fort Lauderdale	954 828 3798	Kwarfel@fortlauderdale.gov
	BEN ROGERS	CITY OF FORT LAUDERDALE	954.828.3781	BRogers@fortlauderdale.gov
	CHRISTINE W. FANCHI	"	954.828.5226	cfanchi@fortlauderdale.gov
	Marlon Lobban	CFL	954 828 4355	~~[illegible]~~ mlobban@ " "
	Jenni Morejon	DDA FTL	954.463.6574	jenni@ddaftl.org
	Elizabeth Van Zandt	DDA	9.463.6574	elizabeth@ddaftl.org
	David Mairena	Corradino	305-594-0735	dmairena@corradino.com
	MIKE CISCAR	CORRADINO	305-586-7107	MCISCAR@CORRADINO.COM
	Alex Barr	FDOT	954-777-4284	alexander.barr@dot.state.fl.us
	LEO Villalobos	HDR	954-610-2635	LEONARDO.VILLALOBOS@HDRINC.COM

NEW RIVER BRIDGE FEASIBILITY STUDY

Marine Industries Association South Florida
Coordination Meeting
221 SW 3rd Avenue, Fort Lauderdale, Florida 33312
December 5, 2019; 10:30 am

Meeting Notes

- MIASF asked if tunnel concept could be built without closing the New River. The Consultant team clarified that there would be minimal impacts to the river since the tunnel will be bored below the riverbed.
- MIASF states that passenger trains are at capacity per USCG. Brightline currently is operating 36 trains per day.
- MIASF states that Mid- & High-Level Bridges seems to provide a solution with traffic issues at Broward Boulevard.

Meeting Sign In

Project: New River Crossing Feasibility Study
Subject: Marine Industries Association South Florida
Location: 221 SW 3rd Avenue Fort Lauderdale, FL 33312

Date: 12/5/2019
Time: 10:30 AM

	PRINT NAME	ORGANIZATION	PHONE	EMAIL
1.	Patience Cohn	MIASF	954-524-2733	patience@miasf.org
2.	Phil Purcell	MIASF	954-524-2733	phil@miasf.org
3.	Lori Wheeler	MIASF	954-524-2733	lori@miasf.org
4.	Alexander Barr	FDOT	954-777-4284	Alexander.Barr@dot.state.fl.us
5.	Mike Ciscar	Corradino	305-586-7107	mciscar@corradino.com
6.	David Mairena	Corradino	305-594-0735	dmairena@corradino.com
7.	Howard Newman	HDR	407-420-4167	howard.newman@hdrinc.com
8.	Todd Riley	HDR	-	todd.riley@hdrinc.com

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
Marine Advisory Board Meeting
City Hall - City Commission Conference Room – Eight Floor
100 North Andrews Avenue
Thursday, December 5, 2019; 6:00 PM

Agenda

1. Call to Order/Roll call
2. Approval of Minutes – October 3, 2019 | November 7, 2019
3. Statement of Quorum
4. Waterway Crime & Boating Safety Report
5. Discussion – Water Quality Update / Larry Teich
6. Presentation – Tri-Rail Coastal Link, New River Bridge Feasibility Study – Update
    - Board member asked if pedestrian traffic would be accommodated in the low-level alternative at the Riverwalk and Himmarshee Street. The consultant team clarified that pedestrians can be accommodated along the Riverwalk, but not along Himmarshee Street.
    - Board member asked what the horizontal clearance is in the mid-level alternative. It was stated that the alternatives provide a 70-foot clearance.
    - Board member asked why the bascule equipment was placed on opposite end of the existing FEC bridge. It was clarified that this one done to reduced impacts to right of way.
    - Board member asked what the impacts are to cross streets due to walls. It was clarified that impacts due to walls will be at areas where clearance is less than acceptable clearance for roadways, in some cases a few hundred feet.
    - Board member asked if the team considered accommodating freight on the tunnel. It was clarified that the feasibility study was under constraint of not impacting the existing freight tracks and bascule bridge. In addition, not all freight cargo can move through the tunnel due to safety reasons.
    - Board member asked if the team investigated accommodations for pedestrians across Broward Blvd and the New River.
    - Board member stated that from the maritime perspective, the High-Level and Tunnel alternatives are the only alternatives that address the Maritime issues with crossing the freight/passenger tracks.
7. Waiver of Limitations – Benjamin Koppenhoefer / 1749 SE 14th Street (Deferred)

8. Old/New Business
9. Adjournment

NEW RIVER BRIDGE FEASIBILITY STUDY
Meeting Notes
Broward County Commission Office
115 South Andrews Avenue, Suite 409G
Fort Lauderdale, FL 33301
December 6, 2019 at 9:00 AM – 10:00 AM

Meeting Notes

- Ms. Gretchen Cassini asked if SW 2nd Ave and Himmarshee Street will be closed in the Low-Level alternative. The Consultant team confirms that this is true for the Low-Level alternative.
- Mr. Derrick Chan mentioned that an additional alternative involving replacing the existing river crossing bridge with a new bridge and accommodating freight plus passenger should be investigated in future evaluations.
- Ms. Gretchen Cassini asked if pedestrians can be accommodated underneath the bridge. Mr. Larry Merrit stated that this may be further evaluated in future phases.

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes

City of Fort Lauderdale/ Downtown Development Authority (DDA)

Transportation and Mobility

290 NE 3rd Ave, Fort Lauderdale, FL 33301

December 10, 2019 at 11:00 AM – 12:00 PM

Attendees

Mike Ciscar - Corradino	David Mairena - Corradino	Leonardo Villalobos – HDR
Ben Rogers – City of Fort Lauderdale	Marlon Lobban – City of Fort Lauderdale	Raymond Nazaire – City of Fort Lauderdale
Karen Warfel – City of Fort Lauderdale	Christine W. Fanchi – City of Fort Lauderdale	Elizabeth Van Zandt – City of Fort Lauderdale DDA

Meeting Notes

- The City of Fort Lauderdale and DDA asked if there should be consideration given to providing two TBMs to bore the tunnel to reduce the construction duration. The consultant team stated that it could be potentially investigated in the next phase of the project; it could be just a matter of how much more cost it would incur on the project.
- No further comments.

HDR

Meeting Sign In

Project: New River Crossing Feasibility Study Project – Meeting with City of Ft. Lauderdale and DDA

Date: December 10, 2019

Location: City of Fort Lauderdale – 290 NE 3rd Avenue, FT. Lauderdale

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
	MIKE CISCAR	THE CORRADINO GROUP	305-586-7107	MCISCAR@CORRADINO.COM
	David Mairena	" "	305-594-0735	dmairena@corradino.com
	Marlon Lobban	CFL	(954) 828 4355	mlobban@fortlauderdale.gov
	Raymond Nazaire	CFL	(954) 828-8954	rnazaire@fortlauderdale.gov
	BEN ROGERS	FTL CITY STAFF	954.828.3781	BROGERS@FORTLAUDERDALE.GOV
	Karen Warfel	Fort Lauderdale	954.828.3798	kwarfel@fortlauderdale.gov
	LEO VillAlobos	HDR	954 610 2635	LVillAlobo@HDRINC.COM
	CHRISTINE W. FANCHI	CITY OF FORT LAUDERDALE	954.828.5226	cfanchi@fortlauderdale.gov
	Elizabeth VanZandt	FTLDDA	9.463.6574	elizabeth@ddaftl.org

NEW RIVER CROSSING FEASIBILITY STUDY

Meeting Notes
Broward County MPO
100 West Cypress Creek Rd Suite 650
Fort Lauderdale, FL 33309
December 13, 2019 at 1:30 PM – 2:30 PM

Attendees

Mike Ciscar - Corradino	David Mairena - Corradino	Leonardo Villalobos – HDR
Alexander Barr - FDOT	Paul Calversi - MPO	Greg Stuart - MPO
Jaime Lopez – RS&H		

Meeting Notes

- Mr. Greg Stuart requested to be invited to any future meetings with the Mayor of City of Fort Lauderdale. No further comments.

Meeting Sign In

Project: New River Crossing Feasibility Study Project – Meeting with Broward MPO

Date: December 13, 2019

Location: Borward MPO

In Attendance	NAME	COMPANY	PHONE NO.	EMAIL
✓	MIKE CISCAR	THE CORRADINO GROUP	305-586-7107	MCISCAR@CORRADINO.COM
✓	Alex Barr	FDOT	954-777-4284	alexander.barr@dot.state.fl.us
✓	LEO Villalobos	HDR	954-610-2635	LVillAlobo@HDRINC.COM
✓	JAIME Lopez	RS&H	7/388-0234	JAIME.Lopez@RSandH.com
✓	David Mairena	Corradino	305-594-0735	dmairena@corradino.com
✓	Paul Calvaresi	BMPO	9 876-0037	
✓	Greg Stuart	BMPO	0035	

Appendix C – Design Criteria

Tri-Rail Coastal Link (TRCL) Track Design Criteria

Contents

SECTION 1

Track Alignment and Clearances

1.1 Codes and Standards

1.1.1 Codes and Standards

The design is to be consistent with the following codes and standards as applicable.

- American Railway Engineering and Maintenance-of-Way Association's (AREMA) Manual for Railway Engineering and Portfolio of Trackwork Plans, current version
- Association of American Railroads – Equipment Clearance Diagrams
- Amtrak Maintenance of Way Track Standard Plans
- Federal Railroad Administration 49CFR Parts 201 through 238
- Federal Railroad Administration – Department of Safety Track Safety Standards Part 213, revised September 21, 1998
- FEC Standard Plans
- All Aboard Florida (AAF) – Track Design Criteria v1.1
- South Florida Regional Transportation Authority – Design Criteria and Standard Plans

1.2 Design Speed and Clearances

1.2.1 Design Speed

- Design speed for TRCL RGR shall be 80 mph.
- Design speed on FEC freight tracks shall be according to FEC timetable, AAF timetable or 60 mph, whichever is more restricting.
- Design Speed for Tri-Rail and Amtrak shall be 80 mph.
- Design speed on all connector tracks between FEC and SFRC, sidetracks and storage tracks shall be at least 15 mph.

1.2.2 Wayside Clearances

Design within the FEC Corridor shall be based on the maximum allowable clearance for interchange by the Association of American Railroads (AAR). This is Plate "F" of their published clearance diagrams (found in AREMA Manual, Chapter 28, Part 2, Section 2.1, Figure 2.7) and allows for a vehicle with a maximum width of 10'-8" and maximum height above the rail of 17'- 0".

Horizontal clearance shall be measured from the centerline of the track (perpendicular for tangent track and radial for curved track.) Minimum horizontal clearances shall be as follows:

• Permanent Structures	18'
• Obstructions on sidetracks	12'
• Catenary Poles and Signals	8'
• High passenger platforms (All Aboard Florida)	6'1"
• Low passenger platforms	5'1"
• Shelters on passenger platforms	6'7"

On curves, the minimum horizontal clearances shall be increased as follows based on Florida State requirements:

- Outside clearance shall be increased 2” per degree of curvature.
- Inside clearance shall be increased 2” per degree of curvature plus the amount of superelevation (Ea).

Vertical Clearance and Heights shall be measured from the top of highest rail.

Minimum vertical clearances shall be as follows:

• Overhead wires	27’
• New Overhead bridges	24’-3” (Legal State of Florida Statute)
• Doorways or structures over sidetracks	18’

Maximum height of platforms as follows:

• CFH (car floor height) passenger platforms-Florida State Requirement	4’
• Low passenger platforms	8”
• Freight platforms on sidetracks	4’+ 2”

1.2.3 New Structures

Any proposed grade structures located over the proposed corridor shall be designed and constructed to provide a minimum horizontal clear span of 100 feet, and not less than 25 feet from the centerline of the outermost existing or proposed track unless specifically and explicitly exempted elsewhere herein. Any new grade-separated highway and pedestrian crossing, or any other new structure over the project shall be designed and constructed to provide a clear vertical opening of at least 24’-3’’. This clear opening height shall be measured from the top of the highest existing rail or proposed rail for the entire clear span distance, and be of sufficient width to clear-span the ultimate build-out track configuration for the project.

1.3 Track Geometry

1.3.1 Horizontal Alignment

Alignments shall depict the centerline of track and consist of tangents joined by simple circular curves, simple compound curves, or by spiraled circular or compound curves.

The minimum length of tangent track between curved sections of track shall be as follows:

Condition	Tangent Length
Desirable Minimum	200 ft
Absolute Minimum	100 ft or 3 times the design speed (in mph), whichever is greater

At station platforms, the horizontal alignment shall be tangent throughout the length of the entire platform. The tangent shall be extended beyond both ends of the platform as follows:

Condition	Tangent Length
Desirable Minimum	100 ft
Absolute Minimum	85 ft

Track centers on tangent track shall be as follows:

Adjacent main tracks, desired	15’
Adjacent main tracks, minimum	14’
Main tracks and other adjacent tracks	17’
Adjacent sidetracks	14’
Yard ladder track and adjacent track	18’

FRA Non-Compliant Vehicle tracks and FEC Tracks	17’
FRA Compliant Vehicle tracks and FEC Tracks	15’
Adjacent FEC tracks	14’

Providing clearance between trains depends on adjacent curved tracks equivalent to that obtained on adjoining tangents, the track center distance shall be increased as follows:

Where the amount of superelevation is the same on adjacent tracks or where the superelevation of the inner track is greater than that of the outer track, increase the track center distance one inch for each 30 minutes of curvature.

Where the superelevation of the outer track is greater than that of the inner track, increase the track center distance one inch for each 30 minutes of curvature plus 3-1/2” for each one inch of difference in superelevation of the two tracks considered.

Tracks through the normal side of turnouts shall be tangent.

1.3.2 Horizontal Curvature

Circular curves shall be defined by the chord definition of curvature and specified by degree of curve (Dc):

$$Dc = 2 \sin^{-1} (50/R)$$

Every opportunity shall be taken to lessen the degree of curvature on all tracks to the minimum that physical constraints permit. The desirable minimum radii for mainline tracks shall be 1,910 ft or Dc = 3°00’.

The absolute minimum radii for connection tracks (TRCL-SFRC) secondary tracks, yard and service tracks shall be 500 ft (Dc = 11°30’) and requires approval from the FDOT.

The desirable minimum circular curve length, excluding spirals, shall be determined by the following formula:

$$L = 3V$$

Where L = minimum length of curve, in ft
V = design speed through the curve, in mph

The absolute minimum circular curve length with superelevation shall be 62 ft, but 100 ft is preferred.

1.3.3 Spiral Transitions

Spiral transition curves shall be used in order to develop the superelevation of the track and limit the lateral acceleration during the horizontal transition of the commuter rail vehicle as it enters the curve. Spirals shall be required on all mainline track horizontal curves with a radius less than 10,000 ft.

Simple curves with superelevation shall be connected to tangents by spiral transition curves.

Clothoid transition spiral curves shall be used and minimum lengths shall be the greatest length obtained from the following formulas:

$L_s = 62E_a$ (up to 60 mph)
$L_s = 82.66E_a$ (from 61mph to 90 mph)
$L_s = 1.63E_uV$
$L_s = 1.22E_uV$
$L_s =$ 31’ (min)

Where: Ls = Length of spiral transition curve, in feet
Ea = Track superelevation in inches
Eu = Underbalance elevation in inches

V = Design speed in miles per hour

A spiral is preferred, but not required for yard tracks where design speeds are less than 15 mph.

If adjacent curves in the same direction which are in close proximity to one another cannot be replaced by a single simple curve due to geometrical restraints, a series of compound curves shall be the preferred arrangement. Broken back curves, (e.g., short tangents between curves in the same direction) shall be avoided. Where compound circular curves with superelevation are used, they shall be connected to tangents and to each other with spiral transition curves.

All special trackwork shall be located on horizontal tangents.

Coordination of horizontal and vertical alignment shall avoid a combination of minimum radius, maximum grade, and maximum unbalanced superelevation.

1.3.4 Track Superelevation and Unbalance

The design speed for a given horizontal curve shall be based on its degree of curvature, its superelevation, and its unbalance elevation.

Mainline tracks shall be designed with superelevation to permit desired design speeds to be achieved without resorting to excessively large radii of curvature. Note that due to local constraints, the design speed may be less than either the system maximum speed or the maximum possible speed for a curve of given radius. The design speed criteria herein are based on a maximum lateral acceleration of the passenger of 0.1 g.

1. Equilibrium superelevation is the amount of superelevation that would be required so that the resultant force from the center of gravity of the rail vehicle will be perpendicular to the plane of the two rails at the centerline of the track for a given speed.
2. Track superelevation is the difference of the elevation of the top of the outside rail minus the elevation of the top of the inside rail on a curve. Unbalance is the difference between equilibrium elevation (E) and superelevation.
3. For RGR, maximum track superelevation shall be E_a = 5". Maximum unbalance shall be E_u=5” for passenger equipment and 3” for freight equipment.
4. Minimum superelevation or unbalance is 0”. Superelevation and unbalance should not be negative.
5. Superelevation shall be constant through circular curves, which shall be obtained by elevating the outside rail by the amount of track superelevation.
6. The track superelevation shall be run in or run out linearly throughout the length of the spiral curve as follows:

Speed	Maximum Runoff Increment
0-60 mph	1 /2” per 31’
61-90	3 /8” per 31’

Track superelevation shall be calculated to the closest ½” as follows:

$$E = E_a + E_u = 0.0007\ D\ V^2$$

Where:

E = Equilibrium elevation in inches
E_a = Track superelevation in inches

E_u = Unbalanced elevation in inches
D = Degree of curvature
V = Track speed in mph

In practice, the full equilibrium superelevation (E) is rarely installed in track as doing so would require excessively long spiral transition curves. The difference between the equilibrium superelevation and the actual superelevation is called the unbalance, and is designated as Eu. Maximum unbalance superelevation for passenger rail shall be 5” and for freight shall be 3”.

1.3.5 Vertical Alignment

The vertical alignment shall be composed of constant grade tangent segments connected at their intersection by parabolic vertical curves having a constant rate of change in grade along crests and sags.

Compensated gradient shall be utilized when a horizontal curve is located on a grade. The profile grade will be compensated at a rate of 0.04% per Dc. In locations where trains frequently stop, the grade should be compensated at a rate of 0.05% per Dc.

Vertical Grades – The following profile grade limitations shall apply:

1.3.5.1 Mainline

Preferred maximum grade on any track with both passenger and freight operations (sustained grade unlimited length)	1.0%
Absolute maximum grade on any track with both passenger and freight operations	2.0%
Passenger only preferred maximum	2.5%
Passenger only absolute maximum	3.0%

1.3.5.2 Station Area

Desirable	0.0%
Maximum	1.0%

1.3.5.3 Yard Storage and Pocket Tracks

Desirable	0.0%
Maximum	0.4%

All tracks entering the yard shall either be level, sloped downward away from the mainline, or dished to prevent rail vehicles rolling from the yard onto the mainline. For yard secondary tracks, it is desirable to have a slight grade sloping away from the mainline, maximum 1.0% and minimum 0.35%, to achieve good drainage at the subballast level.

Through storage tracks shall have a sag in the middle of their profile to prevent rail vehicles from rolling to either end. It is desirable that the profile grade of a stub end storage track descend toward the stub end, and, if adjacent to a mainline or secondary track, be curved away from that track at its stub end. If it is necessary for the profile grade of a storage track to slope up toward the stub end, the grade shall not exceed 0.2%

Tracks located in maintenance shop facilities shall be level.

1. The minimum vertical tangent length should not be less than 100 ft or 3 times the design speed in MPH, whichever is greater.

2. Grades through turnouts, highway-railroad grade crossings, and through station platforms should be constant. Vertical curves within the limits of switch points are forbidden.
3. The profile grade line in tangent track shall be along the centerline of track between the two running rails and in the plane defined by the top of the two rails. In curved track, the inside rail of the curve shall remain as the profile grade line and superelevation achieved by raising the outer rail above the inner rail.

1.3.6 Vertical Curvature

The vertical alignment shall be composed of constant grade tangent segments connected at their intersection by parabolic curves having a constant rate of change in grade. The minimum length of vertical curve shall be determined by the following formula.

$L = (D*V^2*2.15)/A$

Where:

L = Length of vertical curve in feet
D = The absolute value of the difference in rates of grades expressed in decimal (% grade/100)
A = Vertical acceleration in ft/s2
V = Velocity in MPH

The recommended vertical acceleration (A) shall be based on the following:
Freight Operations ~ A = 0.10 ft/s2
Passenger Operations ~ A = 0.60 ft/s2

Vertical curves shall be also meet the following requirements for the rate of change of curvature “r”:

$r = (G2-G1)/L$

Where:

r = rate of change of grade
G2 = grade at end of vertical curve in percent
G1 = grade at beginning of vertical curve in percent
L = length of vertical curve in stations

The maximum values of r permitted shall be as follows:

On Main tracks	0.40% per 100’
On Secondary tracks	1.0% per 100’
On station viaducts	1.5% per 100’

1. The desired minimum length of vertical curve shall be determined by the greater of the rate of change (r) and the above formula. The absolute minimum length of vertical curve should not be less than 100 ft or 3 times the design speed in MPH, whichever is greater.
2. Tangents between reverse vertical curves should be a minimum of 100 ft minimum or 3 times the design speed in MPH, whichever is greater.

SECTION 2

Trackwork

2.1 General

2.1.1 Design Criteria Scope

The following criteria will establish the requirements for the design and operational characteristics of the trackwork to be used for the TRCL Project.

2.2 Trackwork Requirements

2.2.1 General

The design of new track construction or rehabilitation of existing tracks under the TRCL Project when using FRA compliant vehicles shall be classified as follows:

Type	Class
Main Line Double Track	FRA Class 4
Connector Track between FEC & SFRC	FRA Class 3
Yard, Industrial Sidetracks & Layover Tracks	FRA Class 3

Main Line Tracks and connection tracks using FRA compliant vehicles shall consist of tracks designed for the operation of vehicles carrying revenue passengers along the FEC Corridor as governed by FRA regulations.

Yard, Industrial Sidetracks and Layover Tracks shall consist of all other tracks, including those constructed for the purpose of switching, storing or maintaining vehicles not carrying revenue passengers. Tracks that are seldom used except in emergency or other unusual situations may be designed as secondary tracks regardless of whether or not passengers are carried in the coaches. Secondary tracks shall be constructed of continuously welded rail (CWR).

2.2.2 Types of Track Designs

Primary Track: Main Line Track for the operation of vehicles carrying revenue service. Non-revenue tracks which are critical to the system operation, including transfer and pocket tracks, shall also be classified as primary track. - Ballasted CWR track with concrete ties.

Rehabilitated FEC Freight Tracks – Ballasted CWR track with concrete crossties.

Rehabilitated Tri-Rail Tracks – Ballasted CWR track with concrete crossties.

Connector Tracks between TRCL and SFRC - Ballasted CWR with concrete ties.

Yard Tracks and Layover Tracks: Track is constructed for the purpose of switching, storing or maintaining vehicles not carrying revenue passengers - Ballasted CWR track with concrete ties.

Direct Fixation Track. Direct fixation track is constructed for primary track in tunnel, cut-and-cover, and retained earth sections. The direct fixation track construction shall be designed to utilize a second pour concrete plinth method of construction. Track shall be constructed of Continuous Welded Rail (CWR).

Industrial Sidetracks - Ballasted jointed track with new or relay wood ties and cut spikes.

2.3 Rail

The rail section for all running tracks shall be new 136 when locomotives are used for push-pull operations similar to current Tri-Rail operations.

Rail shall meet all requirements of the AREMA Manual for chemical composition, surface hardness, internal hardness, strength, hydrogen elimination, branding and stamping, dimensional tolerances, and straightness.

Rails on all Main tracks, except where noted otherwise, shall be 136 RE or 115 RE, standard, control-cooled rail with a minimum Brinell hardness of 285 BHN. Such rail shall be a low alloy rail in conformance with current AREMA Manual for Railway Engineering, Chapter 4 “Specification for Steel Rails.” For consistency of rail supply, rails selected for primary track may also be used on yard tracks.

Rails on certain sections of Main tracks such as tight radius curves, where specified, shall be 136 RE or 115 RE high strength rail, achieved by head hardening, fully heat treating, or by line hardening, with or without alloying, with a Brinell hardness of between 321 BHN and 388 BHN. Alloying shall be in accordance with the current AREMA Manual for Railway Engineering, chapter 4, “Specifications for Steel Rails.” High-strength rails shall be used on curves with a radius of less than 1,500 feet and in special trackwork. High strength rail shall not be used in yard tracks or yard turnouts.

Rails in yards and layover facilities shall be 136 RE or 115 RE control- cooled carbon steel rail manufactured in accordance with current AREMA Manual of Railway Engineering, Chapter 4 “Specifications for Steel Rails.”

Rails for industrial sidetracks shall be relay jointed rail.

Rails, other than those that will be used in locations where joint bars will be applied, shall be delivered un-drilled. Where drilling is required, it shall be in accordance with the AREMA requirements for six-hole joint bars. Where joints are to be thermite welded after track installation, the first hole closest to the rail end shall not be drilled. Holes in the rails shall have a 1/32” by 45º chamfer on both sides of the web.

Rails shall be furnished in nominal lengths of not less than 78 ft in order to minimize the number of welds or bonded joints required. Minimum rail length shall be 18 ft except for connections within certain turnouts & crossovers and temporary conditions, where the minimum shall be 14 ft.

Rail welding shall meet all AREMA requirements relevant to welding of rail and the additional requirements listed herein:

a) All joints in running rails shall be welded, except insulated joints and industrial sidings, and shall be welded by the electric flash-butt pressure method wherever possible. Where electric welds are impractical, thermite welds shall be used. Electric welding shall be performed by a fixed welding plant set-up, or by a mobile welding plant.

2.3.1 Rail Joints

Standard rail joints shall not be used in Main track, except in special trackwork areas. All rail ends shall be beveled and end- hardened in accordance with the AREMA Manual. All joint bars shall be 36”, six-hole type, conforming to AREMA specifications. High-strength track bolts shall be used in all rail joints, except where expansion and contraction of rail must be allowed for structural and safety reasons.

Bonded, insulated rail joints shall be located where required to achieve the signal system design. The length of insulated joint bonding shall be 36”**.**

2.3.2 Guarded Track

Tracks with centerline curvature less than 600 ft shall have restraining rail added to the inside traffic rail. The restraining rail shall extend beyond the curve onto tangent track on each end of the curve a minimum distance of 10 ft except where the curve is spiraled, the restraining rail may end at the spiral-to-tangent point provided that point is at least 10 ft beyond the point on the spiral where the instantaneous radius is equal to the specified threshold for curve guarding.

2.3.3 Pre-curved Rail

Where the track radius is sharp enough to exceed the elastic limit of the rail, the rail must be precurved. These are the general guidelines:

Standard Rail:

- Precurve rail horizontally for curve radius below 400 ft.
- Precurve rail vertically for curve radius below 984 ft.

High-Strength Rail:

- Precurve rail horizontally for curve radius below 325 ft.
- Precurve rail vertically for curve radius below 755 ft.

2.4 Cross Ties

Cross ties shall be prestressed concrete for all new passenger tracks meeting the requirements of the AREMA Manual, Chapter 10. Nominal tie length shall be 8 ft – 6”. The concrete ties shall provide for a rail seat cant of 1:40 inward.

Fasteners for concrete ties shall use boltless, snap-in rail fastening spring clips, such as the Pandrol Fastclip or equivalent. Concrete ties shall have an elastomeric pad placed between the rail and bearing surface of the tie. The elastomeric pad shall meet the requirements specified in Chapter 10 of the AREMA Manual, with the exception that the minimum thickness of the pad shall be ¼”.

Tie spacing shall be 21-1/4” for all tracks with curvature greater than 4°, and shall be 24” for tangent track and for track with curvature less than 4°. Tie spacing for special trackwork shall conform to applicable AREMA standards.

Wood crossties shall be used on all new or rehabilitated freight industrial sidetracks. Yard and sidetrack ties shall be 8” wide by 6” deep by 8’ 6” long. Wood crossties shall meet the requirements specified in AREMA Chapter 30. Wood tie spacing shall be 19 ½” on all running tracks and 22” on all yard and sidetracks.

Fasteners for wood ties in CWR track shall use boltless, snap-in rail fastening spring clips, such as the Pandrol Fastclip or equivalent. Wood ties shall have a canted double shoulder tie plate (40:1) accommodating the spring clip meeting the requirements of AREMA Chapter 5. Tie plates shall be secured to crossties with cut spikes.

Tracks using wood ties shall use drive-on anchors. Ties shall be box anchored on every other tie and on every tie within 200 of turnouts or grade crossings. Tie plates shall be canted (40:1). All OTM shall meet the requirements of AREMA Chapter 5.

Switch ties for turnouts and special trackwork shall be of the same material as the track in which the turnout is located.

2.5 Ballasted Track Designs

Ballast shall be Type 4 (0.75” to 1.5”) conforming to AREMA Chapter 1 specifications on all new and rehabilitated tracks. A minimum of 12” of ballast shall be used between the bottom of the tie and the top of the sub-ballast on all new running tracks, and 8” on all new yard tracks. The shoulder ballast shall extend 12” beyond the end of the ties on all tracks.

Sub-ballast shall conform to AREMA Chapter 1 specifications. A 12” layer of sub-ballast shall be installed on top of the subgrade on new main and running tracks and 6” on all new yard and sidetracks. The sub-ballast layer shall be sloped at 2% downward away from the centerline of single tracks or the center point located between the two tracks.

The subgrade shall be compacted to at least 95% compaction of maximum dry density determined by the current revision of ASTM Specification, Designation D 698T (Proctor Test). If the existing material is unsuitable, or the compaction requirements defined above cannot be achieved, the material shall be removed and replaced with clean, sound and properly compacted granular material as specified herein.

The subgrade shall be drained by suitable ditches according to the typical track section. Positive drainage away from the tracks shall be maintained at all times. Trackside ditches shall not be used for retention/detention facilities.

Track stability requires that water seepage or overland flow towards the track be intercepted and diverted before it reaches the track and that precipitation falling upon the track area is quickly drained away.

When required, non-woven geotextile fabric shall be installed on top of the subgrade in all track sections in "cut", and shall extend to the end of the subballast section.

Reinforced concrete approach slabs shall be installed where the track transitions from ballasted to direct fixation track and from direct fixation to ballasted track, in order to provide a smooth transition from one track modulus area to another. The approach slabs shall be located 12" below the bottom of crossties and shall taper from the direct fixation invert to the top of the sub-ballast elevation. Adequate drainage shall be provided so that no ponding occurs.

2.6 Turnouts and Special Trackwork

When possible, turnouts shall be off-the-shelf with service-proven materials which will reduce the probability that future maintenance will be complicated by the need to purchase expensive one-of-a-kind products. This also avoids the situation where essential replacement parts may not be available when needed.

Turnout size should not unduly restrict operating speed below that permitted by route geometry. Turnout size selection should be consistent with achieving the objectives of operations analysis and planning for the TRCL.

The maximum permissible speeds for diverging movements through turnouts without superelevation when located in tangent track shall be as indicated in Table 6.1.

TABLE 2-1
Maximum Passenger Rail Speed for Diverging Movements

Frog	Switch Rail Length	Speed (MPH)
24		60
20	39 ft. equilateral	60
20	39 ft. lateral	45
15	26 ft. or 30 ft.	30
10	19'-6"	15

Turnouts and special trackwork shall meet all AREMA standards, FEC Standards and Tri-Rail Standards, where applicable, except as modified herein. Standard Turnouts and special trackwork shall use AREMA standard RBM frog numbers 10, 15, 20 and 24. Turnouts and special trackwork shall be installed in tangent, constant grade track. No horizontal or vertical curves will begin within 100' or 3*V, whichever is greater, from the point of switch.

The type of rail fastening spring clip used shall be the same as that used on track outside the special trackwork areas.

2.6.1 Universal Crossover

When space permits, a universal crossover is recommended consisting of two single crossovers of two turnouts each positioned in two tracks that allow the vehicle to switch from one track to another in either direction. The two tracks should be parallel, and the turnouts must be identical.

2.6.2 Crossings Diamonds

Crossing diamonds, to the extent practical, shall be straight on both sides, and shall be standard turnout frog numbers, except those of angles larger than No. 4 (14° 15' 00”), which shall be to full degrees or half degrees. Flangeway width shall be 1.75”. Full guarding as on AREMA Plan 757 shall be used for crossings at angles of 15 degrees or larger. For smaller crossing angles, guard rails for the end frogs shall be placed as described in the paragraph on guard rails for turnouts. Raised guards shall be used on the center frogs if the angle is at the No. 5 frog (11° 25' 16") angle or below. The inside guard rail for such frogs shall be 102 RE section. Angles smaller than the No. 6 frog (9° 31' 38") shall not be used. With the 1.75” flangeway and raised guards, rigid crossings with angles at or above that of the No. 7 frog (8° 10' 16") may be used. If such angles are used, the diamond shall be straight.

Frogs in crossing diamonds shall be manganese insert crossings to AREMA Plans 750, 757, 761 and 769, as applicable. Frogs in crossing diamonds of emergency crossovers may, as an alternative, be fabricated in accordance with the AREMA three-rail design as shown on Plans 701, 703, 705, 708, and 710. Easer rails shown as the “alternative” on Plans 708 and 710 shall be used.

2.7 Direct Fixation Track

2.7.1 General

The rail shall be attached to the concrete plinth or grout pad with direct fixation fasteners. One type of direct fixation fastener shall be used on all direct fixation tracks throughout the system, unless otherwise required and approved by the operating railroad's Chief Engineer. The direct fixation fastener shall:

- Support the rail and secure it to the concrete track bed using the minimum number of parts practical.
- Provide vertical, lateral, and longitudinal stability and provide for vertical and lateral adjustments.
- Provide longitudinal restraint between 1,600 and 3,000 lbs.
- Provide electrical insulation without the use of additional pieces.
- Isolate vibrations and attenuate noise generated by vehicles.
- Have a vertical stiffness of approximately 300,000 lbs per inch of deflection.
- Provide a 40 to 1 cant in the rail (except those fasteners within special trackwork units, which shall provide no cant).
- Be attached to the concrete by two anchor bolts of 7/8” diameter.
- Have fixed rail shoulder of between 0.50 and 3.00” high.
- Use a resilient rail fastening spring clip without spring clip insulators.

2.7.2 Fastener Details

Direct Fixation Fasteners shall use a resilient rail fastening spring clip, such as the Pandrol E-clip.

2.8 Grade Crossings

Grade crossing shall be constructed with CWR at all locations. The CWR shall extend at least 85 ft beyond the edge of the crossing surface.

The profile of the roadway shall be adjusted to match the design profile of the track or tracks and provide a smooth transition across the tracks. In multiple track territory, the track profiles should be designed to accommodate a smooth crossing without excessive differences in elevation between tracks.

All crossings should be designed for full depth, lag down, steel clad, and concrete crossing panels. The crossing panels should be installed on timber ties that are fully box anchored within the crossing limits

If possible, railroad/highway grade crossings should be located in tangent track and on tangent roadway, with unhindered lines of sight for both cars and trains.

2.9 Bumping Posts

All tracks which are stub-ended shall have bumping posts. The bumping post shall be located so that there is a minimum of 20 ft between the bumping post and the physical end of track. All bumping posts shall be secured to the rails per manufacturer's recommendations; however they shall not be welded to the rails.

All bumping posts shall be Western Cullen Hayes Type WD or equal. All bumping posts on passenger car track shall have spring or hydraulic impact absorbing head.

Crossties dug into the track or piles of earth or aggregate shall not be used as bumping posts. Aggregate piles may be used behind bumping posts for emergency impact attenuation.

2.10 Staging of Track and Bridge Work along the FEC Corridor

The proposed TRCL project will have a significant impact on other railroads within the project area, both during and after construction. All efforts shall be made to minimize impacts to the operations of the FEC Railway, Tri-Rail, Amtrak and CSX while achieving and maintaining the planned level of service for TRCL operations through the area.

Proposed trackwork that impacts the operators shall be coordinated through the FDOT Project Manager. Trackwork shall be scheduled so that "fouling" tracks or removing tracks from service shall be kept to a minimum and should occur during nights, weekends, or off-peak hours.

Trackwork shall be performed in a manner which complies with all Tri- Rail and FEC safety rules and operating rules.

2.11 Guard Rails

Inside guard rails shall be 100 RE or larger, but not exceeding 115 RE. The guard rail shall be located so that there will be 11" clear between the gauge line of the running rail and the face of the guard rail next to the running rail.

The guard rail shall be electrically isolated from the running rail. The guard rail shall be placed in segments of not over 85 ft. Connections between guard rail segments shall be insulated.

Guard rails shall extend to 50 ft beyond the length of track requiring guarding in both directions. Ends of guard rails shall be tapered. The taper shall be 21 ft long and bring the guard rails to the center of track. Ends shall be turned down or cut down at a slope not steeper than one in two. A full taper is not required at short gaps, which may be required for the mounting of signal and other devices between the rails. No turning down of ends is required at such locations. If the gap is less than 3 ft, no taper is required. If over 3 ft, but less than 10 ft, a 6" offset by 6 ft long taper is required. If the required guarding area extends through a turnout, the guarding on the point end will be brought to a 6" offset tapered end three tie spaces ahead of the point of switch. If train control and electrical hardware interfere, a full taper ending before such hardware shall be installed. On the frog ends, emergency guard rails shall stop short of the ends of the frog guard rails.

2.12 Track Drainage

Drainage of the existing track system within the FEC corridor is provided through infiltration of the ballast and natural ground by the underlying soils and storm run-off sheet flowing to surrounding vegetation and roadways. There is currently no known drainage facilities (swales or ponds) designed for the FEC track system although several culverts and canals cross the corridor.

New trackside swales will be considered for all new track construction to accommodate the proposed TRCL track configuration. These swales are interconnected through culverts located at the crossing roads (East to West), low points and at the track embankments (South to North). The swales should be routed into various discharge or receiving points. These receiving points include natural drainage courses, canals, lakes, wetlands and adjacent drainage systems. Based on right-of-way restrictions, other types of drainage systems such as track underdrains may be required.

The subballast and ballast section of the track structure are pervious layers allowing stormwater runoff to percolate down to the subgrade. If stormwater management is required by the SFWMD, the grading and sizing of the trackside swales will be controlled by providing the proposed drainage systems with the necessary retention/detention volume required to comply with stormwater quality and quantity criteria as outlined in the SFWMD Permit Information Manual Volume IV.

Infiltration systems shall also be considered, if necessary, to secure required retention ditch system drawdown. The proposed drainage work activities will also include the modification, extension, relocation and replacement of existing drainage structures, cross drains as needed to accommodate the railroad corridor improvements.

As a design objective the top of rail elevation shall be above the flood level created by a 100 year storm event (100 year floodplain). Proposed drainage facilities shall prevent flooding of adjacent properties, roadways, and track system roadbed.

A. TRCL drainage criteria apply only to design of drainage facilities under the jurisdiction of the FDOT. Drainage of other facilities and connections to other drainage systems shall be designed in accordance with the criteria of the respective agency having jurisdiction.

B. Invert elevations and location of drainage facilities at the ends of contract design segments shall be coordinated with adjacent segments.

C. As far as practical, drainage shall be by gravity flow. Where sections are below points where gravity outfalls cannot be provided, pumping stations shall be installed.

D. No sanitary sewer discharge shall be permitted to enter the TRCL or FEC drainage system.

E. Drainage facilities for the transit system shall be designed so that the proposed track bed will not:

- Increase the flood or inundation hazard to adjacent property
- Reduce the flood storage capacity or impede the movement of floodwater within a drainage basin
- Increase soil erosion or sedimentation
- Increase in magnitude the peak outflow of drainage water from the subject area into adjacent open bodies of surface water (i.e. canals)

All Aboard Florida (AAF) Structures Design Criteria Version 1.2

STRUCTURAL DESIGN CRITERIA

FOR

ALL ABOARD FLORIDA

PRELIMINARY ENGINEERING AND FINAL DESIGN FOR

REHABILITATION OF EXISTING RAILWAY BRIDGES;
REPLACEMENT OF EXISTING RAILWAY BRIDGES;
NEW RAILWAY BRIDGES

Prepared by HNTB Corporation for All Aboard Florida

August 2, 2013
Rev2. June 30, 2014

Revisions

REVISION NO.	DATE	SECTION	DESCRIPTION
1	11/5/2013	2.2	Changed “Cocoa Beach” to “Cocoa”
		2.3.1, 2.3.1.1, 2.3.1.2.	Revised loads for Maximum Vertical Deflection Criteria
		3.4.2	Changed geographic limits of passenger-only track
2	6/30/14	2.3.2	Clarified application of AREMA for Lateral Deflection
		2.3.4, 3.2	Corrected Section and/or Figure references.
		2.7	Added use of Direct Fixation at Miami and Orlando stations.
		3.1, 3.2	Added Nosing and Hunting Effects
		3.3.2	Clarified utility load.
		3.5.1	Added impact for Direct Fixation track
		3.5.1.1	Clarified application of AREMA for Rocking Effects
		3.6	Added reference to AREMA for Centrifugal Force on concrete structures and removed centrifugal force equation.
		3.8	Divided into Sections 3.8.1 and 3.8.2. Added Nosing and Hunting effects.
		3.13.1	Clarified load application for Derailment, Design Situation 2.
		8.1	Corrected FDOT concrete class references and added higher strength beam concrete.
		11.4.1	Revised LL surcharge for passenger rail.
		11.4.2	Added back-to-back MSE wall criteria and stray current criteria.
		12.0	Added new section for Aesthetics
		13.0	Added new section for Special Miscellaneous Design Criteria, including noise walls and structures at OIA.

Table of Contents

1.0 General

1.1 Overview

These design criteria document the specifications, design approaches, design methodology and governing criteria to be used for the design of the All Aboard Florida (AAF) Project. The design of all structures constructed as part of this project shall comply with the criteria provided herein. Where special design cases are encountered that are not specifically covered in these criteria, supplemental design criteria based on documented technical sources shall be submitted by the designer for acceptance by AAF, prior to their use in the design.

1.2 Standard Design Specifications

The design of structures shall be based on, but not limited to, the current adopted versions of the following codes, manuals and specifications.

- AREMA Manual for Railway Engineering
- AASHTO LRFD Bridge Design Specifications
- FDOT, Structures Manual
- Florida East Coast Railway Engineering Standards and Special Specifications
- FDOT, Roadway and Traffic Design Standards
- FDOT, Soils and Foundation Handbook
- Specification Package developed by AAF and/or Engineer of Record
- FDOT, Standard Specifications for Road and Bridge Construction
- AASHTO/AWS Bridge Welding Code
- AASHTO Guide Specification for Highway Bridge Fabrication with HPS70W, 2nd Edition
- AASHTO Guide Specifications for Seismic Isolation Design
- AASHTO Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges
- ACI Committee 224, "Cracking of Concrete Members in Direct Tension", reapproved 2004
- FDOT, Plans Preparation Manual
- NFPA 130
- ACI Committee 358, Analysis and Design of Reinforced and Prestressed-Concrete Guideway Structures
- European Standard EN 1990:2002/A1, EuroCode – Basis of structural design

In case of conflict between the requirements of the above listed design specifications/codes, the order in which the documents are listed indicates the criteria hierarchy. A separate list of required codes, manuals and specifications for Foundations and Geotechnical Designs is provided in Section 11.

1.3 Units

All structures are designed and detailed using the Customary U.S. Units, e.g., feet (inches), pounds (kips), degrees Fahrenheit (°F).

2.0 Special Requirements

2.1 Fracture Critical Elements

For all structural steel components, structural steel meeting Charpy V-notch test requirements as specified in AREMA Chapter 15, Section 1.14.5 shall be provided.

2.2 Design Speed

- The design speed for freight traffic is 70 mph.
- The Maximum Allowable Speed (MAS) for high speed rail is shown in Table 2.2-1 for each segment of the railway. This is the speed used to determine the following:
  - whether or not a dynamic analysis is required
  - deflection limitations
  - deck twist
  - impact for structures not requiring a dynamic analysis
  - centrifugal forces for all structures
  - fatigue effects
  - aerodynamic effects from passing trains

  Where a dynamic analysis is required, the analysis shall be performed using a Maximum Design Speed (MDS) equal to 1.2 times the Maximum Allowable Speed.

Segment	MAS	MDS[1]
Miami to W. Palm Beach	79 mph	-
W. Palm Beach to Cocoa	110 mph	135 mph
Cocoa to Orlando.	125 mph	150 mph

[1] Dynamic analysis not required for speeds under 90mph

Table 2.2-1 - Maximum Allowable Speed and Maximum Design Speed

2.3 Deflections and Serviceability Requirements

2.3.1 Vertical Deflection

The AREMA maximum vertical deflection for all existing, new, and rehabilitated spans shall be limited to L/640. Vertical deflection shall be computed using E80 live loading plus impact between the Miami station and Cocoa, and E60 live loading plus impact between Cocoa and the Orlando airport station.

For new or replacement structures, the maximum vertical deflection shall also be checked against the criteria indicated in Sections 2.3.1.1 and 2.3.1.2, based on AAF Intercity Train loads, plus impact, with only one track loaded. These criteria, based on the more stringent of passenger comfort or track maintenance considerations, are similar to the ones found in EuroCode for high speed passenger trains. Existing structures along the construction corridor need not satisfy the vertical deflection limits based on passenger comfort and track maintenance.

2.3.1.1 Passenger Comfort

For passenger comfort, the vertical vehicle acceleration is limited to 3.28 ft/sec^2.

The maximum vertical deflections are given in Figure 2.3.1.1-1 below as a function of the span length L (ft) and the Maximum Allowable Speed (mph).

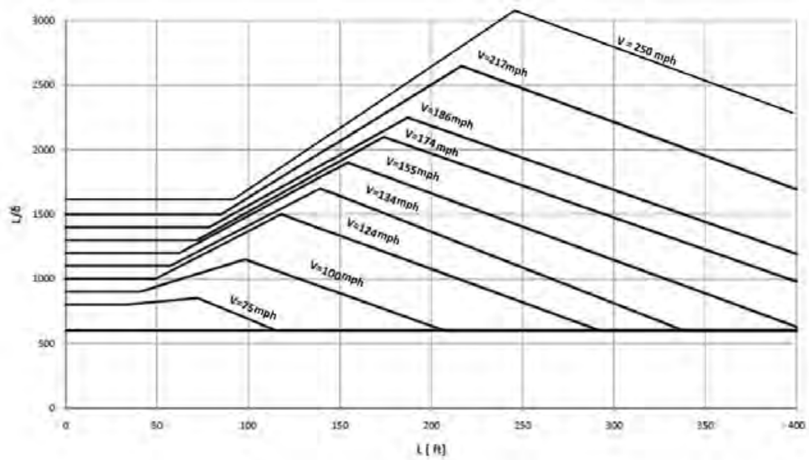


Figure 2.3.1.1-1 – Deflection Limitations for Passenger Comfort

2.3.1.2 Track Maintenance

To reduce the frequency of track maintenance, the maximum vertical deflection under the AAF Intercity Train live load shall be limited to L/1500, L/2250, and L/2600 for a maximum allowable speed of 79mph, 110mph and 125mph, respectively. The general equation for various speeds is given below.

V < 50 MPH	$\Delta \leq L/800$
50 ≤ V ≤ 125 MPH	$\Delta \leq L/(24.15 * V - 400)$
V > 125 MPH	$\Delta \leq L/2600$

where:

V = MAS in mph
L = length of span in feet

2.3.2 Lateral deflection

The lateral deflection shall be according to AREMA Chapter 15 Section 1.2.5. These criteria shall apply to either concrete or steel superstructure types.

2.3.3 Longitudinal Displacement

For longitudinal displacement under braking and longitudinal forces, the one inch limit for the displacement of the structure (AREMA Chapter 8 Section 2.2.3.j) shall be applied with E80 loading when one track is loaded and E60 when two or more tracks are loaded. For members receiving load from more than one track, the design live load on the tracks shall be applied per AREMA Chapter 15 Section 1.3.3d.

2.3.4 Deck Twist

The twist of the bridge deck shall be calculated taking into account the static effects of the following loads:

- the controlling of:
  - live loads specified in section 3.4.1 and 3.4.2 plus impact as per 3.5.1
  - live loads specified in section 3.4.2 plus dynamic effects as per section 3.5.3 for structures requiring a dynamic analysis
- centrifugal effects

The maximum twist *t* (inch/9.84 ft) of a track gauge *s* (ft) of 4.71 feet measured over a length of 9.84 feet (Figure 2.3.4-1) shall not exceed 0.18 inch for MAS V≤75mph, 0.12 inch for 75mph<V≤125mph, and 0.06 inch for V>125mph.

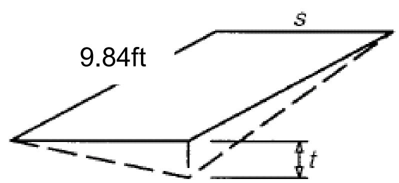


Figure 2.3.4-1

The total track twist due to the combination of any twist which may be present in the unloaded condition (for example in a transition curve), plus the track twist due to the total deformation of the bridge resulting from rail traffic actions shall not exceed 0.30 inch/9.84 feet.

2.4 Superstructure

Ballasted deck on simply-supported precast prestressed concrete girders or structural steel girders are the preferred type of superstructure and shall be used wherever possible.

If through-plate girder spans are proposed, end floorbeams and connections shall be designed such that jacks can be placed under the end floorbeams for lifting the span.

2.5 Design Life Expectancy

The structures shall be designed to provide the following Design Life Expectancy:

Overall Design Service Life	100 years
Superstructure Elements (Steel I Girders, Concrete Box Girders, Concrete I Girders)	100 years
Concrete Deck	75 years
Bearings	50 years
Expansion Joints	25 years
Piers and Foundations	100 years

2.6 Re-use and Rehabilitation of Existing Structures

Any superstructure or substructure that is to be re-used and/or rehabilitated shall be analyzed to verify its ability to support the proposed design loads. Repairs/retrofits for bridge rehabilitation shall be designed for the loadings provided in this Design Criteria and in accordance with these Structural Criteria, AREMA Chapter 8, Section 14, and AREMA Chapter 15, Section 7.4.

Trains may not be able to operate over existing structures at the speeds specified in the track charts; a detailed analysis is required to determine the allowable operating speed at which the vibrational criteria are satisfied. A detailed fatigue analysis shall also be performed to determine the remaining fatigue life.

Review stresses in the existing structural members of the existing bridge for construction conditions and the final condition.

Materials used in the construction of the rehabilitation should have the same thermal and elastic properties as those of the existing structure.

2.7 Bridge Deck

- The deck is the portion of the bridge that supplies a means of carrying the track rails.
- The bridges shall use a ballasted deck with rails anchored to concrete ties, unless otherwise specified.
- The minimum ballast depth under the ties shall be 12”. To accommodate future track raises, the designer shall calculate the dead load for a ballast depth of 28” (12” below the concrete tie, 10” for the thickness of the tie, and 6” for future profile corrections), and neglecting the weight of the concrete tie.
- For the bridge decks converted from open to ballasted, the designer shall calculate the dead load for a ballast depth of 22” (12” below the concrete tie plus 10” for thickness of tie) or as approved by AAF, in addition to the dead load of the concrete deck.
- For the Miami and Orlando stations, the concrete bridge decks within the limits of the respective station platforms shall utilize a non-ballasted track (i.e. Direct Fixation).

2.8 Distribution of Axle Loads

For the design of girders spaced symmetrically about the centerline of tangent track, the axle loads shall be distributed equally to all beams or girders whose centroids are within a lateral width equal to the length of tie plus twice the minimum distance from bottom of tie to top of beams or girders. Distribution of loads for other conditions shall be determined by the referenced codes or an approved and recognized method of structural analysis.

2.9 Rails and Ties

Refer to the Track Design Criteria. In the absence of other specifications, use the following data for the purpose of calculating dead loads.

- Maximum Tie Spacing
  - Prestressed Concrete Ties: 24” O.C.
  - Bridge Ties or Timbers on Open Deck Bridges: 18” O.C.
- Tie plates shall be provided as per Florida East Coast Railway (FECR) standards.

2.10 Bearing Replacement Considerations

Provisions shall be made for bearing and anchor bolt replacements. Anchor bolts are to be installed using couplers at the interface of concrete to masonry plate such that the entire bolt can be removed for replacement.

Jacking locations shall be provided at each bearing location. Jacking loads for the bearing replacement condition need not include live load on the bridge. A section shall be provided in the design plans showing proposed jack locations and the design jacking force. The design jacking force shall be equal to 150 percent of the load calculated for the dead load of the bridge, including any potential increase in ballast weight, if appropriate.

2.11 Piers and Abutments

- Protection for piers and abutments adjacent to railroad tracks shall be designed in accordance with AREMA Chapter 8, Section 2.1.5 and FDOT Structures Manual Section 2.6.7.
- Piers adjacent to channels of navigable waterways shall have a protection system in accordance with AREMA Chapter 8, Part 23 and FDOT Structures Manual Section 2.11.
- Vehicular and vessel collision analyses shall be considered in accordance with AASHTO.
- Piers and Abutments shall be designed in accordance with Chapter 8 of the AREMA Manual, including requirements for temperature reinforcing steel and dampproofing.

2.12 Safety Walkways

- Provide minimum walkway width per FECR standards.
- For through girder structures, walkways shall be inboard of girders.
- Handrails shall be fabricated from pipes or angle sections as per FECR standards.
- For all spans that are inaccessible from the ground, inspection and maintenance platforms shall be provided.

2.13 Track Geometrics and Clearances

Refer to the Track Design Criteria.

- Minimum required horizontal and vertical clearances over waterways, roadways, and railroads shall be provided in accordance with FDOT, FECR, AAF and AREMA criteria.
- Where bridges are rehabilitated or modified, existing horizontal and vertical clearances at a minimum shall be maintained, unless otherwise approved or directed by AAF.
- Minimum clear distance between centerline of track and structural members in a through-girder or through-truss system shall be 9’-0” plus curve corrections.

3.0 Loads

3.1 Load and Load Designation

The following loads and forces shall be considered in the design of railway steel and concrete structures supporting tracks (AREMA 8-2.2.3a):

D	=	Dead Load
L	=	Live Load
I	=	Impact
CF	=	Centrifugal Force
E	=	Earth Pressure
B	=	Buoyancy
SF	=	Stream Flow Pressure
W	=	Wind Forces on Bridge (loaded or unloaded)
WL	=	Wind Forces on Live Load
LF	=	Longitudinal Force from Live Load
F	=	Longitudinal Force due to Friction or Shear Resistance at Expansion Bearings
OF	=	Other Forces (Rib Shortening, Shrinkage, Temperature and/or Settlement of Supports)
EQ	=	Earthquake (Seismic)
CL	=	Vessel or Truck Collision
LFFE	=	Lateral Forces from Equipment
AE	=	Aerodynamic Effects from Passing Trains
NE	=	Nosing and Hunting Effects
DR	=	Derailment Load

3.2 Load Combinations

Stresses shall be combined as per AREMA Chapter 15, Section 1.3.14.

Tables 3.2-1 and 3.2-2 represent various combinations of loads and forces to which the structure may be subjected. For combinations not including Wind Load on Live Load (II and V), the load definition for Wind Forces on Unloaded Bridge from AREMA Chapter 15 is utilized; for combinations including Wind Load on Live Load (III and VI), the load definition for Wind Forces on Loaded Bridge from AREMA Chapter 15 is utilized.

Service Load Design: These load combinations shall be used for the design of steel substructures and steel superstructures.

Group	D	L+I	CF NE	E	B	SF	W	WL	LF	F	OF	DR	Allowable Percentage of Basic Unit Stress
I	1.0	1.0	1.0	1.0	1.0	1.0							100
II	1.0			1.0	1.0	1.0	1.0						125
III	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0			125
IV	1.0	1.0	1.0	1.0	1.0	1.0					1.0		125
V	1.0			1.0	1.0	1.0	1.0				1.0		140
VI	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0		140
IX	1.0					1.0				1.0		1.0	150

Table 3.2-1 - Group Loading Combinations - Service Load Design

Load Factor Design: These load combinations shall be used for the design of concrete superstructures and concrete substructures.

Group	D	L+I	CF NE	E	B	SF	W	WL	LF	F	OF	EQ	DR	CL
I	1.4	2.3	1.4	1.4	1.4	1.4								
IA	1.8	1.8	1.8	1.8	1.8	1.8								
II	1.4			1.4	1.4	1.4	1.4							
III	1.4	1.4	1.4	1.4	1.4	1.4	0.7	1.4	1.4	1.4				
IV	1.4	1.4	1.4	1.4	1.4	1.4					1.4			
V	1.4			1.4	1.4	1.4	1.4				1.4			
VI	1.4	1.4	1.4	1.4	1.4	1.4	0.7	1.4	1.4	1.4	1.4			
VII	1.0			1.0	1.0							1.0		
EX1	1.0	0.5	0.5	1.0	1.0	1.0				1.0				1.0
EX2	1.0					1.0				1.0			1.0	

Table 3.2-2 - Group Loading Combinations - Load Factor Design

3.3 Dead Loads

3.3.1 Structural Components

Steel .... 490 pcf
Normal Weight Reinforced Concrete .... 150 pcf
Ballast .... 120 pcf
Timber .... 60 pcf

A minimum 10% increase shall be considered as an allowance for the dead load of splice and fill plates, stiffeners, nuts and bolts, welds, and other miscellaneous components during analysis for all structural steel components.

3.3.2 Non-Structural Elements

Track rails, inside guard rails and their fastenings (AREMA Chapter 15, Section 1.3.2.b) .... 200 plf/track
Concrete ties .... 800 lbs each
Safety walkway (FRP) .... 25 psf max
Safety walkway (steel) .... 40 psf max
Utilities .... 200* plf/walkway

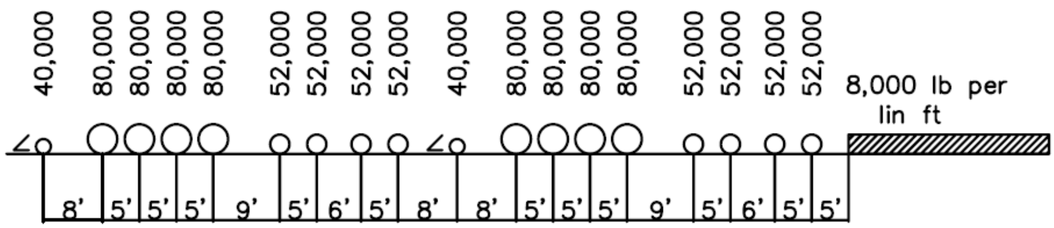
* Prior to design, verify the utility load value based on the proposed location(s) of the utility.

3.4 Live Load

Live loads shall be applied as specified below. Traffic actions which produce a relieving effect shall be neglected, however traffic actions which produce uplift shall be considered.

3.4.1 Freight Traffic

For structures carrying freight traffic or combined freight and passenger traffic, the structural strength design of the steel, steel composite and concrete members shall be based on the Cooper E 80 Train Load (heavy axle), shown in Figure 3.4.1-1. Structures shall also be checked for resonance using the criteria specified in section 3.5.3.



Cooper E 80 Load

Figure 3.4.1-1

For Live Load acting on multiple tracks, see section 3.22.

3.4.2 Passenger Traffic

- It is anticipated that the rail in the east-west alignment (from the Cocoa through to the Orlando International Airport station) will not be designed to carry freight.
- For structures carrying passenger rail only and not requiring a dynamic analysis as discussed in section 3.5.3, the structural strength design of the steel, steel composite and concrete members shall be based on Cooper E 60.
- Passenger-only structures requiring a dynamic analysis shall be designed for HSLM (see Section 3.4.2.1) and AAF "Intercity Train" loads (see Section 3.4.2.2) magnified by the dynamic factor $1+\varphi$ (see section 3.5.3.2), but not less than Cooper E 60 magnified by impact as specified in section 3.5.1.

3.4.2.1 High Speed Load Models (HSLM)

Either HSLM-A or HSLM-B shall be applied in accordance with the following requirements:

1. For simply-supported spans with only longitudinal line beam or simple plate behavior with skews less than 20 degrees on rigid supports and a span of up to 23 feet, use a single critical train from HSLM-B for the dynamic analysis.
2. For simply-supported spans with only longitudinal line beam or simple plate behavior with negligible skew effects on rigid supports and a span of 23 ft or greater, use all trains A1 to A10 inclusive from HSLM-A for the dynamic analysis.
3. For continuous structures with only longitudinal line beam or simple plate behavior with negligible skew effects on rigid supports, use all trains A1 to A10 inclusive from HSLM-A for the dynamic analysis.
4. For complex structures (any structure that has a dynamic behavior different from longitudinal line beam or simple plate behavior with negligible skew effects on rigid supports, for example, a skew structure, bridge with significant torsional behavior, half-through structure with significant floor and main girder vibration modes, etc.), use all trains A1 to A10 inclusive from HSLM-A for the dynamic analysis; in addition, for complex structures with significant floor vibration modes

(e.g. half-through or through bridges with shallow floor) and with members having spans up to 23 feet, HSLM-B shall also be applied.

3.4.2.1.1 HLSM-A

The HSLM-A load set (A1 through A10) is defined in Figure 3.4.2.1.1-1 and Table 3.4.2.1.1-1.

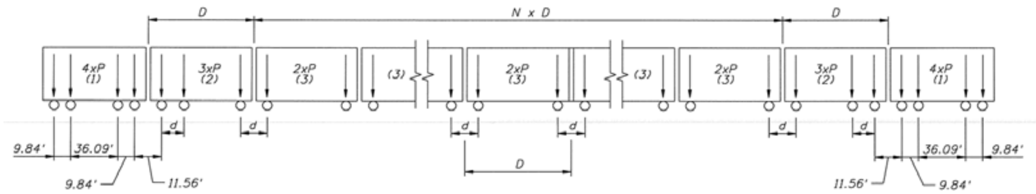


Figure 3.4.2.1.1-1

Legend:
(1) Locomotive (leading and trailing locomotives are identical)
(2) End Car (leading and trailing cars are identical)
(3) *Intermediate Car*

Train Type	Number of Intermediate Cars	Car Length D (ft)	Axle Spacing d (ft)	Axle Load P (kips)
A1	18	59.06	6.56	38.22
A2	17	62.34	11.48	44.96
A3	16	65.62	6.56	40.47
A4	15	68.90	9.84	42.71
A5	14	72.18	6.56	38.22
A6	13	75.46	6.56	40.47
A7	13	78.74	6.56	42.71
A8	12	82.02	8.20	42.71
A9	11	85.30	6.56	47. 21
A10	11	88.58	6.56	47. 21

Table 3.4.2.1.1-1 – HLSM-A Train Parameters

3.4.2.1.2 HLSM-B

The HSLM -B load set comprises of *N* number axle loads of 38.22 kip at uniform spacing d (ft), where *N* and *d* are defined in Figures 3.4.2.1.2-1, 3.4.2.1.2-2 and 3.4.2.1.2-3, where *L* is the span length (ft).

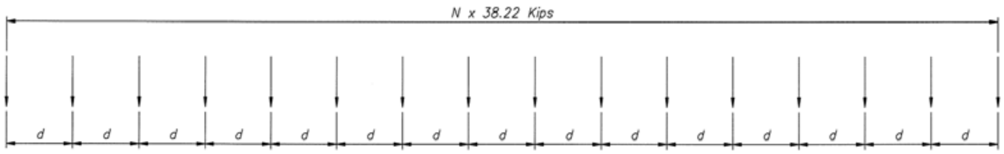


Figure 3.4.2.1.2-1

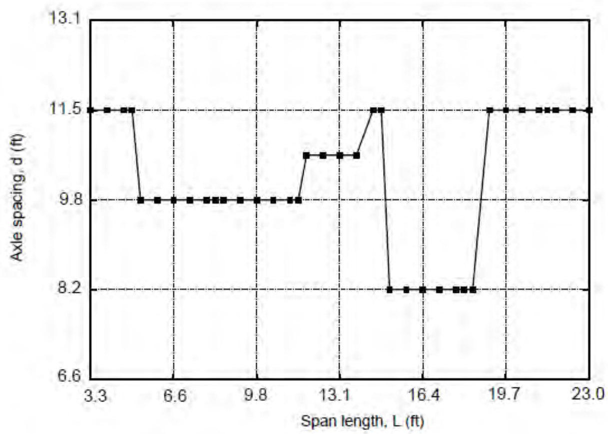


Figure 3.4.2.1.2-2

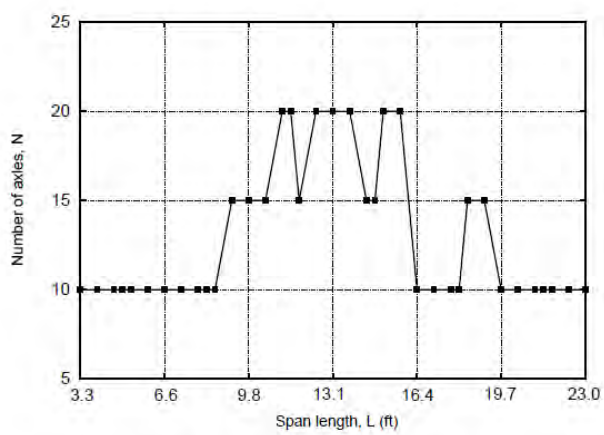


Figure 3.4.2.1.2-3

3.4.2.2 AAF Intercity Trains

The anticipated AAF "Intercity Train" (Passenger) is shown in Figure 3.4.2.2.-1.

The proposed standard passenger train set consists of a locomotive followed by three coach cars, one café car, two coach cars and a locomotive at the back end. The proposed total train length inclusive of locomotives is 660 feet.

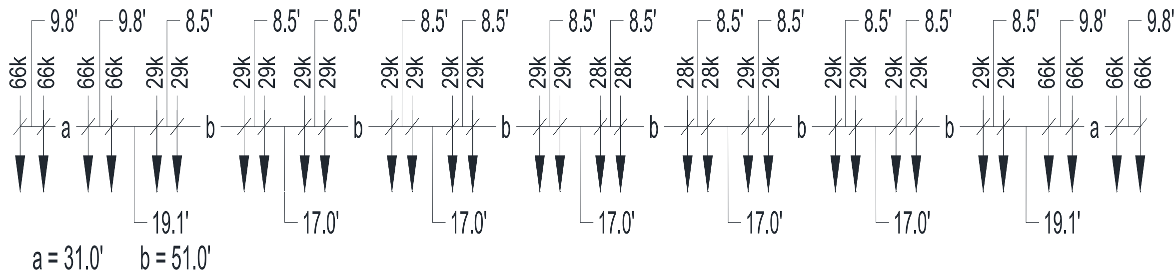


Figure 3.4.2.2-1 – AAF Intercity Train Load

3.4.3 Fatigue

3.4.3.1 Freight

For structures carrying freight or combined freight and passenger traffic, the fatigue design of the steel members and reinforcement of concrete members shall be based on the Cooper E 80 Train Load. For structures requiring a dynamic analysis as per section 3.5.3, the additional requirements of section 3.5.3.9 shall be checked.

3.4.3.2 Passenger

For structures carrying passenger rail only, the fatigue design of the steel members and reinforcement of concrete members shall be based on the Cooper E loading specified in section 3.4.2.

Structures requiring a dynamic analysis as discussed in section 3.5.3 shall also be checked for infinite load induced fatigue life using load models HSLM-A, HSLM-B, and "AAF Intercity Trains" excluding the "real maintenance and construction trains". See sections 3.4.2, 3.5.3.2 and 3.5.3.9.

3.5 Impact Loads

3.5.1 General

Cooper E loads shall be magnified by Impact as per AREMA Chapter 8, Section 2.2.3d and Chapter 15, Section 1.3.5 for concrete and steel, respectively.

For determining impact factors (I) associated with train loading for direct fixation on concrete non-ballasted track with spans less than 40 feet, European Standard EN 1991-2 shall be used as modified below. For spans longer than 40 feet, AREMA ballasted track impact factors shall be used.

Direct fixation on concrete non-ballasted track:

$$I = 100\left(\frac{2.16}{\sqrt{0.305L} - 0.2} - 0.27\right) \leq 100\%$$

where:

L ≤ 40 feet

L = span length for member under consideration (main girder, bridge deck, etc.)

3.5.1.1 Rocking Effects, RE

Impact forces applied as per AREMA shall include contributions due to rocking effects. This shall be expressed as a force couple equal to 20% of the wheel load applied vertically at each rail, as shown in Figure 3.5.1.1-1. Rocking Effect shall be applied to all superstructure types, including concrete beams.

- For tracks supported by two girders, symmetrically placed about the center line of the track, RE can be expressed as (100/S) % of the vertical live load applied at each rail, where S is the distance between centerline of girders (AREMA commentary Chapter 15, Section 9.1.3.5).
- Impact forces due to rocking effects shall be considered for design and shall also contribute to the fatigue stress range.
- For live load acting on multiple tracks, force couples shall be applied according to section 3.22 of the Design Criteria in the manner that will produce the worst-case response.

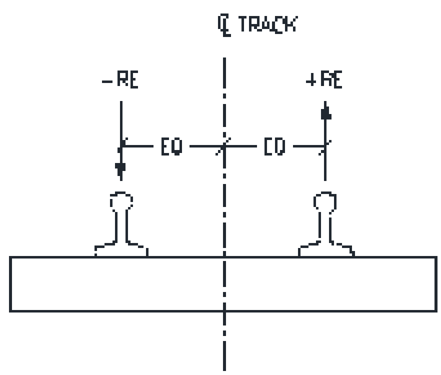


Figure 3.5.1.1-1

3.5.2 Impact Loads due to Fatigue Effects

- When Cooper E loads are applied, mean Impact shall be equal to the percentage found in AREMA Table 15-1-8 multiplied by the Impact specified in section 3.5.1.
- For structures requiring a dynamic analysis, see section 3.5.3.2.

3.5.3 Dynamic Analysis for High Speed Rail

For structures carrying high speed rail at speeds in excess of 90mph, special consideration must be given to the phenomena of “resonance” due to the repetitive application of axle loads at high frequencies. Where the criteria below are not satisfied, there is a risk that resonance or excessive vibration of the bridge may occur, with a possibility of excessive deck accelerations leading to ballast instability and excessive deflections and stresses. For such cases, a dynamic analysis shall be carried out to calculate impact and resonance effects as prescribed in section 3.5.3.2.

Impact forces shall be taken as a percentage of the sum of vertical effects and rocking effects, similar to EuroCode Section 6.4, as described below. Buried structures may have a reduced impact factor as per AASHTO 3.6.2.2. For members receiving load from more than one track, the impact load shall be applied as specified in section 3.22.

Bridges exempt from the requirement for an at-resonance dynamic analysis are as follows:

1. Continuous bridges with MAS 90mph<V≤125mph, and which meet the requirements for resistance, deformation limits given in section 2.3, and the maximum coach body acceleration (or associated deflection limits) corresponding to a very good standard of passenger comfort given in section 2.3.1.1
2. Simply-supported bridges with MAS 90mph<V≤125mph, and with only longitudinal line beam or simple plate behavior with negligible skew effects on rigid supports and first natural bending frequency $n_{0,}$ within the limits given by Figure 3.5.3-1
3. Simply-supported bridges with MAS V>125mph and with only longitudinal line beam or simple plate behavior with negligible skew effects on rigid supports, span L≥131ft and first natural bending frequency, n_0, within the limits given by Figure 3.5.3-1

A dynamic analysis is required for the bridges that do not meet the above requirements to calculate bridge deck acceleration and the dynamic impact component, φ'_{dyn}, for AAF Intercity Trains and load models HSLM-A and HSLM-B as per section 3.5.3.2. A dynamic analysis is also required where the Frequent Operating Speed of an AAF Intercity Train equals a Resonance Speed of the structure (see section 3.5.3.4) and for bridges with a first natural frequency, n_0, exceeding the upper limit in Figure 3.5.3-1. Both directions of train circulation shall be analyzed in non-symmetrical continuous structures.

Dynamic analyses shall always be performed in steel and steel-composite decks, which are susceptible to experience high levels of vibration in resonance conditions due to low mass and damping factor, to assess the vibration levels on the deck, the fatigue damage, and the comfort of passengers. Continuous decks are recommended in both steel and steel-composite construction.

The first natural bending frequency, n_0, of the bridge (Hz) loaded by permanent actions shall be determined taking account of mass due to permanent actions. For the purpose of determining whether a dynamic analysis is required, for simply-supported bridges subjected to bending only, the natural frequency may be estimated using the formula:

$$n_0\ [\text{Hz}] \approx \frac{3.52}{\sqrt{\delta_0}}$$

where:

δ_0 is the deflection at mid span due to permanent actions [in] and is calculated, using a short term modulus for concrete bridges

The upper limit (1) of n_0 in Figure 3.5.3-1 is governed by dynamic enhancements due to track irregularities and is given by:

$$n_{0\_max} = 230.41L_{\Phi}^{-0.748}$$

The lower limit (2) of n_0 is governed by dynamic impact criteria and is given by:

$$n_{0\_min} = 262.47/L_{\Phi} \quad \text{for } 13\text{ft} \le L \le 66\text{ft}$$

$$n_{0\_min} = 47.64L_{\Phi}^{-0.592} \quad \text{for } 66\text{ft} < L \le 330\text{ft}$$

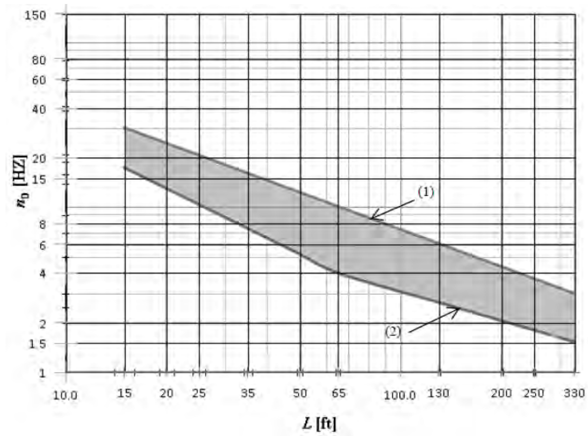


Figure 3.5.3-1

In Figure 3.5.3-1, L is the span length (ft) for simply-supported bridges, and the determinant length, L_{Φ}, as per section 3.5.3.1 for other bridge types.

3.5.3.1 Determinant Length, L_{Φ}

Since the dynamic factor 1+φ was established for simply-supported girders, the determinant length, $L_{\emptyset}$, allows these factors to be used for other structural members with different support conditions. The determinant length $L_{\emptyset}$ [ft] is defined as follows:

1. For steel deck plate – closed deck with ballast bed (orthotropic deck plate with cross girders and continuous longitudinal ribs), for local and transverse stresses:
   a. deck plate (for both directions): 3 times cross girder spacing
   b. continuous longitudinal ribs (including small cantilevers up to 1'-8"; all cantilevers greater than 1'-8" supporting rail traffic actions need a special study with dynamic analysis): 3 times cross girder spacing
   c. cross girders: twice the length of the cross girder
   d. end cross girders: 12 ft
2. For steel deck plate – closed deck with ballast bed (orthotropic deck plate with cross girders only), for local and transverse stresses:
   a. deck plate (for both directions): twice cross girder spacing + 10 ft
   b. cross girders: twice cross girder spacing + 10 ft
   c. end cross girders: 12 ft

3. For steel grillage – open deck without ballast bed, for local and transverse stresses:
   a. rail bearers as an element of a continuous grillage: 3 times cross girder spacing
   b. simply-supported rail bearers: cross girder spacing + 10 ft
   c. cantilever of rail bearer (all cantilevers greater than 1’-8” supporting rail traffic actions need a special study with dynamic analysis): 12 ft
   d. cross girders as part of cross girder / continuous rail bearer grillage: twice the length of the cross girder
   e. end cross girders: 12ft
4. For concrete deck slab with ballast bed, for local and transverse stresses:
   a. deck slab as part of box-girder or upper flange of main beam spanning transversely to the main girders: 3 times span of deck plate
   b. deck slab as part of box-girder or upper flange of main beam spanning in the longitudinal direction: 3 times span of deck plate
   c. cross girders: twice the length of the cross girder
   d. transverse cantilevers supporting railway loading: for e ≤ 1’-8” (see Figure 3.5.3.1-1), 3 times the distance between the webs. Cantilevers greater than 1’-8” supporting rail traffic actions need a special study with dynamic analysis
   e. deck slab continuous (in main girder direction) over cross girders: twice the cross girder spacing
   f. deck slab for half-through and through bridges spanning perpendicular to the main girders: twice the span of deck slab + 10 ft
   g. deck slab for half-through and through bridges spanning in the longitudinal direction: twice the span of deck slab
   h. deck slab spanning transversely between longitudinal steel beams in filler beam decks: twice the determinant length in the longitudinal direction
   i. longitudinal cantilevers of deck slab: for e ≤ 1’-8” (see Figure 3.5.3.1-1) 12 ft; cantilevers greater than 1’-8” supporting rail traffic actions need a special study with dynamic analysis
   j. end cross girders or trimmer beams: 12 ft

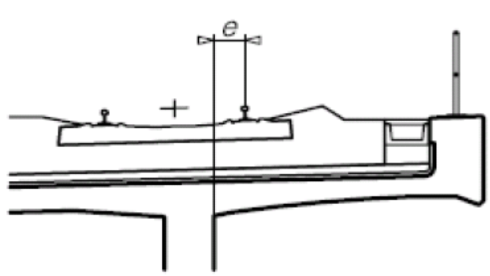


Figure 3.5.3.1-1

5. For main girders:
   a. simply-supported girders and slabs (including steel beams embedded in concrete): span in main girder direction

b. girders and slabs continuous over n spans with $\mathrm{L_m} = (\mathrm{L_1} + \mathrm{L_2} + \cdots + \mathrm{L_n})/\mathrm{n}$, $\mathrm{L_\phi} = \mathrm{k} \times \mathrm{L_m}$ with $\mathrm{k} = 1.2$ for $\mathrm{n} = 2$, $\mathrm{k} = 1.3$ for $\mathrm{n} = 3$, $\mathrm{k} = 1.4$ for $\mathrm{n} = 4$ and $\mathrm{k} = 1.5$ for $\mathrm{n} \geq 5$, but not greater than the maximum length of the spans
c. single-span portal frames and closed frames or boxes: consider as three-span continuous beam (use 5.b) with vertical and horizontal lengths of members of the frame or box
d. multi-span portal frames and closed frames or boxes: consider as multi-span continuous beam (use 5.b) with lengths of end vertical members and horizontal members
e. single arch, arch rib, stiffened girders of bowstrings: half span
f. series of arches with solid spandrels retaining fill: twice the clear opening
g. suspension bars (in conjunction with stiffening girders): 4 times the longitudinal spacing of the suspension bars

6. For structural supports – columns, trestles, bearings, uplift bearings, tension anchors and for the calculation of contact pressures under bearings: determinant length L_ϕ of the supported members

For all cases 1.a through 4.j inclusive, $L_\emptyset$ is subject to a maximum of the determinant length of the main girders.

Where no value of $L_\emptyset$ is specified above, the determinant length shall be taken as the length of the positive portion of the influence line for deflection of the element being considered.

If the resultant stress in a structural member depends on several effects, each of which relates to a separate structural behavior, then each effect shall be calculated using the appropriate determinant length, L_Φ.

3.5.3.2 Dynamic Factor, *1+φ*

To take account of dynamic effects resulting from the movement of actual service trains at speed, the forces and moments calculated from the specified static loads shall be multiplied by a dynamic factor, *1+φ*, appropriate to the MAS. The dynamic factor $1 + \varphi$ is also used for fatigue damage calculations.

The static load due to the AAF Intercity Train or HSLM load model shall be multiplied by:

$$1 + \varphi = 1 + \varphi'_{\text{dyn}} + \varphi''$$

where:

$$\varphi'_{\text{dyn}} = \max \left|\frac{y_{\text{dyn}}}{y_{\text{stat}}}\right| - 1$$

y_{dyn} = maximum value of the dynamic response

y_{stat} = corresponding maximum value of the static response (from static influence-line analysis compared with dynamic analysis at quasi-static 5 mph speed) at any particular point in the structural element due to the passage of each of the AAF Intercity Trains or the HSLM-A or HSLM-B train load models

$\varphi"$ = the increase in calculated dynamic load effects (stresses, deflections, bridge deck accelerations, etc.) resulting from track defects and vehicle imperfections

$$= \frac{1}{100}\left[56e^{-\left(\frac{L_\phi}{32.8}\right)^2} + 50\left(\frac{L_\phi n_0}{262.5} - 1\right)e^{-\left(\frac{L_\phi}{65.6}\right)^2}\right] \geq 0$$

where:

n_0 is the first natural bending frequency of the bridge loaded by permanent actions (Hz)

L_ϕ is the determinant length in accordance with section 3.5.3.1 (ft)

3.5.3.3 Loading and Load Combinations

The dynamic analysis shall be undertaken using load values from the AAF Intercity Trains specified in section 3.4.2.2. The selection of AAF Intercity Trains shall take into account each permitted or envisaged train formation for every type of high speed train permitted or envisaged to use the AAF structures at speeds over 90 mph during the entire service life of the project. The AAF Intercity Trains shall include calibrated projections of future loads to account for the future evolution of high speed train systems. The dynamic analysis shall also be undertaken using load models HSLM-A and HSLM-B. Load models HSLM-A and HSLM-B together represent the dynamic load effects of articulated, conventional and regular high speed passenger trains. Either HSLM-A or HSLM-B shall be applied as specified in section 3.4.2.1.

Where the frequency limits of Figure 3.5.3-1 are not satisfied and the MAS does not exceed 125 mph, the dynamic analysis shall take into account the influence of the following factors on dynamic behavior:

1. High speed of traffic across the bridge producing inertial forces which are not included in static calculations
2. Span, *L*, of the element and the length of the positive portion of the influence line for deflection of the element being considered
3. Mass of the structure
4. Natural frequencies of the whole structure and relevant elements of the structure and the associated mode shapes along the line of the track
5. Number and spacing of axles, leading to resonance effects, and the axle loads
6. Damping of the structure
7. Wheel load variations due to random vertical irregularities in the track
8. Unsprung/sprung mass and suspension characteristics of the vehicle
9. Presence of regularly spaced supports of the deck slab and/or the track (cross girders, railroad ties etc.)
10. Vehicle imperfections (wheel flats, out of round wheels, suspension defects etc.)
11. Dynamic characteristics of the track (ballast, railroad ties, track components etc.)

For the dynamic analysis, the calculation of the value of mass associated with self-weight and removable loads (ballast etc.) shall use nominal values of density. Loads according to section 3.3 shall be used for dynamic analysis.

For the dynamic analysis of the structure only, one track (the most adverse) on the structure shall be loaded as follows:

1. For single track bridges, one track loaded by each AAF Intercity Train load, each HSLM-A and/or HSLM-B train load, if required, traveling in the permitted direction of travel
2. For dual track bridges with trains normally traveling in opposite directions, either track loaded by each AAF Intercity Train load, each HSLM-A and/or HSLM-B train load, traveling in the permitted direction of travel, with the other track unloaded

Where the load effects from a dynamic analysis exceed the static effects from Cooper E loading plus the AREMA impact factor on a track, the load effects from a dynamic analysis shall be combined with:

- the load effects from horizontal forces on the track subject to the loading in the dynamic analysis
- the load effects from vertical and horizontal loading on the other track(s), in accordance with the requirements of section 3.0 and Table 3.22-2.

and the dynamic rail loading effects (bending moments, shears, deformations etc. excluding acceleration) determined from the dynamic analysis shall be enhanced by the load factors given in section 3.2.

Load factors shall not be applied to the loading given in section 3.4.2 when determining bridge deck accelerations. The calculated values of acceleration shall be directly compared with the design values in section 3.5.3.7.

For fatigue, the bridges shall be designed for the additional fatigue effects at resonance from the loading in accordance with section 3.5.3.9.

3.5.3.4 Speeds to Be Considered

For each AAF Intercity Train, load models HSLM-A and HSLM-B, a series of speeds from 90 mph up to the Maximum Design Speed (MDS) for each segment (see Table 2.2-1) of the AAF project shall be considered at 3 mph intervals; smaller speed steps shall be used in the vicinity of resonant speeds to capture the peak values of dynamic response.

For simply-supported bridges that may be modeled as a line beam the Resonant Speeds may be estimated using the formula:

$$v_i = n_0 \lambda_i$$

where:

90 mph $\leq v_i \leq$ MDS

v_i is the Resonant Speed [ft/sec]

n_0 is the first natural frequency of the unloaded structure [Hz]

λ_i is the principal wavelength of frequency of excitation [ft] and may be estimated by:

λ_i $= \frac{d}{i}$
d is the regular spacing of groups of axles [ft]
i = 1, 2, 3 or 4

A quasi-static speed of 5 mph shall also be analyzed and compared with the results of static influence-line analysis. Calculations are required to demonstrate that safety considerations (maximum deck accelerations, maximum load effects, etc.) are satisfactory for structures at speeds in excess of 125 mph. Fatigue and passenger comfort criteria need only be checked at the Maximum Allowable Speed (MAS), not the Maximum Design Speed (MDS).

3.5.3.5 Bridge Parameters

The peak response of a structure at traffic speeds corresponding to resonant loading is highly dependent upon damping. Only lower bound estimates of damping shall be used. The following values of damping [%] shall be used in the dynamic analysis in relation to the span length, L (ft):

1. For steel and composite bridges: $\zeta = 0.5 + 0.0385 \times (65 - L)$ for $L < 65$ ft
   $\zeta = 0.5\%$ for $L \geq 65$ ft

2. For prestressed concrete bridges: $\zeta = 1.0 + 0.0215 \times (65 - L)$ for $L < 65$ ft
   $\zeta = 1.0\%$ for $L \geq 65$ ft

3. For filler beams and reinforced concrete bridges:
   $\zeta = 1.5 + 0.0215 \times (65 - L)$ for $L < 65$ ft
   $\zeta = 1.5\%$ for $L \geq 65$ ft

Maximum dynamic load effects are likely to occur at resonant peaks when a multiple of the frequency of loading and a natural frequency of the structure coincide. Mass underestimation will overestimate the natural frequency of the structure and overestimate the traffic speeds at which resonance occurs.

At resonance, the maximum acceleration of a structure is inversely proportional to the mass of the structure. Two specific cases for the mass of the structure including ballast and track shall be considered:

- a lower bound estimate of mass to predict maximum deck accelerations using the minimum likely dry clean density and minimum thickness of ballast
- an upper bound estimate of mass to predict the lowest speeds at which resonant effects are likely to occur, using the maximum saturated density of dirty ballast with allowance for future track lifts

The minimum density of ballast may be taken as 106 pcf. In the absence of specific test data, the values for the density of materials shall be taken from section 3.3. Barrier walls, both presence and absence, shall be considered in the evaluation of vibration and deflection limits.

Owing to the large number of parameters which can affect the density of concrete, it is not possible to predict enhanced density values with sufficient accuracy for predicting the dynamic response of a bridge. Alternative density values may be used when the results are confirmed by trial mixes.

Overestimating bridge stiffness will overestimate the natural frequency of the structure and the speed at which resonance occurs. A lower bound estimate of the stiffness throughout the structure shall therefore be used.

Values of Young's modulus may be taken from AASHTO LRFD Article 5.4.2.4. For concrete compressive strength $f'_c \geq 7.25$ ksi, the value of Young's modulus shall be limited to the value corresponding to a concrete of strength $f'_c = 7.25$ ksi. Enhanced values of Young's modulus may be used when the results are confirmed by trial mixes.

The numerical models for dynamic analysis shall implement upper- and lower-bound values of the dynamic stiffness of foundations and shall consider rigid body modes due to soil flexibility.

3.5.3.6 Modeling the Excitation and Dynamic Behavior of the Structure

The dynamic effects of load models HSLM-A and HSLM-B and of AAF Intercity Trains may be represented by a series of travelling point forces. Vehicle/structure mass interaction effects are sometimes negligible. The analysis shall take into account variations throughout the length of the train in axle forces and the variations in spacing of individual axles or groups of axles.

Where appropriate, the analysis technique shall allow for the proximity of adjacent frequencies and associated mode shapes of vibration in complex structures, the interaction between bending and torsional modes, the local deck element behavior (shallow floors and cross girders of half-through type bridges or trusses, etc.), the behavior of skewed slabs, etc.

The representation of each axle by a single point force tends to overestimate dynamic effects for loaded lengths of less than 33 feet. In such cases, the load distribution effects of rails, railroad ties and ballast may be taken into account. The individual axle loads shall not be distributed uniformly in the longitudinal direction for a dynamic analysis.

For spans less than 100 feet, dynamic vehicle/bridge mass interaction effects tend to reduce the peak response at resonance. Account may be taken of these effects by carrying out a dynamic vehicle/structure interactive analysis or by increasing the value of damping assumed for the structure according to Figure 3.5.3.6-1. For continuous beams, the smallest value $\Delta\zeta$ for all spans shall be used. The total damping to be used is given by:

$$\zeta_{TOTAL} = \zeta + \Delta\zeta$$

where:

ζ is the percentage value of critical damping defined in section 3.5.3.5.

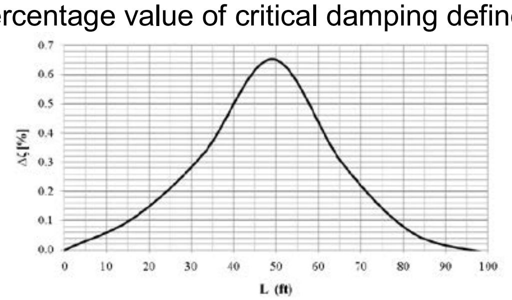


Figure 3.5.3.6-1

The increase in calculated dynamic load effects (stresses, deflections, bridge deck accelerations, etc.) due to track defects and vehicle imperfections may be estimated by multiplying the calculated effects by a factor of:

$$(1 + \varphi")$$

where:

$\varphi"$ is as per section 3.5.3.2 and shall not be taken as less than zero

Where the bridge satisfies the upper limit in Figure 3.5.3-1, the factors that influence dynamic behaviors (7) to (11) identified in section 3.5.3.3 may be considered to be allowed for in $\varphi"$ given in section 3.5.3.2.

The determination of $\varphi"$ shall take into account mass interaction between the unsprung axle masses of the train and the bridge. The analysis shall include:

1. A series of vehicle speeds up to the Maximum Design Speed (MDS) of the AAF project
2. Loading of the AAF Intercity Trains specified in section 3.4.2.2.
3. Dynamic mass interaction between vehicles in the AAF Intercity Train and the structure
4. Damping and stiffness characteristics of the vehicle suspension
5. A sufficient number of vehicles to produce the maximum load effects in the longest span
6. A sufficient number of spans in a structure with multiple spans to develop resonance effects in the vehicle suspension, galloping movements in the train cars (rotations about a horizontal axis due to unequal vertical accelerations of front and rear suspension bogies) and resonant galloping with increased cyclic angular rotations

The analysis shall contain a sufficient number of degrees of freedom to allow modeling of structure, rolling stock, primary suspension, secondary suspension, and the carriage body. It shall make provisions for the placement of the train in various locations to model the passage of the train. When the exact configuration of either the train or the structure is not known, the analysis shall assume a reasonable range of parameters and shall model combinations of those parameters as deemed appropriate.

The values of $\varphi' + \varphi"$ shall be determined using upper and lower limiting values of the first natural bending frequency n_0 (Hz) of the bridge loaded by permanent actions, unless it is being made for an individual bridge of known first natural frequency.

The upper limit of n_0 is given by:

$$n_{0\_max} = 230.41 L_{\Phi}^{-0.748}$$

and the lower limit is given by:

$$n_{0\_min} = 262.47/L_{\Phi} \qquad \text{for } 13\text{ft} \le L \le 66\text{ft}$$

$$n_{0\_min} = 47.64 L_{\Phi}^{-0.592} \qquad \text{for } 66\text{ft} < L \le 330\text{ft}$$

3.5.3.7 Peak Deck Acceleration

Intensive vertical resonant vibrations of railway bridges may cause loss of interlock and destabilization of ballast, partial wheel-rail contact with risk of derailment, deterioration of passenger comfort, settlement of railroad ties and rapid deterioration of track quality with need for frequent maintenance, and possible structural damage.

The maximum peak values of bridge deck acceleration calculated along each track shall not exceed the following design values:

- $a_{bt} = 11.5$ ft/sec^2 for ballasted track
- $a_{df} = 16.4$ ft/sec^2 for direct fastened tracks with track and structural elements designed for high speed traffic

The above limits apply for all members supporting the track considering frequencies (including consideration of associated mode shapes) up to the greater of 30 Hz, 1.5 times the frequency of the fundamental mode of vibration of the member being considered, and the frequency of the third mode of vibration of the member.

3.5.3.8 Verification of the Limit States

To ensure traffic safety:

1. Verification of maximum peak deck acceleration shall be regarded as a traffic safety requirement checked under serviceability for the prevention of track instability.

2. The results of the dynamic analysis shall be compared with the results of the static analysis for Cooper E loading plus Impact and the most unfavorable load effects shall be used for the bridge design.

3. A check shall be carried out according to section 3.5.3.9 to establish whether the additional fatigue loading at high speeds and at resonance is covered by consideration of the static stresses due to Cooper E loading plus impact; the most adverse fatigue loading shall be used in the design.

The maximum peak design values of bridge deck acceleration calculated along the line of a track shall not exceed the values given in section 3.5.3.7.

For the design of the bridge, taking into account all the effects of vertical traffic loads, the most unfavorable of the values below shall be used:

$$(1+\varphi) \times \begin{pmatrix} \text{HSLM} \\ \text{or} \\ \text{RT} \end{pmatrix}$$

or:

$$IM_{AREMA} \times (\text{Cooper})$$

where:

$1+\varphi$ is the calculated dynamic load effects as per section 3.5.3.2
HSLM is the load model for high speed lines defined in section 3.4.2.1
RT is the loading due to all AAF Intercity Trains defined in section 3.4.2.2

IM_{AREMA} is the calculated impact as per section 3.5.1
Cooper is the E loading specified in section 3.4

3.5.3.9 Additional Verification for Fatigue

The fatigue check of the structure shall allow for the stress range resulting from elements of the structure oscillating above and below the corresponding permanent load deflection due to:

- additional free vibrations set up by impact effects from axle loads travelling at high speed
- the magnitude of dynamic live loading effects at resonance
- the additional cycles of stress caused by the dynamic loading at resonance

Where the Frequent Operating Speed of an AAF Intercity Train on a structure is near to a resonant speed, the design shall allow for the additional fatigue loading due to resonance effects. The stress ranges shall be computed by the rain flow counting method and checked against the limiting values for load-induced fatigue in AASHTO LRFD Article 6.6, in relation to the relevant fatigue detail categories. Fatigue in reinforcement steel and prestressing tendons shall be checked as per AASHTO LRFD Article 5.5.3.

3.6 Centrifugal Force

- Centrifugal forces shall be calculated as per AREMA Chapter 15, Section 1.3.6, for steel structures and AREMA Chapter 8, Section 2.2.3e for concrete structures.
- Centrifugal forces on curves shall be applied horizontally through a point 8 feet above the top of rail measured along a line perpendicular to the plane at top of rails and equidistant from them.

3.7 Wind Loads

3.7.1 Wind Forces on Loaded Bridge

- Wind forces on loaded bridge shall be applied as per the larger of the forces derived from AREMA Chapter 15, Section 1.3.7 and FDOT Structures Manual, Section 2.4.1. Lateral and longitudinal wind forces are to be applied independently.
- Wind force on Live Load shall be 300 plf applied at 8 ft above top of rail

3.7.2 Wind Forces on Unloaded Bridge

Wind forces on unloaded bridge shall be applied as per the larger of the forces derived from AREMA Chapter 15, Section 1.3.8 and FDOT Structures Manual, Section 2.4.1. Lateral and longitudinal wind forces are to be applied independently.

3.8 Other Lateral Loads

3.8.1 Lateral Forces from Equipment (LFFE)

Lateral Forces from Equipment shall be applied as per AREMA Chapter 15, Section 1.3.9.

- Lateral bracing and cross frames shall be verified against a single moving concentrated lateral force equal to 25% of the heaviest axle of the Cooper E 80, without impact, applied at the base of rail in either direction and at any point along the span in addition to the other lateral forces specified.

3.8.2 Nosing and Hunting (NE)

For structures with non-ballasted track and direct fixation fasteners, nosing and hunting effects (NE) of the AAF Intercity Train wheels contacting the rails on curved and straight track shall be accounted for by a 22 kip concentrated horizontal force applied to the top of the low rail, perpendicular to the centerline of track at the most unfavorable position.

The nosing force shall always be combined with a vertical traffic load. No dynamic factor needs to be applied to the Nosing and Hunting loads. Nosing forces are not applicable for the design of structures with ballasted track.

3.9 Stability Check

Stability shall be checked as per AREMA Chapter 15, Section 1.3.10, as modified below.

- In calculating the stability of spans and towers, the live load on one track shall be 685 lb per linear foot applied without impact. On multiple track bridges, this live load shall be on the leeward track.
- For beam and girder deck spans requiring lateral bracing, a single line of wheel loads (Q) equal to the design Cooper E loading per rail plus impact shall be applied at an eccentricity of 5 ft from the centerline of track, but no further than the edge of the deck, as a check to cross frames and diaphragms.
  - The permissible resulting stress in these elements is to be 1.5 times that listed in AREMA Chapter 15, Section 1.4.

3.10 Longitudinal Forces

3.10.1 General

Longitudinal forces shall be distributed to structures as per AREMA Chapter 8, Section 2.2.3.i(2) and Chapter 15, Section 1.3.12b.

- Traction and braking forces act at the top of the rails in the longitudinal direction of the track.
- The direction of the traction and braking forces shall take account of the permitted direction(s) of travel on each track. Braking and traction shall be analyzed in both directions in non-symmetrical structures.
- Impact shall not be applied to traction and braking forces.

3.10.2 Structures Carrying Combined Traffic

Structures shall be designed for the more severe of the loads in section 3.10.3 or longitudinal forces based on Cooper E 80 as per AREMA Chapter 8, Section 2.2.3i and Chapter 15, Section 1.3.12.

For structures carrying multiple tracks, the longitudinal force for design shall be based on the more severe of the following:

- 1 track with E80
- 2 tracks with E60

For design loads other than E80, these forces shall be scaled proportionally.

3.10.3 Structures Carrying Passenger Rail Only

For structures carrying passenger rail only, irrespective of the requirement for a dynamic analysis, the longitudinal forces shall be computed as per the EuroCode Section 6.5.3, but shall not be taken less than the forces in section 3.10.2 scaled proportionally for the live loading specified in section 3.4.2.

- Braking forces BR (kips) = 1.37 kip/ft * L ≤ 1350 kips,
where L is the lesser of expansion length or 1000ft
- Traction forces TR (kips) = 2.26 kip/ft * L ≤ 225 kips,
where L is the lesser of expansion length or 100ft

3.11 Thermal Loads

The more severe of the two scenarios described below shall be applied:

3.11.1 Superstructure Expansion

The design shall account for a minimum rate of 1 inch in 100 feet for the change in length of spans to accommodate change in temperature. See section 8.7.

3.11.2 Uniform Temperature Change

- All concrete only structures and concrete deck on steel girder shall be subjected to the following changes in temperature:
  - Low Temperature: 30°F
  - High Temperature: 110°F
- As per FDOT Structures Manual, Section 2.7.1, the ranges of temperature for structural steel shall be taken as:
  - Low Temperature: 30°F
  - High Temperature: 120°F
- The Mean Temperature for all structures shall be 70°F

3.12 Longitudinal Force due to Friction

The structure shall be designed to accommodate forces due to friction at expansion bearings as described in AREMA 8.2.2.3k. See section 8.7 for more information.

3.13 Derailment Loads

AREMA does not provide design criteria for derailment; therefore, the EuroCode and ACI shall be used for this special case loading. The derailment conditions, as described by the EuroCode Section 6.7, prescribe the two vertical load design situations. The American Concrete Institute Committee 358, Section 3.5.2 prescribes the horizontal load condition. Derailment Load is considered as an extreme event design condition. Two design situations shall be considered. Design Situations I and II shall be examined separately. A combination of these loads need not be considered. Other rail traffic actions shall be neglected for the track subjected to derailment actions. No dynamic factor needs to be applied to the derailment design loads.

3.13.1 Vertical Loads

Vertical derailment loads shall be used for checking GLOBAL stability. Overturning of the bridge shall be avoided. Permanent damage to local elements may be tolerated. The following two (2) Design Situations shall be analyzed:

Design Situation 1: The derailed vehicles remaining in the track area on the bridge deck with vehicles retained by the adjacent rail or an upstand wall. The train should be moved transversely in the most unfavorable position inside an area of width 1.5 times the track gauge on either side of the center-line of the track.

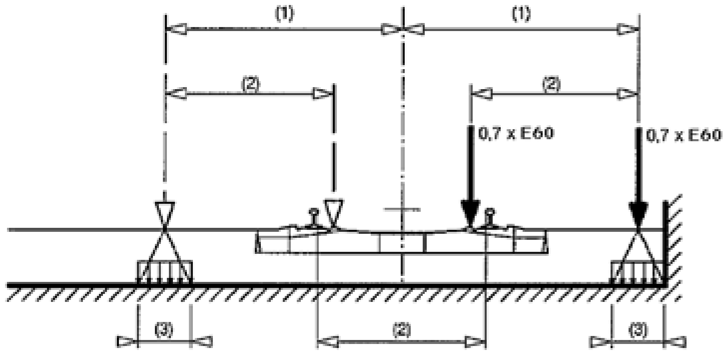


Figure 3.13.1-1

For ballasted decks the point forces may be assumed to be distributed on a square of side 18 in at the top of the deck.

Design Situation 2: The derailed vehicles balanced on the edge of the bridge and load the edge of the superstructure (excluding non-structural elements such as walkways). For the determination of overall stability, a maximum total length of 65 ft of uniform live load shall be taken as a single uniformly distributed vertical line load acting on the edge of the structure under consideration. For bridges in the Miami-to-Cocoa segment, the load shall be Cooper E 60. For bridges in the Cocoa to Orlando segment, the load shall be the AAF Intercity Train load. A load factor of 1.4 shall be applied to the vertical component.

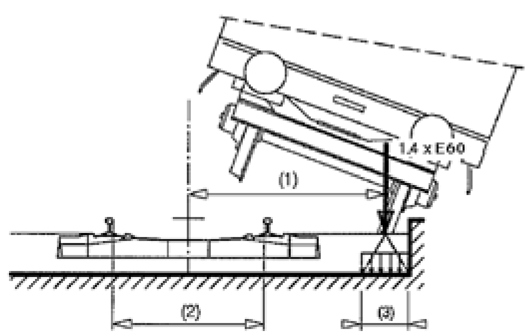


Figure 3.13.1-2

3.13.2 Horizontal Loads

The horizontal containment (ballast retainer) barrier shall resist a lateral force equivalent to 50% of the AAF Intercity Train vehicle distributed over 15 feet along the wall acting at the axle height with the spacing and arrangement of axles to create a maximum loading condition. This force is equivalent to a deceleration rate of 0.5g.

3.14 Earthquake Forces

See Section 7.0 for seismic design.

3.15 Vessel Impact

Vessel impact shall be in accordance with the Vessel Impact Risk Analysis Report.

3.16 Effect of Scour

The effect of scour is to be analyzed based on the Bridge Hydraulics Reports.

3.17 Stream Flow Pressure

The design loads due to flowing water on piers shall be applied in accordance with AREMA Chapter 8, Section 2.2.3m.

When the direction of stream flow is other than normal to the exposed surface area, the effects of the directional components of stream flow pressure shall be investigated and loads applied in accordance with AASHTO LRFD Section 3.7.3.

3.18 Safety Walkway Load

Safety walkways provided shall meet the minimum width required by the FECR Standards. According to AREMA Chapter 15, Section 8.5.3, the design loads for handrails and walkways shall be taken as follows:

- Walkway Live Load: 85 psf
- Beam elements supporting walkway shall be designed for walkway dead and live loads.

Each railing and its fastening shall be designed for a single load of 200 lbs, applied laterally or vertically at any point along the span.

Rail posts shall be designed for a single load of 200 lbs, applied laterally or vertically at the point of attachment of the top railing.

The maximum allowable deflection under a single concentrated live load of 250 lbs applied at mid-span of the walkway shall not exceed L/160.

Toe plates shall be provided for safety walkways with a ½" to 1" clear between the grating and bottom of the toe plate to hamper debris clogs.

3.19 Track Service Areas ("bump-out")

Track service areas for new structures, if provided, are to be designed for a live load of 300 psf.

3.20 Buoyancy

Buoyancy shall be considered as it affects the design of either the substructure (including piling) or the superstructure.

3.21 Earth Pressure

Earth pressure forces applied to the structure shall be computed based on the provisions of AREMA Chapter 8 Part 5 Retaining Walls, Abutments, and Piers.

3.22 Multi-Track Structures

In the tables below, the selection of tracks for these loads shall be such as will produce the worst-case response.

- For structures not requiring a dynamic analysis (structures designed for Cooper E loading), Table 3.22-1 indicates reductions made to account for the improbability of multiple tracks being loaded simultaneously. “Full” indicates 100% of the loads specified in section 3.0 (no reduction). This table shall also apply to structures requiring a dynamic analysis where the results of such an analysis are less critical than those of the specified Cooper E loading.
- For structures requiring a dynamic analysis and where the load effects of the dynamic analysis exceed the static effects of the specified Cooper E loading plus Impact, track 1 shall be loaded with an AAF Intercity Train or HSLM, multiplied by the corresponding dynamic factor as specified in section 3.5.3.2; track 2 shall be loaded with the governing of the two scenarios shown in Table 3.22-2, if doing so creates a critical condition.

Load Case	1 Track Loaded	2 Tracks Loaded	
LL	Full on 1 (E80[1])	Full on 2 (E80[1])	
IM	Full on 1	L < 175’	Full on 2
		175’≤L≤225’	Full on 1, percentage on 2 taken as 450 – 2L
		L > 225’	Full on 1, None on 1
LFFE	Full on 1 (without impact)		
Stability Check	Full on Leeward Track (without impact)		
LF	Full on 1 (E80[1])	Full on 2 (E60[1])	
CF	Full on 1	Full on 2	

[1] to be scaled proportionally for structures designed for loads other than E80

Table 3.22-1 – Track Combinations for Structures Not Requiring a Dynamic Analysis

Load Case	Track 1	Track 2		
		Scenario 1	Scenario 2	
LL	RT or HSLM	same as Track 1	Cooper E 80[1]	
IM	$(1+\varphi'_{dyn}+\varphi'')$	same as Track 1	L < 175’	IM[2]
			175’≤L≤225’	$(450-2L_{\varnothing})*IM^2$
			L > 225’	0
LF	as per section 3.10.3	same as Track 1	as per AREMA using E60[1]	
LFFE	applied to either Track 1 or Track 2			
CF	applied to both tracks			
Stability Check	applied to leeward track			

[1] to be scaled proportionally for structures designed for loads other than E80
[2] Impact calculated as per section 3.5.1

Table 3.22-2 – Track Combinations for Structures Requiring a Dynamic Analysis

3.23 Collision Loads (CL)

Collision loads in sections 3.23.1, 3.23.2, and 3.23.3 apply to train impact loads. Section 3.23.4 applies to highway collision loads.

3.23.1 Collision Loads other than at Stations or Platforms

Unprotected structural members within 25 feet of the track center line shall be designed to resist train collision forces of 900 kips and 400 kips, parallel and perpendicular to the tracks, respectively. The loads are applied to a strip 6 feet in length and at a height centered 4 feet above grade. Forces are not applied simultaneously.

3.23.2 Collision Loads on Separation Barriers to Deter Intrusion of Derailed Freight/Passenger Trains

The height of barrier wall shall be in accordance with AREMA. The wall shall be constructed of reinforced concrete. The wall shall extend 15 feet beyond each end of the pier or a wall that is within 25 feet of the track center line.

A moving load of 400 kips transverse to the track center line, applied to a strip 6 feet in length at a height centered 4 feet above ground level. A 900 kip longitudinal force shall be applied to the wall at the same elevation. Loads are not applied simultaneously.

3.23.3 Structures in Areas beyond Track Ends

Overrunning of rail traffic beyond the end of a track (for example at a terminal station) shall be taken into account as an accidental design situation when the structure or its supports are located in the area immediately beyond the track ends.

The measures to manage the risk shall be based on the utilization of the area immediately beyond the track end and take into account any measures taken to reduce the likelihood of an overrun of rail traffic.

Members supporting structures shall not be located in the area immediately beyond the track ends.

Where structural supporting members are required to be located near to track ends, an end impact wall shall be provided within 20 feet of the track ends in addition to any buffer stop.

The design values for the static equivalent force due to impact on the end impact wall are F_{dx} = 1125 kips for passenger trains and F_{dx} = 2250 kips for freight trains or heavy engines pulling conventional passenger cars. It is recommended that these forces be applied horizontally to a 6-foot wide strip at a level of 4 feet above track level.

3.23.4 Highway Vehicle Collision Loads

Highway collision load shall be as per AASHTO LRFD and as supplemented by the FDOT Structures Manual.

3.24 Aerodynamic Effects from Passing Trains

3.24.1 General

Aerodynamic actions from passing trains shall be taken into account when designing structures (retaining walls, barrier walls, sound walls, station canopies, signs, fences, etc.) adjacent to railway tracks in accordance with EuroCode Section 6.6.

The actions may be approximated by equivalent loads at the head and rear ends of a train, when checking ultimate and serviceability limit states and fatigue. Values of the equivalent loads are given in sections 3.24.2 to 3.24.6. In sections 3.24.2 to 3.24.6, the Velocity [mph] shall be taken as the Maximum Allowable Speed.

Actions due to aerodynamic effects of rail traffic and wind actions shall be combined together. If a structural element is not directly exposed to wind, the action due to aerodynamic effects shall be determined for train speeds enhanced by the speed of the wind.

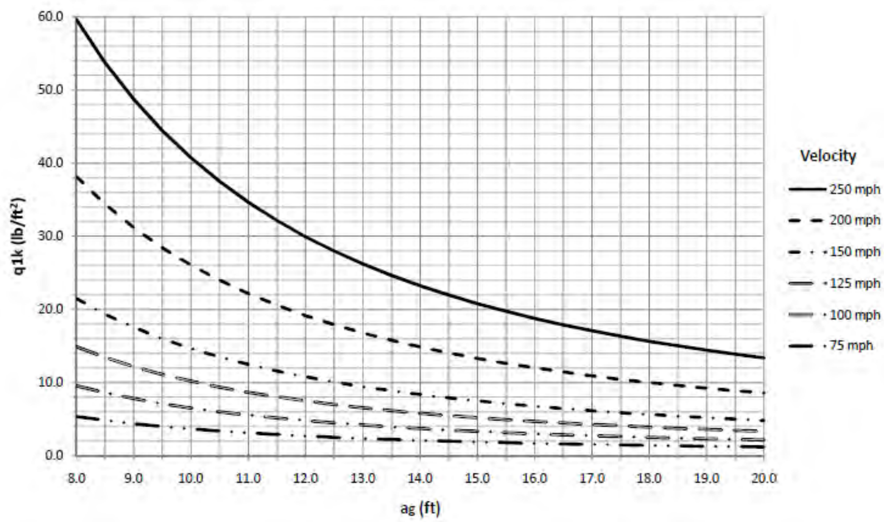
At the start and end of structures adjacent to the tracks, for a zone of length of 16’-5”, measured parallel to the tracks, the equivalent loads in sections 3.24.2 to 3.24.6 shall be multiplied by a dynamic amplification factor of 2.0.

For dynamically sensitive structures, the above dynamic amplification factor may need to be determined by a special study. The study shall take into account dynamic characteristics of the structure, including support and end conditions, the speed of the adjacent rail traffic and associated aerodynamic actions, and the dynamic response of the structure, including the speed of a deflection wave induced in the structure. In addition, for dynamically sensitive structures, a dynamic amplification factor may be necessary for parts of the structure between the start and end zones.

3.24.2 Simple Vertical Surfaces Parallel to the Track (e.g. Sound Walls)

The values of the pressure $\pm q_1$ are given in Figure 3.24.2-1, where a_g is the distance from the structure to the centerline of the track. These values apply to trains with an unfavorable aerodynamic shape and may be multiplied by a reduction factor k_1=0.85 for trains with smooth sided rolling stock and a factor k_1=0.60 for streamlined rolling stock (e.g. US equivalents of ETR, ICE, TGV, Eurostar or similar).

If a small part of a wall with a height less than 3'-4" and a length less than 8'-3" is considered, e.g. end element of a noise protection wall, the actions q_1 shall be increased by a factor k_2 =1.3.



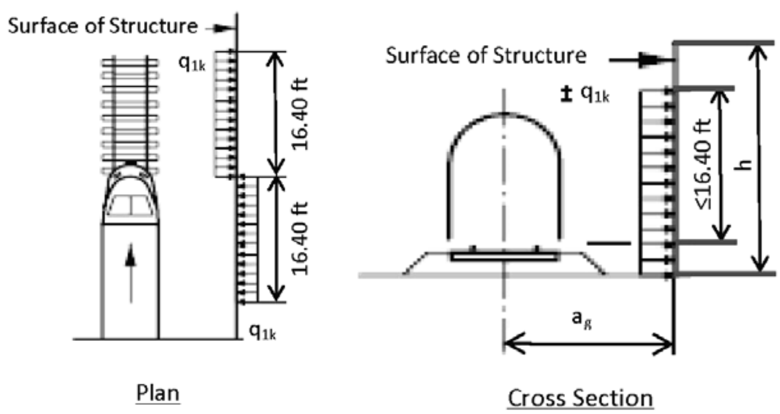


Figure 3.24.2-1

3.24.3 Simple Horizontal Surfaces above the Track (e.g. Overhead Canopies)

The values of the pressure $\pm q_2$ are given in Figure 3.24.3-1, where h_g is the distance from the top of rail to the underside of the structure.

The loaded width for the structural member under investigation extends up to 33 feet to either side of the centerline of the track. For trains passing each other in opposite directions, the actions shall be added. The loading from trains on only two tracks needs to be considered.

The action q_2 may be multiplied by the reduction factor, k_1, as defined in section 3.24.2. The actions acting on the edge strips of a wide structure which cross the track may be multiplied by a factor of 0.75 over a width of up to 5 feet.

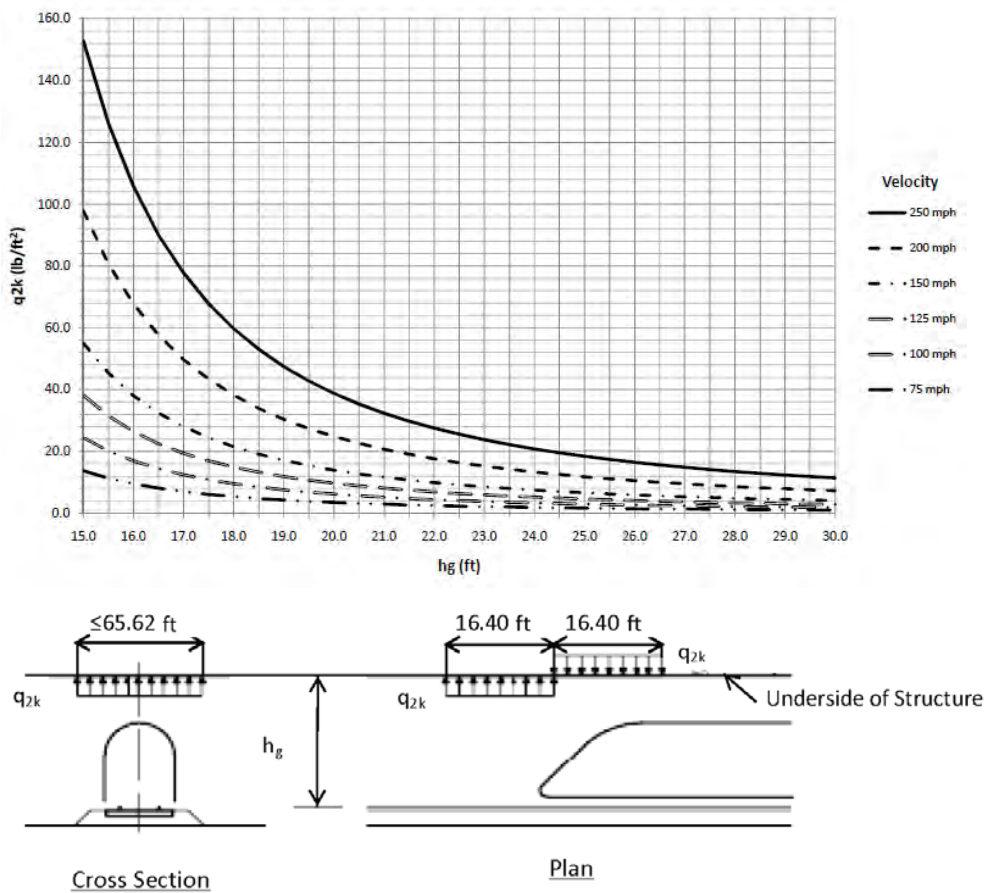


Figure 3.24.3-1

3.24.4 Simple Horizontal Surfaces Adjacent to the Track (e.g. Platform Canopies without any Vertical Wall)

The values of the pressure $\pm q_3$ are given in Figure 3.24.4-1, and apply irrespective of the aerodynamic shape of the train.

For every position along the structure to be designed, q_3 shall be determined as a function of the distance a_g from the nearest track. The actions shall be added if there are tracks on either side of the structural element under consideration.

If h_g, the distance from top of rail level to the underside of the structure, exceeds 12'-6", the action q_3 may be multiplied by a reduction factor, k_3:

$k_3 = (24.6 - h_g)/12.1$ for 12'-6" < h_g < 24'-7"

or

$k_3 = 0$ for h_g > 24'-7"

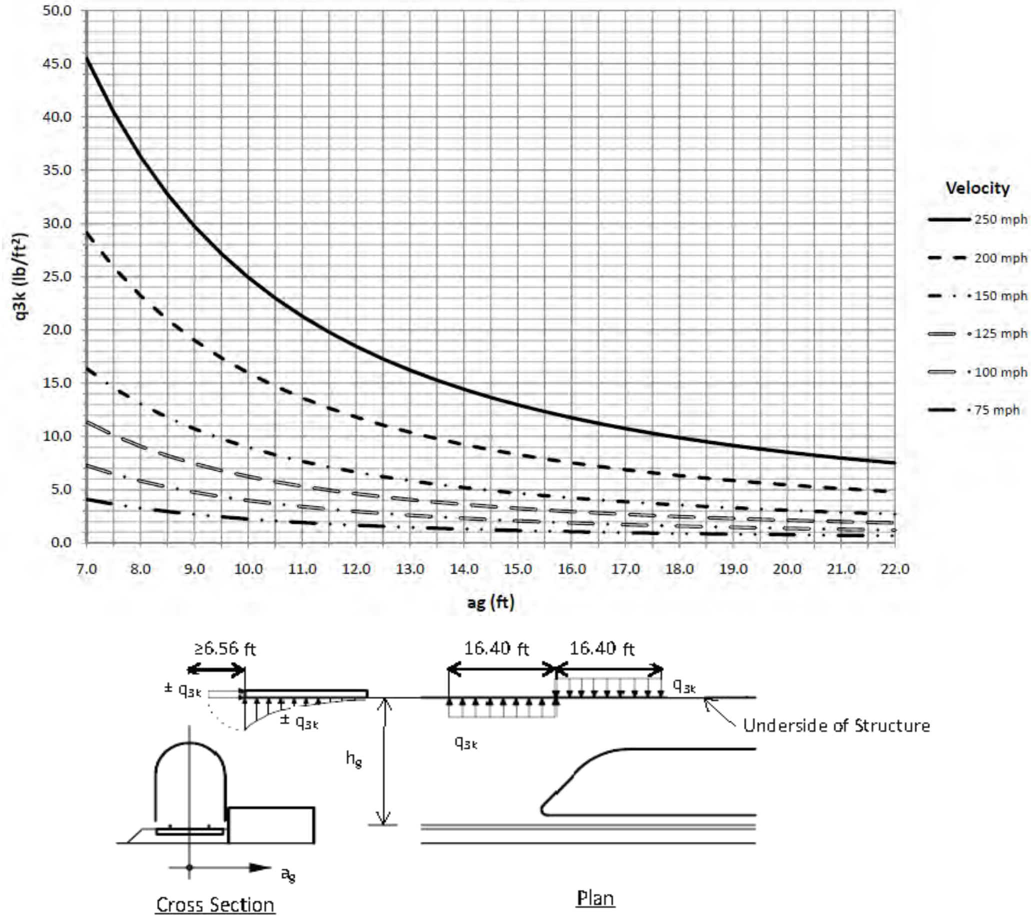


Figure 3.24.4-1

3.24.5 Multiple-Surface Structures alongside the Track with Vertical and Horizontal or Inclined Surfaces (*e.g.* Bent Noise Barriers, Platform Canopies with Vertical Walls etc.)

The values of the pressure $\pm q_4$ as given in Figure 3.24.5-1 shall be applied normal to the surfaces considered. The actions shall be taken from the graphs in Figure 3.24.2-1 adopting a track distance the lesser of:

$a'_g = 0.6 \min a_g + 0.4 \max a_g$

or:

a'_g = 19'- 8"

where distances min a_g and max a_g are shown in Figure 3.24.5-1.

If max a_g > 19'- 8" the value a_g = 19'- 8" shall be used. The factors k_1 and k_2 defined in 3.24.2 shall be used.

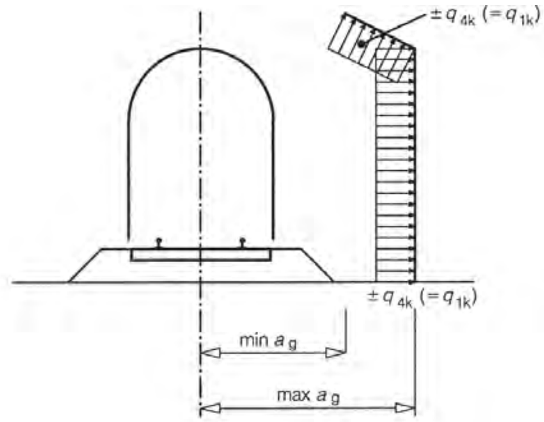


Figure 3.24.5-1

3.24.6 Surfaces Enclosing the Structure Gauge of the Tracks over a Limited Length (up to 65 feet) (Horizontal Surface above the Tracks and at least one Vertical Wall, *e.g.* Scaffolding, Temporary Construction)

All actions shall be applied irrespective of the aerodynamic shape of the train:

- to the full height of the vertical surfaces: $\pm k_4 q_1$ where q_1 is determined according to 3.24.2 and $k_4 = 2$
- to the horizontal surfaces: $\pm k_5 q_2$ where q_2 is determined according to section 3.24.3 for only one track
  - $k_5 = 2.5$ if one track is enclosed
  - $k_5 = 3.5$ if two tracks are enclosed

3.25 Post-Tensioning Forces

Load factors for jacking and post-tensioning forces shall be as specified in AASHTO LRFD Article 3.4.3 and as supplemented by the FDOT Structures Manual.

4.0 Design Method

4.1 Steel Design

Structural steel design shall use the Allowable Stress Design method in accordance with the recommendations of AREMA Chapter 15. Steel structures shall also comply with Fracture Critical Member (FCM) requirements as well as serviceability criteria, such as fatigue and deflection.

4.2 Reinforced Concrete Design

The design of reinforced concrete members shall use the Load Factor Design method, as recommended by AREMA Chapter 8 (Sections 2.30 through 2.39). Load distribution of axle loads shall be determined using an approved method of analysis as specified in AREMA for the design of bridge decks. The design method shall be described in the calculations, with references listed.

The slab shear resistance shall be verified using the following assumptions:

- 60% impact according to AREMA Chapter 8

- Axle load is distributed to the level of the top flange (tie length + ballast depth under tie+ deck thickness) according to AREMA Chapter 15
- Shear force is taken a distance “d” (effective depth of the slab) from the edge of the flange

4.3 Prestressed Concrete Design

The design of prestressed concrete members shall use the Load Factor Design method, as recommended by AREMA Chapter 8, Part 2 as supplemented by Part 17.

4.4 Composite Span Design

The design of composite steel spans shall follow the recommendations provided in AREMA Chapter 15, Section 1.7.9. The elements of the bridge acting compositely shall be designed with a design load of Cooper E 80, while the steel section alone shall provide support for a design load of Cooper E 60, with the assumption that the compression flange remains fully laterally supported. For design loads other than E 80, these forces shall be scaled proportionally. Shear connectors shall be headed studs welded to the top flanges of the steel members and embedded into the concrete deck.

A typical one inch haunch minimum shall be assumed when designing the composite girders of the approach spans. Haunches shall not be treated as structural members.

5.0 Fatigue

The fatigue assessment shall be carried out on the basis of AREMA Chapter 15, Section 1.3.13 with the Cooper E loading specified in section 3.4.

- The lowest acceptable fatigue detail category shall be stress category C (10 ksi).
- Number of constant stress cycles, N, shall be in accordance with AREMA.
- The stress range (algebraic difference between maximum and minimum stress) shall be less than the allowable fatigue stress range defined in AREMA Table 15-1-10.
- Fatigue need not be considered for compression-only members.
- Mean Impact shall be as specified in section 3.5.2.
- For members receiving load from more than one track, a minimum of two tracks shall be loaded in the most unfavorable positions. The impact load shall be applied on the number of tracks designated in AREMA Table 15-1-6.

Structures requiring a dynamic analysis shall also be assessed as per sections 3.4.3, 3.5.3.2, and 3.5.3.9.

6.0 Rail - Structure Interaction

Rail-structure interaction analysis is not required for structures carrying ballasted track, provided pier and abutment stiffnesses satisfy Section 2.3.3 (1 in. rule), and expanding length, $L_{E,}$ to be accommodated by structure expansion joints does not exceed 300 feet.

Where a rail-structure interaction analysis is required to determine the effects of structure deformations under live load, braking and traction forces, and temperature change on track with continuously welded rail, an appropriate procedure is to be developed, subject to approval by AAF.

7.0 Seismic Design

7.1 General Notes

Seismic design shall comply with AREMA Chapter 9.

7.2 Structure Importance Classification

Immediate Safety, Immediate Value and Replacement Value factors shall be as determined by AAF.

7.3 Performance Criteria

The performance criteria for each of the limit states as shown in Table 7.3-1 are described in AREMA Chapter 9, Section 1.3.3.

Limit State	Return Period [Years]	Peak Ground Acceleration [% Gravity]
Serviceability	100	A_{100} = 0.04
Ultimate	500	A_{500} = 0.04
Survivability	2,400	A_{2400} = 0.04

Table 7.3-1

7.4 Site Coefficient

Site coefficient shall be in accordance with the Geotechnical Report and AREMA Chapter 9, Section 1.4.4.1.

7.5 Damping Adjustment Factor

The damping adjustment factor shall be computed with the values given in AREMA Chapter 9, Table 9-C-1.

7.6 Analysis Procedure

The analysis procedure shall be selected as per AREMA Chapter 9, Section 1.4.5.2.

7.7 Load Combinations

Loads shall be combined as per AREMA Chapter 9, Table 9-1-8.

8.0 Materials and Equipment

8.1 Concrete

In the absence of other criteria, all concrete properties shall be in accordance with the following minimum 28-day design compressive strength, f'_c:

- Cast-in-place (Bridge Deck): FECR Class P 5,000 psi
- Cast-in-place (Approach Slabs): FECR Class P 5,000 psi
- Cast-in-Place (Substructure): FECR Class A 4,000 psi
- Cast-in-Place (Railing, Curbs): FECR Class A 4,000 psi
- Precast Prestressed Piling: FDOT Class V (special) 6,000 psi
- Precast Prestressed Beams: FDOT Class V 6,500 psi

Where necessary, Precast Prestressed Beams may use higher strength concrete meeting the criteria and specifications of FDOT Class VI concrete, with a minimum 28-day compressive strength of 8,500 to 10,000 psi.

8.2 Structural Steel

- All steel members to be rolled in the direction of primary stress. All tension members designated FCM are Fracture Critical Members and shall meet Charpy V-notch toughness test requirements applicable to Zone 2 minimum service temperature of −30°F.
- Structural steel shall conform to requirements of ASTM A709, Grade 50 or ASTM A709 High Performance Steel, Grade HPS 50W.
- Steel for handrails, handrail posts, and other miscellaneous non-structural elements shall conform to the requirements of ASTM A709, Grade 36.
- All structural steel shall be painted, unless otherwise specified. Color shall be coordinated with and approved by AAF.
- All structural steel shall meet Charpy impact test requirements for Zone 2.

8.3 Reinforcing Steel

All reinforcing steel shall be new domestic deformed billet steel bars conforming to the requirements of ASTM A615, Grade 60 (AASHTO M31, Grade 60).

All reinforcing splices of deformed bars shall be achieved by lap splices or full-mechanical splices. Welding reinforcing steel shall only be used with the approval of AAF and the Engineer and conform to the welding requirements of the AASHTO/AWS Bridge Welding Code D1.4 and ASTM A706, Grade 60 for deformed bars.

Minimum clear cover to reinforcing steel shall be as per AREMA and FDOT requirements and shall account for the Environmental Classification provisions of FDOT Structures Manual, Sections 1.3 and 1.4.

8.4 Fasteners

All bolts shall be ⅞ inch diameter high-strength bolts (unless otherwise specified) conforming to ASTM A325 (AASHTO M164) Type 1 (slip critical connection Class B), unless otherwise specified.

- Contact surfaces of bolted parts shall meet Class B requirements for Slip Critical Joints in accordance with AREMA specifications. The allowable stress for standard ASTM A325 is 28 ksi (slip load per unit of bolt area).
- All bolted connections shall use a minimum of three (3) bolts as per AREMA (Chapter 15, Section 1.5.9).
- All steel nuts shall conform to ASTM A563 (AASHTO M291) and hardened washers shall conform to ASTM F436 (AASHTO M293), and shall be hot-dipped galvanized in accordance with ASTM A153 (AASHTO M232) Class C, unless otherwise specified.

8.5 Welding Electrodes

All welding electrodes shall conform to the requirements of AASHTO/AWS D1.5. For welding electrode requirements for ASTM A709, Grade HPS 50W, see AREMA Chapter 15, Section 1.2.2d. All welding electrodes shall have a minimum tensile strength of 70 ksi unless otherwise noted.

All welds shall be subject to non-destructive testing. All weldments designated as Fracture Critical Members (FCM) shall conform to the requirements of AREMA Chapter 15, Section 1.10.5.

8.6 Anchor Rods and Bolts

Anchorage of the superstructure shall consist of anchor rods, couplers and anchor bolts as specified in section 2.10. All anchor rods shall be swedged and in accordance with ASTM F1554 (AASHTO M314), Grade 36, 50 or 105 as specified by the Engineer. The anchor rods shall be grouted into circumferentially corrugated galvanized steel or plastic sleeves cast in the concrete. All anchor bolts shall conform to ASTM F1554, Grade 36. Anchor couplers shall be capable of developing 150% of the minimum yield strength of the anchor bolts or rods. Heavy hex nuts shall conform to ASTM A563 (AASHTO M291). Hardened washers shall conform to ASTM F436 (AASHTO M293), plate washers shall conform to ASTM A709 (AASHTO M270) Grade 36. Anchor rods, bolts, couplers, nuts and washers shall be hot-dipped galvanized in accordance with ASTM A153 (AASHTO M232).

8.7 Bearings

Reinforced elastomeric or Polyether Urethane disc are the preferred bearing types and shall be used for appropriate conditions unless an analysis is submitted and approved by AAF and the Engineer that justifies an alternate type of bearing.

Bearings shall be in accordance with AREMA Chapter 15, Part 10. All masonry, sole and other steel plates shall conform to ASTM A709 (AASHTO M270) Grade 50.

The design of bearings shall allow for expansion and contraction of the spans at a rate of 1 inch in 100 feet for the Minimum Service Temperature Zone 1, as stipulated in AREMA Chapter 15, Section 10.1.2c. Expansion bearings shall be capable of accommodating the full anticipated longitudinal movement plus an allowance for construction tolerances as specified in AREMA Chapter 15, Section 10.1.3c.

For PTFE sliding bearing surfaces, the minimum design static coefficient of friction shall be 8%, according to AREMA Chapter 15, Section 10.5.3.1c.

9.0 Bridge Approach Transition

Except where the abutting at-grade trackbed consists of a track slab, an approach slab shall be provided at each abutment to ensure a smooth transition from the at-grade section to the bridge structure. The approach slab shall have a length of not less than 20 feet. Locations where approach slabs are required are listed as below:

- Existing open-deck bridges that are converted to ballasted concrete decks for which the MAS is greater than 90 mph
- Existing Ballasted deck bridges for which the MAS is greater than 90 mph
- At all new structures for which the MAS is greater than 90 mph.

Hot Mixed Asphalt (HMA) can also be considered only for new structures if the approaching track bed has been designed to have a track modulus close to that of the bridge structure subject to approval from AAF and the Engineer of Record.

Approach slabs shall have ballast checks to minimize ballast creep, and provisions shall be made to prevent the scatter of ballast onto the bridge superstructure, deck and bearings.

10.0 Construction Staging and Sequencing

Prepared documents for submission shall include descriptions and details of any required construction staging or sequence of operations.

11.0 Foundations and Geotechnical Design

11.1 Standard Specifications for Foundations and Geotechnical Designs

The foundation, retaining wall, embankment and catenary designs shall be based on, but not limited to, the current adopted versions of the following codes, manuals and specifications.

- AREMA Manual for Railway Engineering
- Florida East Coast Railway Engineering Standards and Special Specifications
- FDOT, Standard Specifications for Road and Bridge Construction
- Specification Package developed by AAF and/or Engineer of Record
- AASHTO “Standard Specifications for Highway Bridges”, 17th Edition, 2002.
- FDOT “Structures Manual”
- FDOT “Soil and Foundation Handbook”
- AASHTO “LRFD Bridge Design Specifications”
- FHWA “Drilled Shafts: Construction Procedures and LRFD Design Methods”, FHWA-NHI-10-016, GEC 10, 2010.
- FHWA “Drilled Shafts: Construction Procedures and Design Methods”, FHWA-IF-99-025, 1999.
- FHWA “Design and Construction of Driven Pile Foundations Reference Manual”, Volume I and II, FHWA-NHI-05-042 and 043, 2006.
- FHWA “Micropile Design and Construction Reference Manual”, FHWA-NHI-05-039, 2005.
- FHWA “LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual”, FHWA-NHI-11-032, GEC 03, 2011.
- FHWA “Evaluation of Soil and Rock Properties”, FHWA-IF-02-034, GEC 05, 2002.
- ASTM “ASTM Book of Standards, Soil and Rock (I and II)”, Vol. 04.08 and 4.09.
- AASHTO “Standard Specifications for Transportation Materials and Methods of Sampling and Testing”.
- AASHTO, Manual on Subsurface Investigations, 1st Edition, 1988.
- USDOD “Soil Mechanics”, Unified Facilities Criteria (UFC) 3-220-10N, 8 June 2005.

In case of conflict between the requirements of the above listed design specifications/codes, the order in which the documents are listed indicates the criteria hierarchy except where specifically stated otherwise herein below.

11.2 Report Requirements

All geotechnical reports, reviews, and submissions shall be in accordance with Chapter 9 of the FDOT Soils and Foundations Handbook.

11.3 Foundation Design

Typical preferred foundation types are drilled shafts, precast prestressed concrete piles, concrete filled pipe piles, steel H-piles driven to rock, or spread footings. Foundation type shall be determined by the results of the Geotechnical Investigation. All foundations shall be designed in accordance with the recommendations of the Geotechnical Report. Applicable and appropriate FDOT design guidelines shall supplement design requirements in AREMA. Battered piles shall not extend outside of the Right-of-Way.

11.3.1 General Design Data

Foundations shall be designed for a 100-year service life.

The maximum scour depth for the 50, 100, and 500-year storm events shall be calculated for all foundation locations within flood plains and/or waterways and shall be utilized for the foundation design.

Foundations shall be designed for Service Load Design for the loads obtained for groups specified in Table 8-2-4 of AREMA Chapter 8, Section 2.2.

Seismic design of foundations shall be performed for Group VII in accordance with Table 8-2-5 of AREMA Chapter 8, Section 2.2. See Section 11.8.

Limitation of lateral deflection of foundations under service loads shall be determined based on type of the foundation at the structure location. Limits shall be jointly established through collaboration of the Engineer and the AAF Program Manager.

Uplift loads shall not be allowed in foundation elements under service load design.

Corrosion of foundation elements shall be evaluated, and mitigated through protection or sacrificial steel, in accordance with the FHWA “Design and Construction of Driven Pile Foundations Reference Manual”, Volume 1, Section 8.8.

11.3.2 Spread Footings

Design of spread footings shall conform to AREMA Chapter 8, Part 3. The net bearing pressure for shallow foundations shall be compression under the entire footing support area for all service load cases. Foundation types and designs must take into consideration effects on adjacent structures and properties. For example, pile driving may initiate settlement of adjacent piers where a second track is being added.

Ultimate bearing capacity and settlement of spread footings shall be in accordance with AASHTO “Standard Specifications for Highway Bridges”, 17th Edition, Section 4.4.

Spread footings on soil or erodible rock shall be located so that the bottom of footing is below scour depths determined for the check flood for scour. Spread footings on scour-resistant rock shall be located to maintain the integrity of the supporting rock.

11.3.3 Pile Foundations

Design of pile foundations shall conform to AREMA Chapter 8, Part 4.

Steel piles (pipe, H-piles, taper tube) and prestressed concrete piles shall be considered and assessed based on cost, constructability and adequacy. The use of battered piles shall be considered for structures with significant lateral loads.

Steel pipe piles shall conform to ASTM A252 Grade 3, and Steel H-piles shall conform to ASTM A 572 Grade 50. Other steel grades may be used with the approval of the AAF Program Manager and the Engineer.

Ultimate axial pile capacity in compression and uplift shall be obtained from the FHWA program Driven version 2.1, FB-Deep version 2.04, APile version 5.0, or approved equal. Lateral capacity of a single pile shall be designed using the computer program Lpile version 6.0 or approved equal. Lateral capacity of pile groups shall be analyzed using FB Multipier version 4.18, Group Version 8.0, or approved equal. P-multipliers for lateral analysis of pile groups shall conform to AASHTO "LRFD Bridge Design Specifications", 2012, Section 10.7.2.4.

Axial and lateral capacity within the zone of scour shall be ignored in determining allowable pile capacity. Settlement shall be estimated for single piles and for pile groups. Negative side friction due to settlement of upper soils and liquefaction induced settlements shall be considered in determining allowable axial pile capacity in compression in accordance with AASHTO 17th Edition, Section 4.5.6.7. Lateral squeeze shall be considered in assessing the lateral pile capacity.

The following details shall be included in the drawings:

- Pile type, size, reinforcement details
- Steel grades and yield strength
- Concrete compressive strength
- Ultimate pile capacity in compression
- Ultimate capacity for driving
- Allowable pile capacity in compression
- Allowable pile capacity in uplift
- Allowable lateral pile capacity
- Minimum pile tip elevation
- Estimated pile tip elevation

A minimum of two (2) dynamic pile load tests shall be performed per substructure unit but no less than two (2) percent of the production piles per substructure, utilizing a Pile Dynamic Analyzer (PDA) with subsequent CAPWAP® analysis in accordance with ASTM D 4945 "Standard Test Method for High-Strain Dynamic Testing of Piles". PDA testing shall be performed for full depth during initial pile driving and during re-strike. CAPWAP analysis shall be performed for End of Initial Drive (EOID) and during re-strike (BOR).

11.3.4 Drilled Shafts

Requirements related to drilled shaft foundations shall conform to AREMA Chapter 8, Part 24. For applicable design procedures and methodology for drilled shaft foundations refer to FHWA General Engineering Circular 10 and FHWA “Drilled Shafts: Construction Procedures and Design Methods” (1999).

Ultimate axial drilled shaft capacity in compression and uplift shall be obtained from the computer program Shaft version 5.0, FB-Deep version 2.4, or approved equal. Lateral capacity of a single drilled shaft shall be evaluated using a computer program Lpile version 6.0 or approved equal. Lateral capacity of drilled shaft groups shall be analyzed using FB Multipier version 4.17, Group version 8.0, or approved equal. P-multipliers for lateral analysis of shaft groups shall conform to AASHTO “LRFD Bridge Design Specifications”, 2012, Section 10.7.2.4.

Axial and lateral capacity within the zone of scour shall be ignored in determining allowable shaft capacity. Negative side friction due to settlement of upper compressive soils and liquefaction-induced settlements shall be considered in determining allowable axial pile capacity in compression in accordance with AASHTO 17th Edition, Section 4.5.6.7.

The following details shall be included in the drawings:

- Shaft diameter, rock socket diameter, reinforcement details
- Steel grade and yield strength
- Concrete compressive strength
- Ultimate drilled shaft capacity in compression
- Allowable drilled shaft capacity in compression
- Allowable drilled shaft capacity in uplift
- Allowable lateral drilled shaft capacity
- Estimated top of rock socket elevation (if applicable)
- Minimum drilled shaft tip elevation
- Estimated drilled shaft tip elevation
- Axial and lateral load requirements for load tests
- Casing steel grades, strengths and thicknesses (as applicable).

11.3.5 Micropiles

Design of micropile foundations shall conform to FHWA “Micropile Design and Construction Reference Manual” (2005).

Lateral capacity of a single micropile shall be designed using the computer program Lpile version 6.0 or approved equal. Lateral capacity of micropile groups shall be analyzed using FB Multipier version 4.17, Group version 8.0, or approved equal. P-multipliers for lateral analysis of micropile groups shall conform to AASHTO “LRFD Bridge Design Specifications”, 2012, Section 10.7.2.4.

Axial and lateral capacity within the zone of scour shall be ignored in determining allowable micropile capacity. Negative side friction due to settlement of upper compressive soils and liquefaction induced settlements shall be considered in determining allowable axial micropile capacity in compression in accordance with AASHTO 17th Edition, Section 4.5.6.7.

The following details shall be included in the drawings:

- Micropile diameter, bond zone diameter, reinforcement details
- Steel grade and yield strength
- Cement group compressive strength
- Ultimate micropile capacity in compression
- Allowable micropile capacity in compression
- Allowable micropile capacity in uplift
- Allowable lateral micropile capacity
- Top of bond zone elevation
- Minimum micropile tip elevation
- Estimated micropile tip elevation

A minimum of one (1) axial verification (sacrificial) load test, and a minimum of two (2) axial proof load test but no less than two (2) percent of production piles shall be performed in accordance with FHWA “Micropile Design and Construction Reference Manual” and ASTM D 1143 “Standard Test Methods for Deep Foundations under Static Axial Compressive Load”.

Piles shall be designed for following factor of safety requirements:

- 2.0 for Axial Compression
- 2.0 for Uplift

11.3.6 Augercast Piles

Augercast piles shall not be used on the project.

11.4 Retaining Walls and Abutments

Retaining wall systems under consideration include reinforced concrete cantilever walls, soldier pile and lagging walls, sheet pile walls, soil nail walls, and proprietary retaining walls (Mechanically Stabilized Earth, MSE, Walls in accordance with AREMA Chapter 8, Part 7, T-Walls® or comparable prefabricated modular walls). Special consideration shall be given to construction sequencing when the wall types are determined.

11.4.1 Loads

Lateral earth pressure shall be obtained utilizing the Rankine method in accordance with AREMA Chapter 8, Part 5. Earth pressures from external loads shall be computed using pressure distributions from “Soil Mechanics”, UFC 3-220-10N, and Chapter 8, Section 20.3 of AREMA. Where conflicts exist, AREMA shall control. Seismic earth pressures shall be assessed based on the Mononobe-Okabe method, as presented in FHWA GEC No. 3.

Live load surcharges for embankments and/or retaining walls shall be as follows:

- Cooper E 80 train loads where freight rail is to be supported
- Cooper E 60 train loads where only passenger rail is to be supported
- 250 psf for vehicular traffic loads from adjacent roadways

Properties of backfill material shall conform to AREMA Chapter 8, Table 8-5-2. Backfill types 3, 4 and 5 shall not be permitted. Where compacted Limerock is utilized as a fill material, a unit weight of 115 pcf and friction angle of 34 degrees shall be assumed.

11.4.2 Design

Design of retaining walls for railway loading shall conform to AASHTO "Standard Specifications for Highway Bridges", 17th Edition, 2002, except as modified in AREMA Chapter 8, Parts 5, 20, and 28. MSE walls shall be designed in accordance with the requirements of the Geotechnical Reports and AASHTO LRFD Section 11.10 with FDOT Structures Manual amendments. Design of retaining walls for roadways shall conform to the requirements of the FDOT Structures Manual.

Deflection at the top of permanent retaining walls shall be limited to a maximum of 1% of the total wall height, not to exceed 2 inches. Deflection at the top of Critical Temporary Walls, as defined by FDOT Plans Preparation Manual, Section 30.3.4, shall not exceed the limits provided in FDOT Structures Manual, Section 3.13.3.

The minimum Factors of Safety for walls shall be as follows:

- global stability for static conditions: 1.3
- global stability for rapid drawdown: 1.1
- global stability for seismic conditions: 1.1
- sliding failure: 1.5
- Where walls support abutments, buildings, or critical structures, or for installations with a low tolerance for failure, a minimum factor of safety of 1.5 is required for static conditions.

Design Back-to-back MSE walls in accordance with Section 6.4 of FHWA publication FHWA-NHI-10-024, "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Slopes – Volume I." To account for rail loading on back-to-back MSE walls, the minimum width-to-height ratio of the walls shall be 1.2.

MSE walls shall be designed and detailed to account for the detrimental effects of stray electrical currents on wall service life.

11.4.3 Sheet Pile and Soldier Pile & Lagging Walls

Allowable bending stress for steel shall be 0.67 times the yield strength.

Anchorages shall conform to AREMA Chapter 8, Section 20.5.

Design of Critical Temporary Walls shall be in accordance with FDOT Structures Manual, Sections 3.5.3 and 3.13.3

Permanent sheet pile walls shall be designed for a 100-year.service life with sacrificial thickness in accordance with FDOT Structures Manual Section 3.5.3.

11.4.4 Proprietary Walls

Minimum factor of safety for sliding, overturning, and bearing capacity specified in AREMA Chapter 8, Part 5 shall be utilized.

Minimum base width of any prefabricated modular wall, measured from the face of the wall to the rear of the modular wall unit/stem, shall be the greater of 6 feet or 60% of the wall height.

11.5 Embankments

Earth embankments shall have a slope of 2 horizontal to 1 vertical (2:1) or flatter. Any embankments steeper than 2:1 shall be reinforced with stabilizing elements such as geotextile, geogrid, soil nails, etc.

Global stability of the embankments shall be performed using the computer program SLOPE/W or approved equal. The minimum Factors of Safety for embankment slopes shall be as follows:

- global stability for static conditions: 1.3
- global stability for rapid drawdown: 1.1
- global stability for seismic conditions: 1.1
- Where slopes support abutments, buildings, or critical structures, or for installations with a low tolerance for failure, a minimum factor of safety of 1.5 is required for static conditions.

Elastic and consolidation settlements shall be computed for post-construction loading of the embankment. If significant, the post-construction settlements shall be accelerated using surcharging or preloading with or without wick drains or sand columns, or shall be mitigated by other ground improvement methods or by the use of lightweight fill.

11.6 Ground Improvements

Ground improvement methods considered for support of embankments, retaining walls and other structures shall include but not be limited to: sand drains, wick drains (PVD's), lightweight fill, vibrocompaction, vibro concrete columns, dynamic compaction, soil mixing, stone columns, and geogrid basal reinforcement.

Design of ground improvement methods shall be in accordance with FHWA "Ground Improvement Methods", Volume I and II, FHWA-SA-98-086, 1998.

Any selected ground improvement method(s) shall be field-verified with a fully-instrumented test program prior to implementation of ground improvement method within the proposed facility footprint.

11.7 Catenary Pole Foundations

Catenary structures will be supported on independent foundations. Catenary foundations shall be deep foundations consisting of driven piles, micropiles, or drilled shafts. Design shall conform to AREMA Chapter 8, Part 12.

Catenary structure loads on retaining walls shall be considered and analyzed.

11.8 Seismic Design of Foundations

Seismic design shall comply with Section 7.0 and AREMA Chapter 9. Determination of seismic loading on retaining walls and analysis of liquefaction potential of existing ground shall be evaluated in accordance with FHWA GEC No. 3, "LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual" (2011). Factor of safety against liquefaction potential shall be 1.0. Liquefaction-induced settlement shall be estimated for soils susceptible to liquefaction.

12.0 Aesthetics

All structures, including bridges, underpasses, concrete trenches, retaining walls and noise walls, shall incorporate aesthetics in accordance with the AAF Infrastructure Aesthetics Criteria.

13.0 Special Miscellaneous Design Criteria

13.1 Noise Walls

Where applicable in the Cocoa-to-Orlando segment, as identified and required by AAF, noise walls shall extend a minimum of 5’-0” above Top of Rail and shall be reinforced concrete with a minimum thickness of 8”.

13.2 Structures at Orlando International Airport

In addition to the criteria required in all other sections of this document, the following special criteria apply to structures located on Orlando airport property owned by the Greater Orlando Airport Authority (GOAA).

13.2.1 Cargo Road Bridge Extension

Design of the Cargo Road Bridge Extension shall include a structural evaluation and Load Rating of the existing pier columns and foundations, performed in accordance with FDOT LRFD criteria. Any existing structural elements that receive new or increased loads shall be designed and/or evaluated per FDOT and AASHTO LRFD criteria.

13.2.2 Future Light Rail Transit (LRT) Live Load

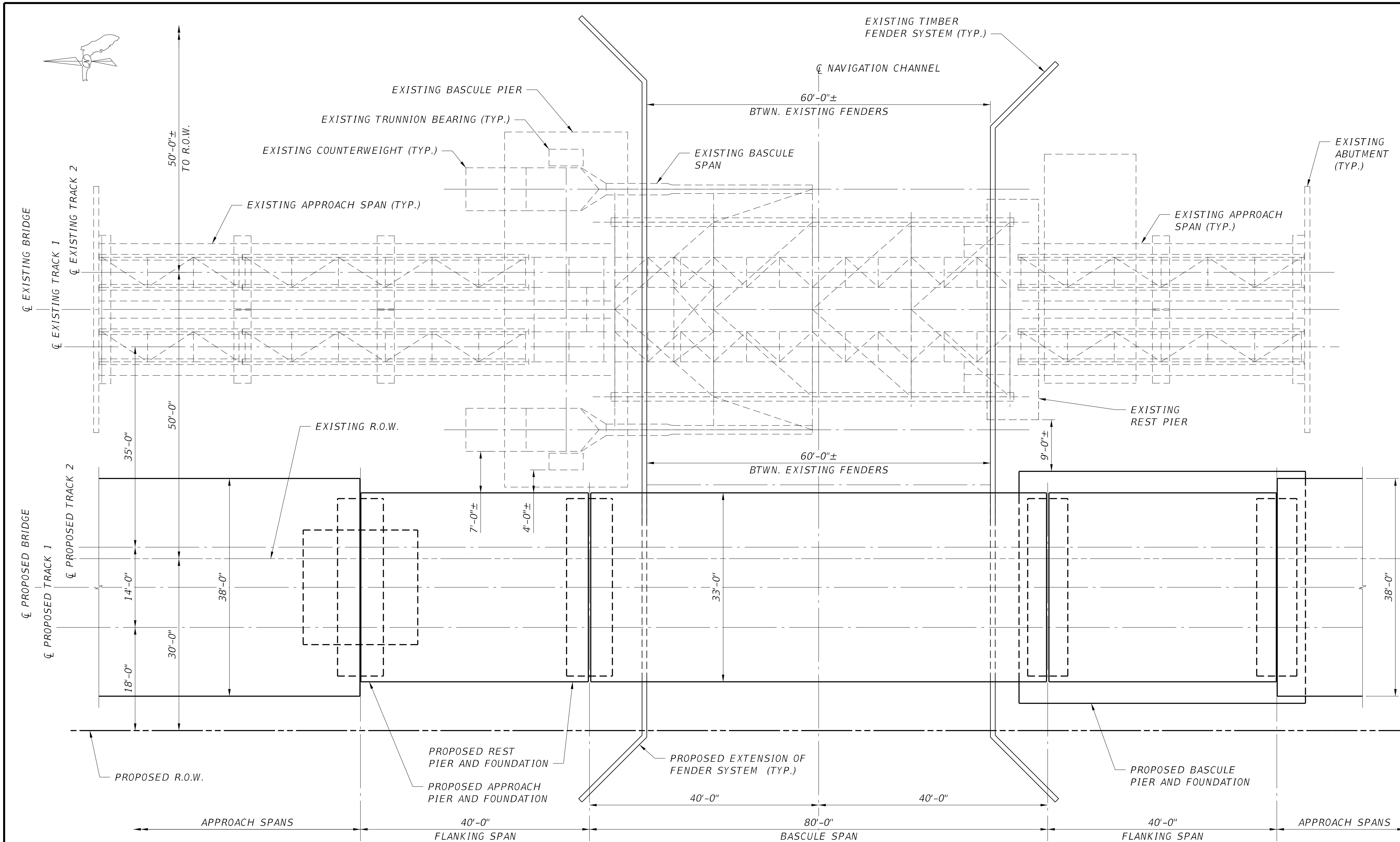
Where designs are required to accommodate future LRT train loads, designers shall assume a Cooper E 60 train load.

13.2.3 Landscaping Planter Walls

Where required by GOAA, landscaping planter walls shall be designed and detailed as cast-in-place cantilever retaining walls in accordance with FDOT Standard Index 6010.

Appendix D – Conceptual Drawings

Typical Sections



PLAN

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: TCS
CHECKED BY: DK
DESIGNED BY: TCS
CHECKED BY: DK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE: LOW AND MID-LEVEL ALTERNATIVES
80'-0" MOVABLE SPAN PLAN

PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO. B1-1A

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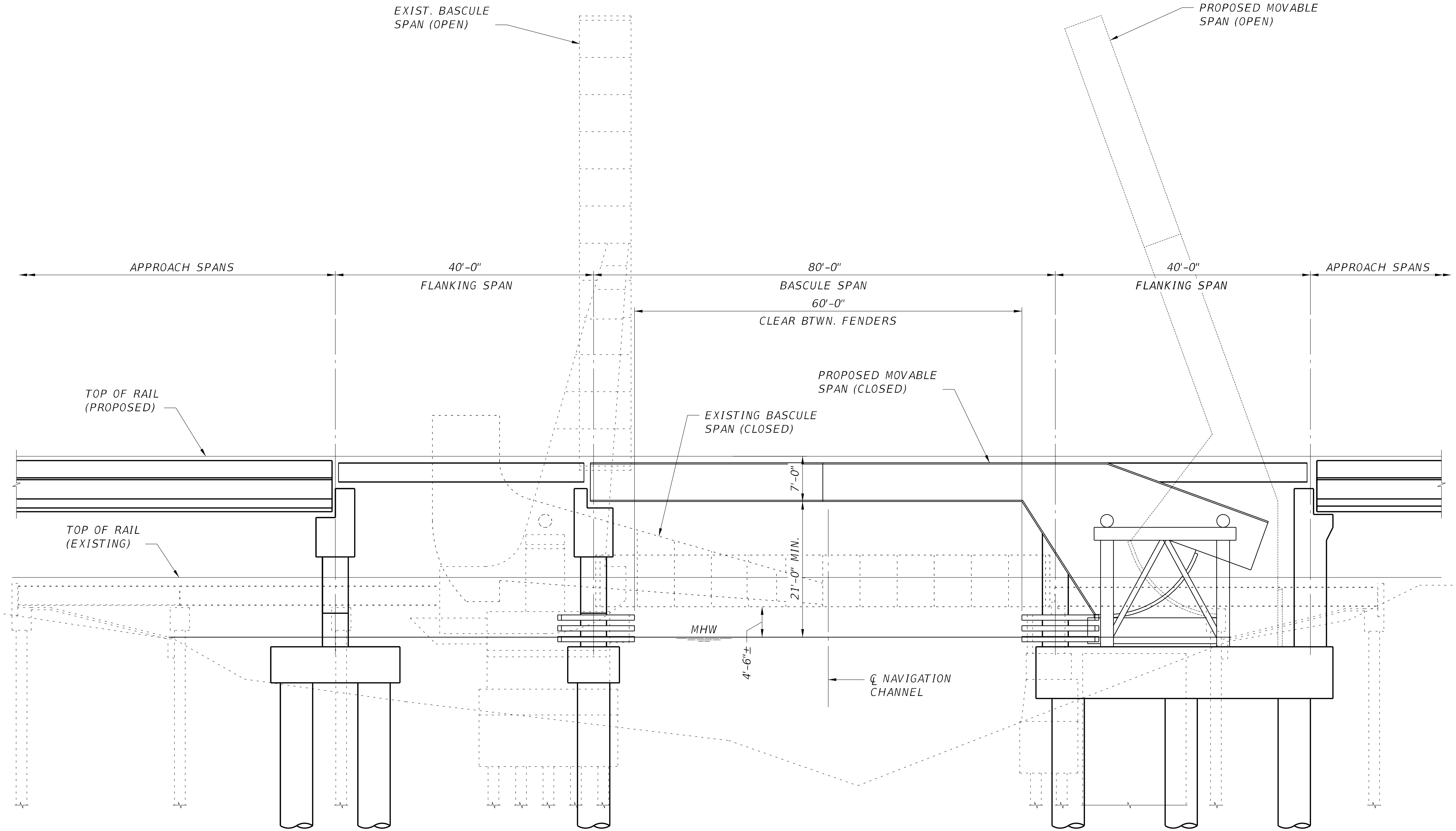

ELEVATION

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: GLH
CHECKED BY: DK
DESIGNED BY: GLH
CHECKED BY: DK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
LOW-LEVEL ALTERNATIVE
80'-0" MOVABLE SPAN ELEVATION

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
B1-1B

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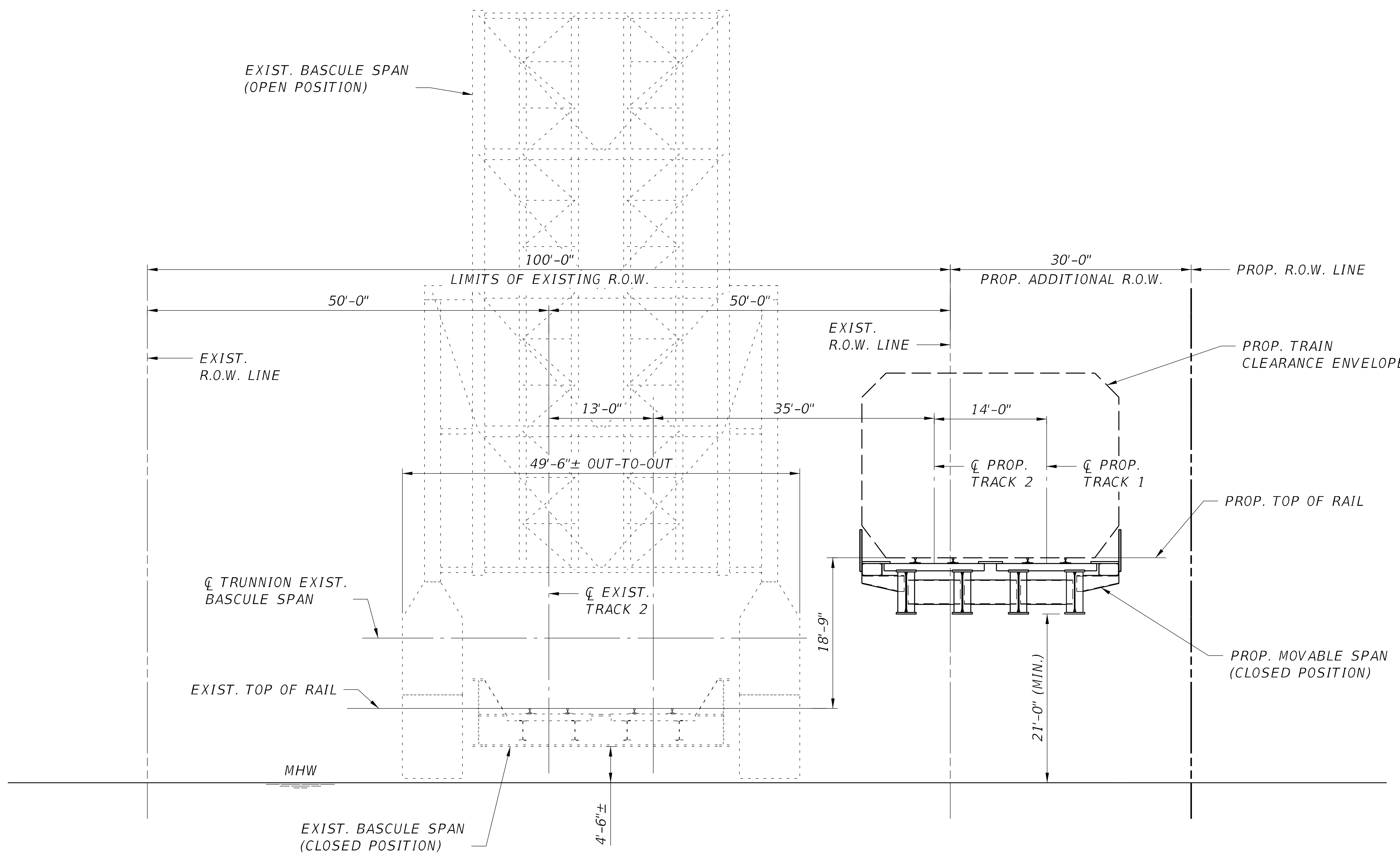

SECTION

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: GLH
CHECKED BY: DK
DESIGNED BY: GLH
CHECKED BY: DK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
LOW-LEVEL ALTERNATIVE
80'-0" MOVABLE SPAN SECTION

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
B1-1C

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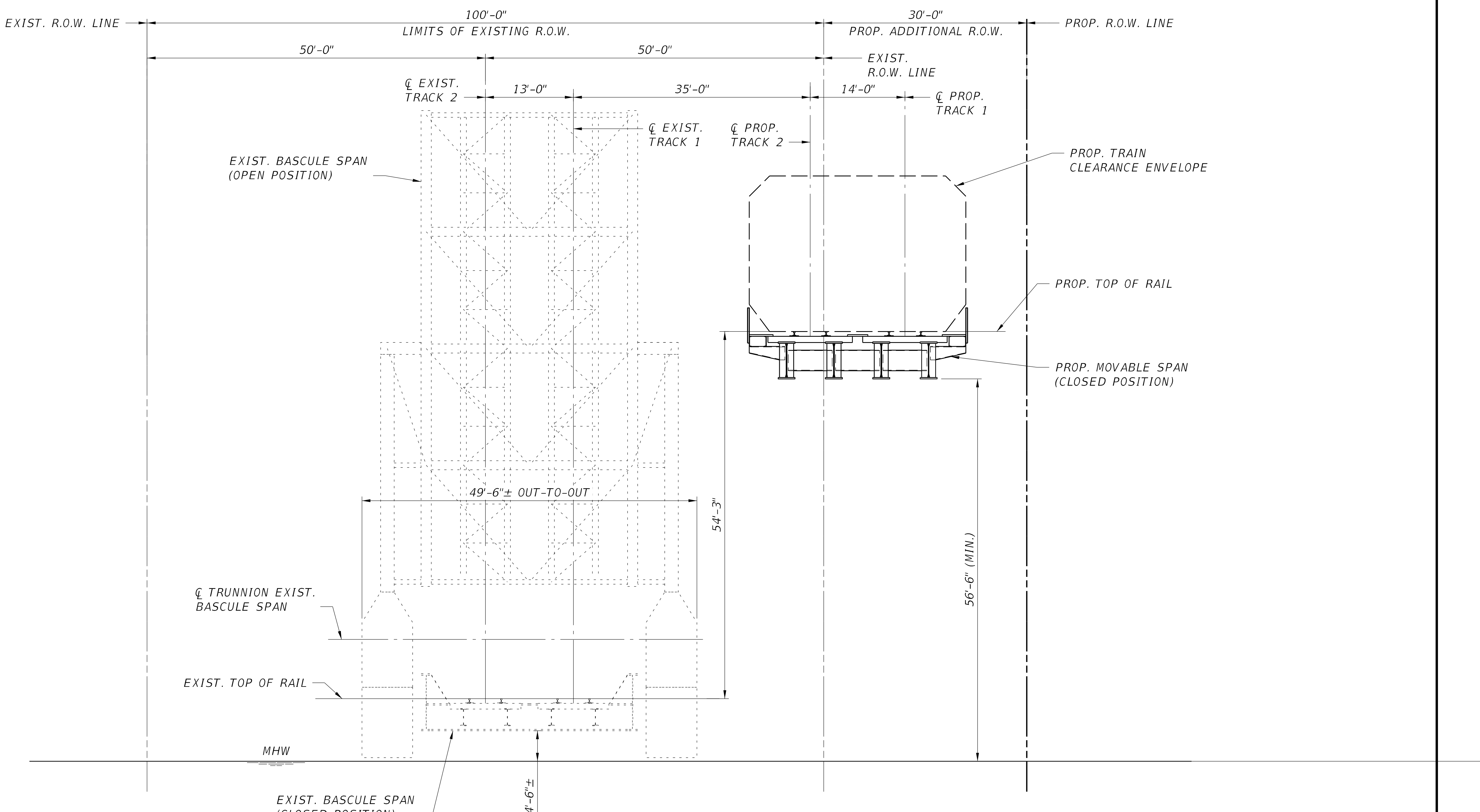

SECTION

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: GLH
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DESIGNED BY: GLH
CHECKED BY: DK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
MID-LEVEL ALTERNATIVE
80'-0" MOVABLE SPAN SECTION

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
B2-1B

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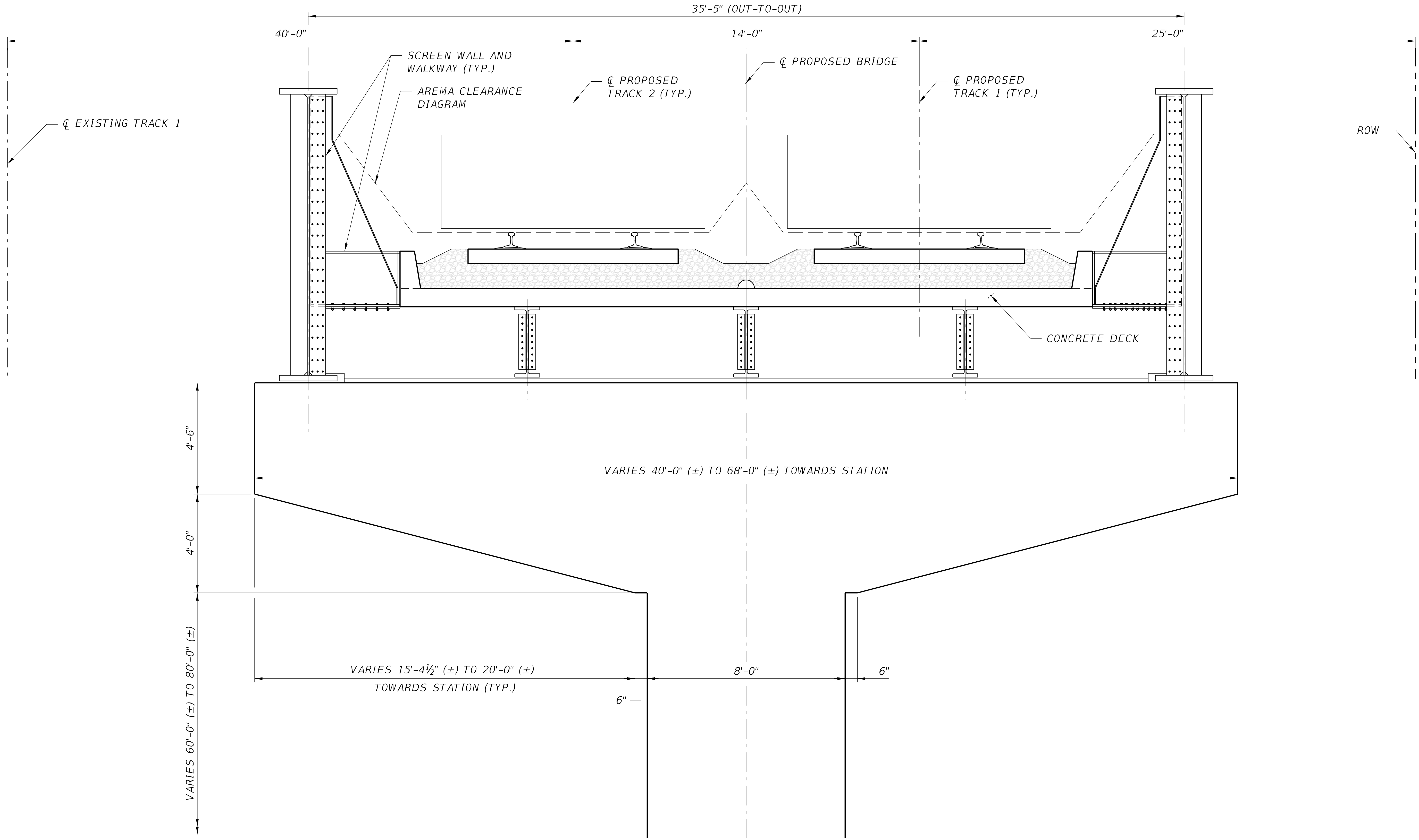


TYPICAL SECTION - STEEL APPROACH SPANS (149 FT)

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					NOT FOR CONSTRUCTION

DRAWN BY: SM
CHECKED BY: TR
DESIGNED BY: SM
CHECKED BY: TR

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

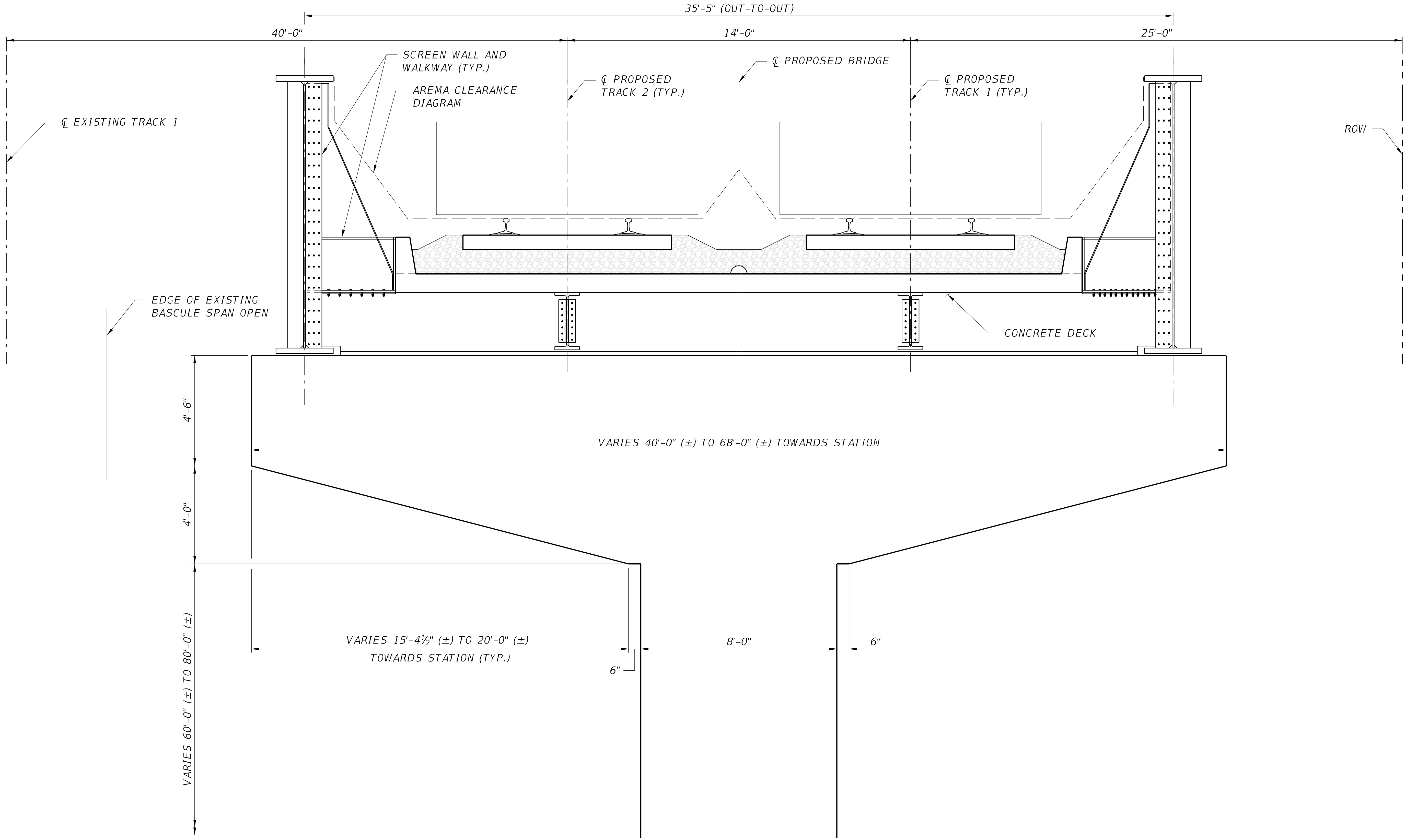
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	

SHEET TITLE:
TYPICAL SECTION (1 OF 3)
STEEL SPANS

PROJECT NAME:
TRI-RAIL COASTAL LINK - NEW RIVER CROSSING
HIGH LEVEL ALTERNATE (80 FEET)

REF. DWG. NO.

SHEET NO.
B4-01



TYPICAL SECTION - MAIN SPAN OVER CHANNEL (116 FT)

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					NOT FOR CONSTRUCTION

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	

SHEET TITLE:

PROJECT NAME:
TRI-RAIL COASTAL LINK - NEW RIVER CROSSING
HIGH LEVEL ALTERNATE (80 FEET)

REF. DWG. NO.

SHEET NO.

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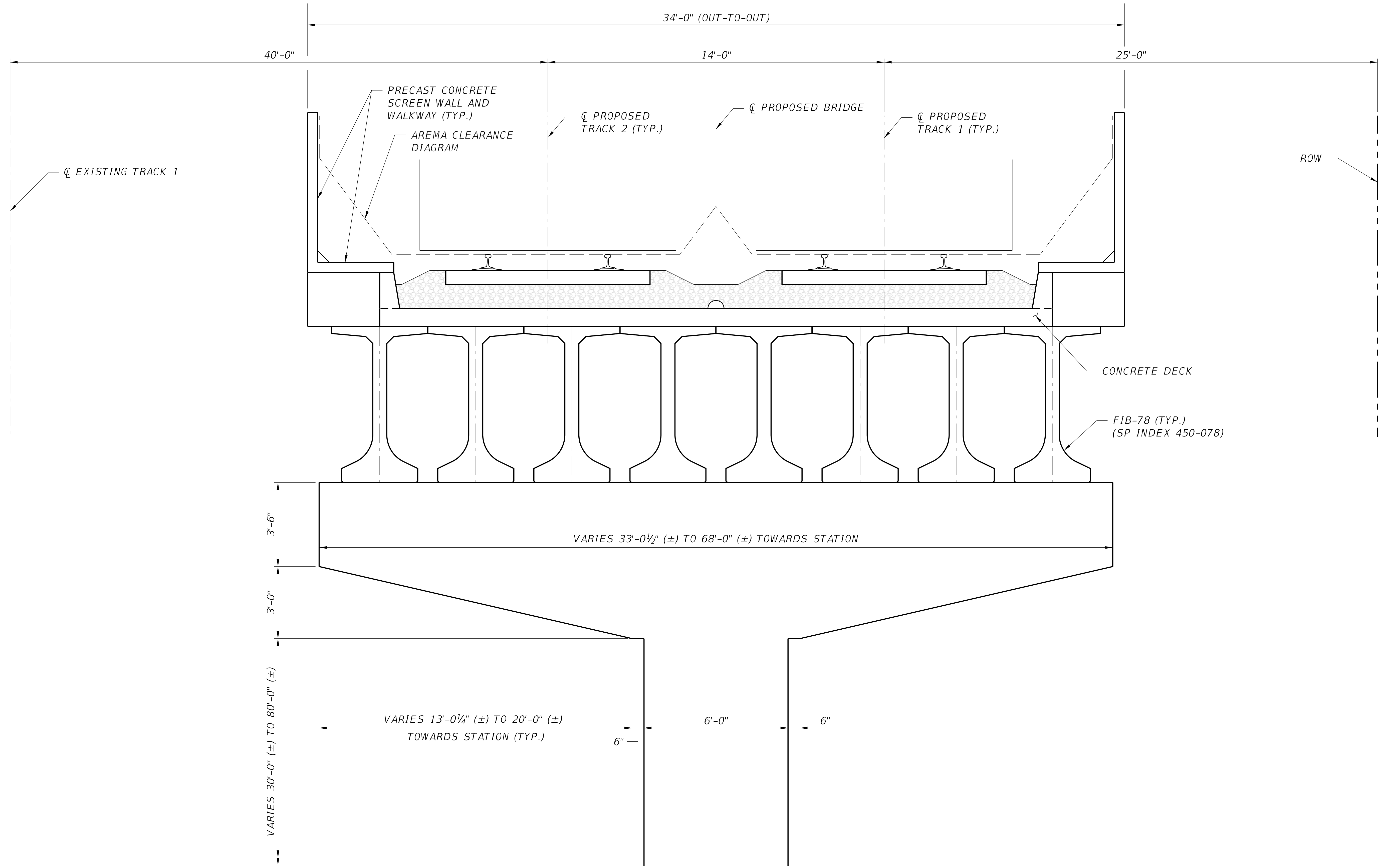

TYPICAL SECTION - CONCRETE APPROACH SPANS

REVISIONS					
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					NOT FOR CONSTRUCTION

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CHECKED BY: TR			
DESIGNED BY: SM	ROAD NO.	COUNTY	FINANCIAL PROJECT ID
CHECKED BY: TR		BROWARD	

SHEET TITLE: TYPICAL SECTION (2 OF 3) CONCRETE APPROACH SPANS

PROJECT NAME: TRI-RAIL COASTAL LINK - NEW RIVER CROSSING HIGH LEVEL ALTERNATE (80 FEET)

REF. DWG. NO.

SHEET NO. B4-02

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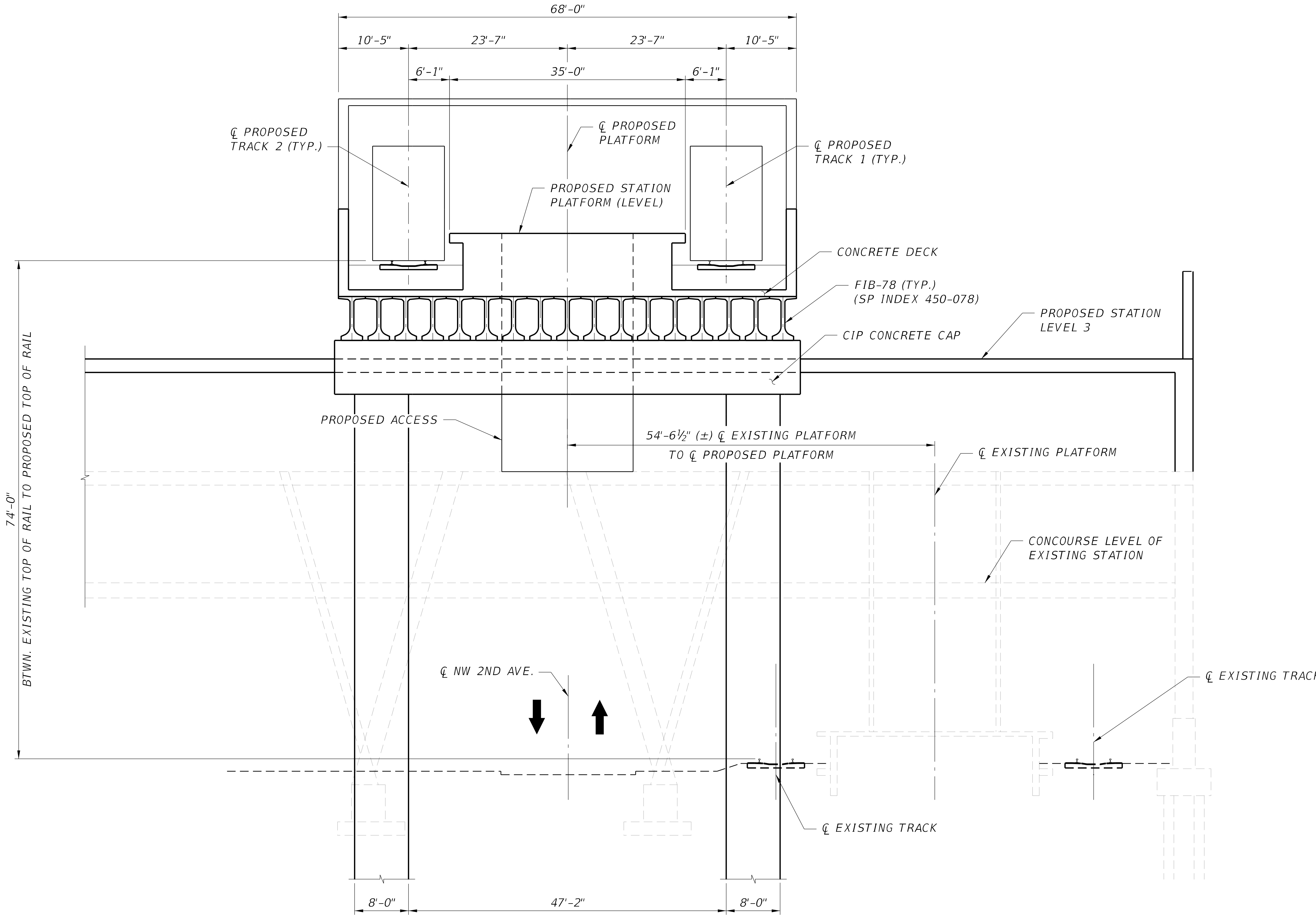

SECTION THRU BRIDGE - CONCRETE APPROACH SPANS AT STATION

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					NOT FOR CONSTRUCTION

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CHECKED BY: TR
DESIGNED BY: SM
CHECKED BY: TR

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

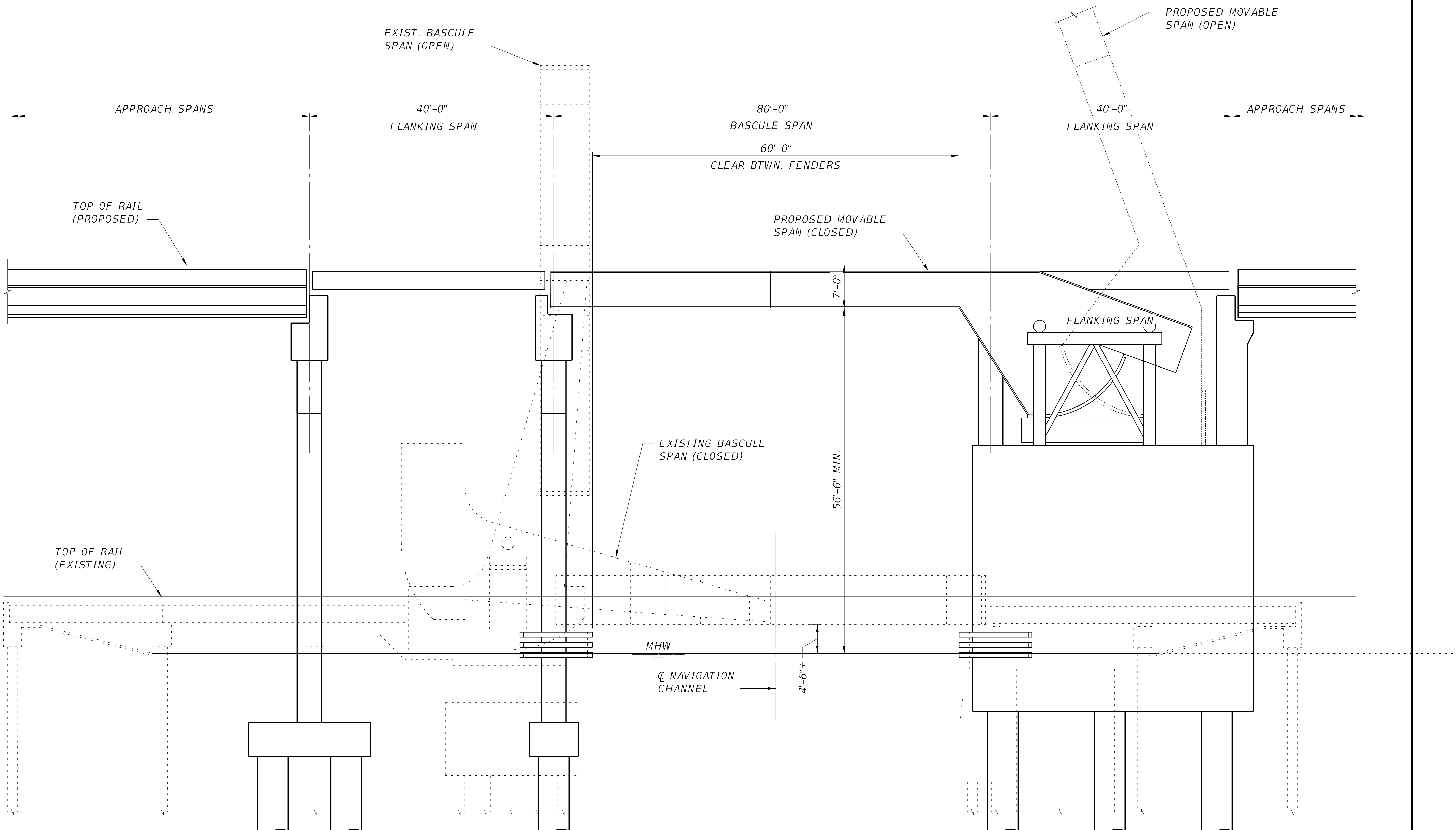
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	

SHEET TITLE: TYPICAL SECTION (3 OF 3) STATION SPANS

PROJECT NAME: TRI-RAIL COASTAL LINK - NEW RIVER CROSSING HIGH LEVEL ALTERNATE (80 FEET)

REF. DWG. NO.

SHEET NO. B4-03



ELEVATION

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: GLH
CHECKED BY: DK
DESIGNED BY: GLH
CHECKED BY: DK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
MID-LEVEL ALTERNATIVE
80'-0" MOVABLE SPAN ELEVATION

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
B2-1A

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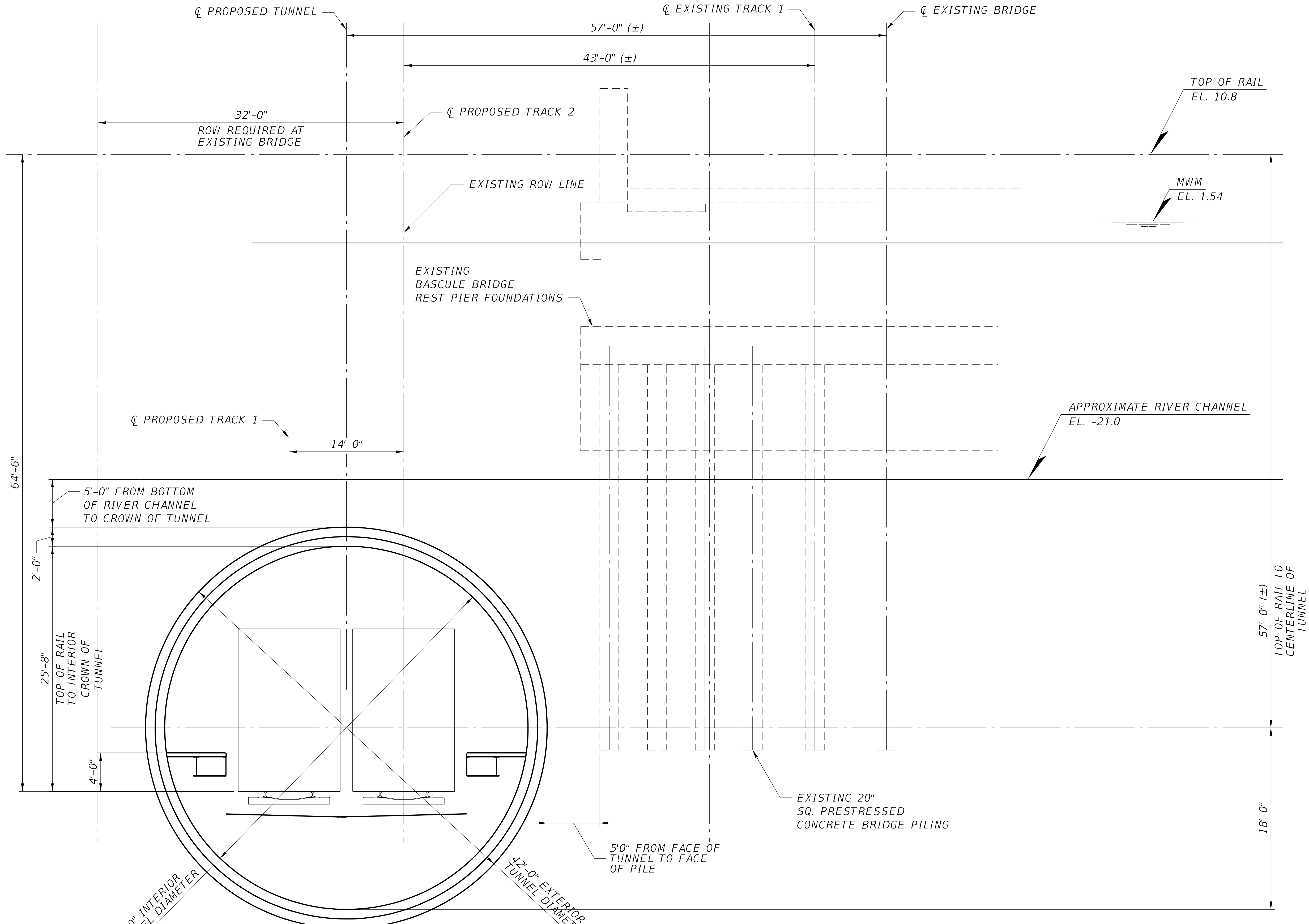

BORED TUNNEL SECTION AT RIVER

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					NOT FOR CONSTRUCTION

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	

SHEET TITLE:
TUNNEL SECTION (1 OF 2)

PROJECT NAME:
TRI-RAIL COASTAL LINK - NEW RIVER CROSSING
TUNNEL ALTERNATIVE

REF. DWG. NO.

SHEET NO.
B5-1

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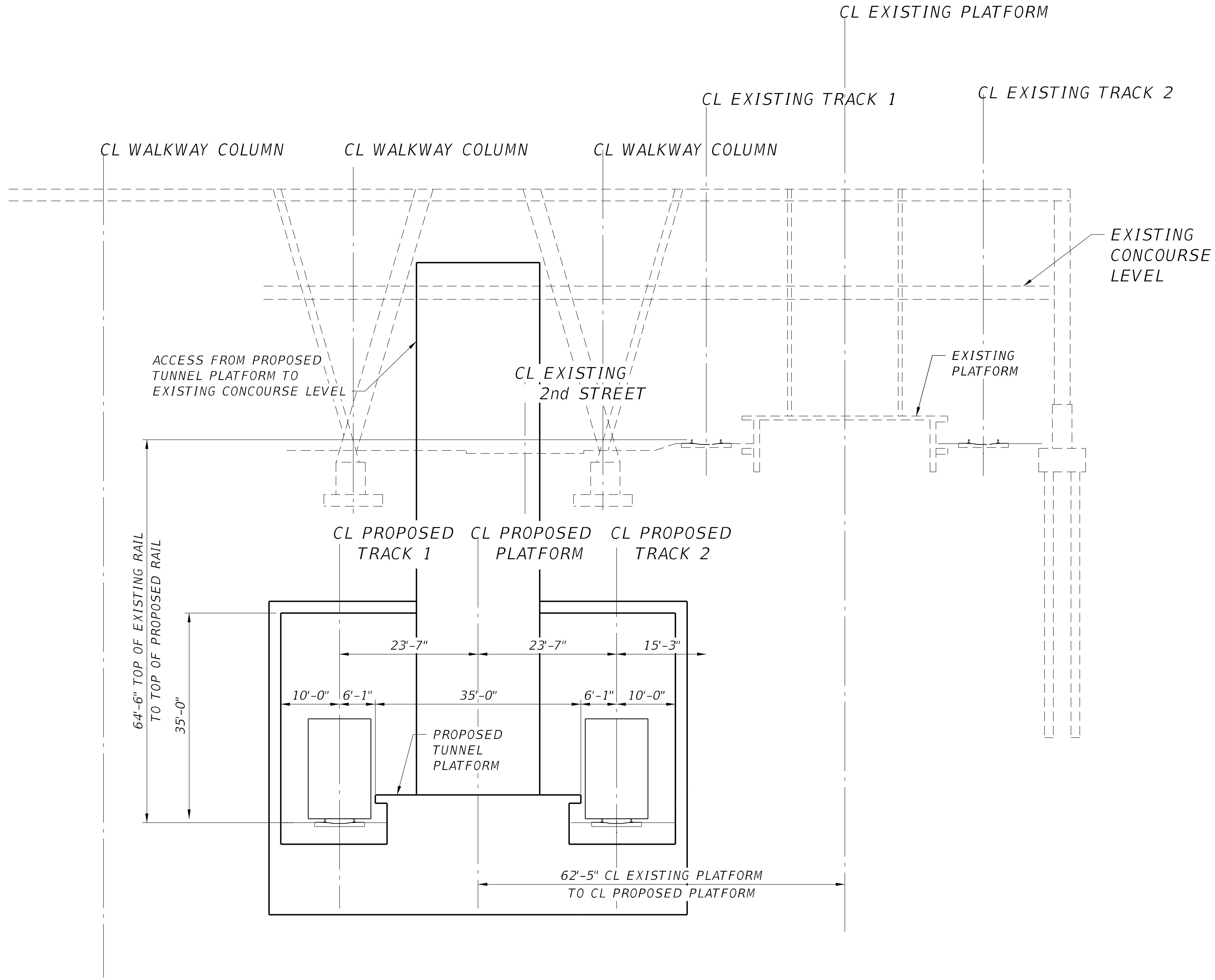

BORED TUNNEL AT STATION

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					NOT FOR CONSTRUCTION

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
	BROWARD	

SHEET TITLE: TUNNEL SECTION (2 OF 2)

PROJECT NAME: TRI-RAIL COASTAL LINK - NEW RIVER CROSSING TUNNEL ALTERNATIVE

REF. DWG. NO.

SHEET NO. B5-2

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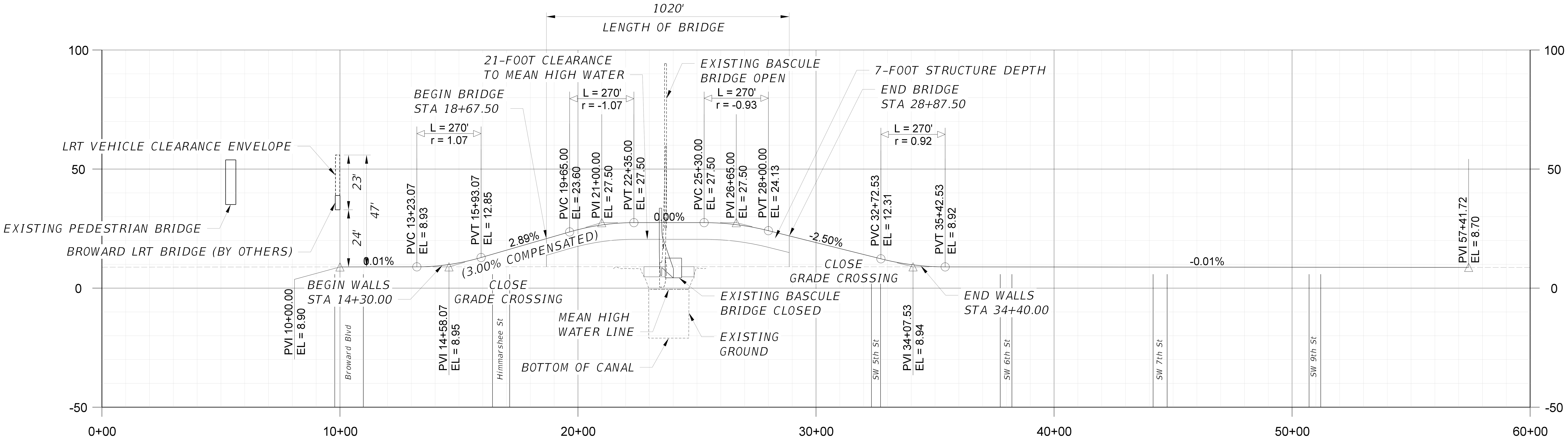
Plan and Profile (Roll Plot)

HORIZONTAL
SCALE

0 100' 200' 300' 400' 500'

PROPOSED TRACK ALIGNMENT
PROPOSED RETAINING WALL
PROPOSED STATION
PROPOSED BRIDGE
PROPOSED R.O.W.
EXISTING PARCEL/R.O.W.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: LOW LEVEL MOVABLE SPAN ALTERNATIVE 35-FOOT OFFSET TO EXISTING TRACK
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE



NOTES:

1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVE LENGTHS MEET ABSOLUTE MINIMUM CRITERIA

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: LOW LEVEL MOVABLE SPAN ALTERNATIVE 35-FOOT OFFSET TO EXISTING
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

HORIZONTAL
SCALE

0 100' 200' 300' 400' 500'

PROPOSED TRACK ALIGNMENT
PROPOSED RETAINING WALL
PROPOSED STATION
PROPOSED BRIDGE
PROPOSED R.O.W.
EXISTING PARCEL/R.O.W.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE:	MID LEVEL MOVABLE SPAN ALTERNATIVE 40-FOOT OFFSET TO EXISTING TRACK CENTER PLATFORM
DATE: 11/04/2019	PROJECT NAME:	TRI RAIL COASTAL LINK NEW RIVER BRIDGE

NOTES:

1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVE LENGTHS MEET DESIRED MINIMUM CRITERIA FOR 80 MPH

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: MID LEVEL MOVABLE SPAN ALTERNATIVE 40-FOOT OFFSET TO EXISTING
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

HORIZONTAL
SCALE

0 100' 200' 300' 400' 500'

PROPOSED TRACK ALIGNMENT
PROPOSED RETAINING WALL
PROPOSED STATION
PROPOSED BRIDGE
PROPOSED R.O.W.
EXISTING PARCEL/R.O.W.

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

DATE:
11/04/2019

SHEET TITLE:
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
65-FOOT VERTICAL CLEARANCE

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

NOTES:

1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY PREFERRED MAXIMUM CRITERIA
3. CURVE LENGTHS MEET DESIRED MINIMUM CRITERIA FOR 80 MPH

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VERTICAL 0 10' 20' 30' 40' 50'

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: HIGH LEVEL FIXED STRUCTURE ALTERNATIVE 65-FOOT VERTICAL CLEARANCE
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

HORIZONTAL
SCALE

0 100' 200' 300' 400' 500'

PROPOSED TRACK ALIGNMENT
PROPOSED RETAINING WALL
PROPOSED STATION
PROPOSED BRIDGE
PROPOSED R.O.W.
EXISTING PARCEL/R.O.W.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: HIGH LEVEL FIXED STRUCTURE ALTERNATIVE 80-FOOT VERTICAL CLEARANCE
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

NOTES:

1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVE LENGTHS MEET DESIRED MINIMUM CRITERIA FOR 80 MPH

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: HIGH LEVEL FIXED STRUCTURE ALTERNATIVE 80-FOOT VERTICAL CLEARANCE
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

PROPOSED TRACK ALIGNMENT
PROPOSED RETAINING WALL
PROPOSED STATION
PROPOSED BRIDGE
PROPOSED R.O.W.
EXISTING PARCEL/R.O.W.
PROPOSED TUNNEL

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: BORED TUNNEL ALTERNATIVE UNDER ANDREWS AVE
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

NOTES:

1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVES MEET DESIRABLE MINIMUM CRITERIA FOR 80 MPH

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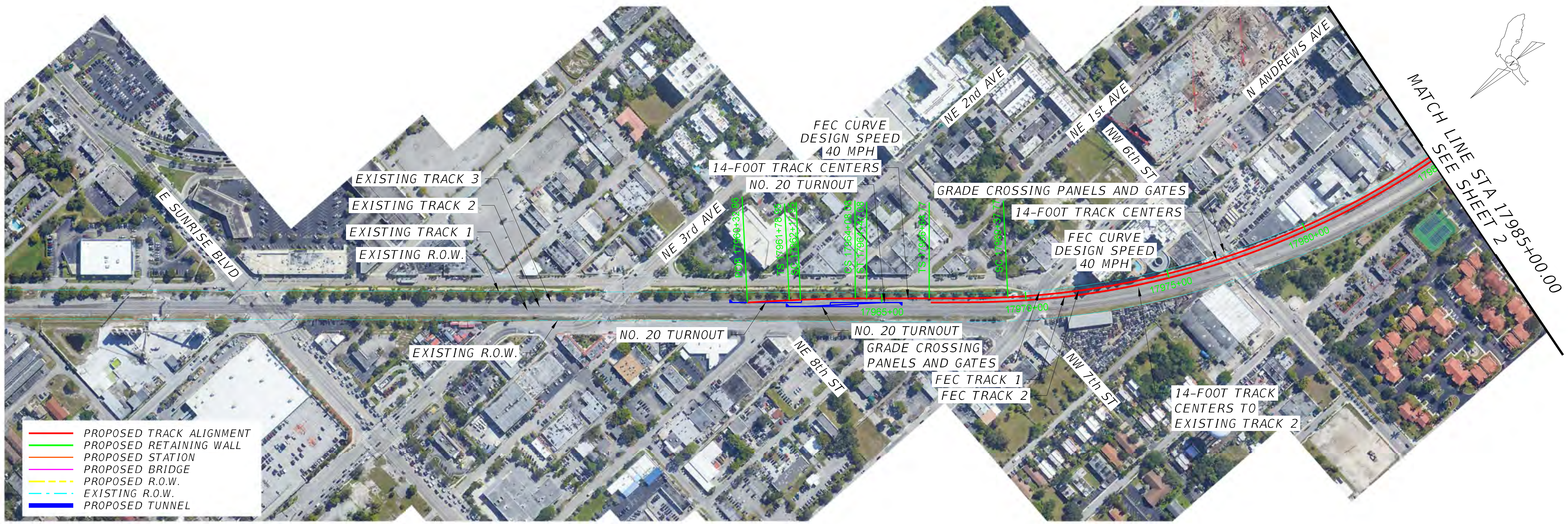
VERTICAL 0 10' 20' 30' 40' 50'

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION	SHEET TITLE: BORED TUNNEL ALTERNATIVE 7085 Foot Long Tunnel
DATE: 11/04/2019	PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

Plan and Profile (Sheets)



REVISIONS					
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VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

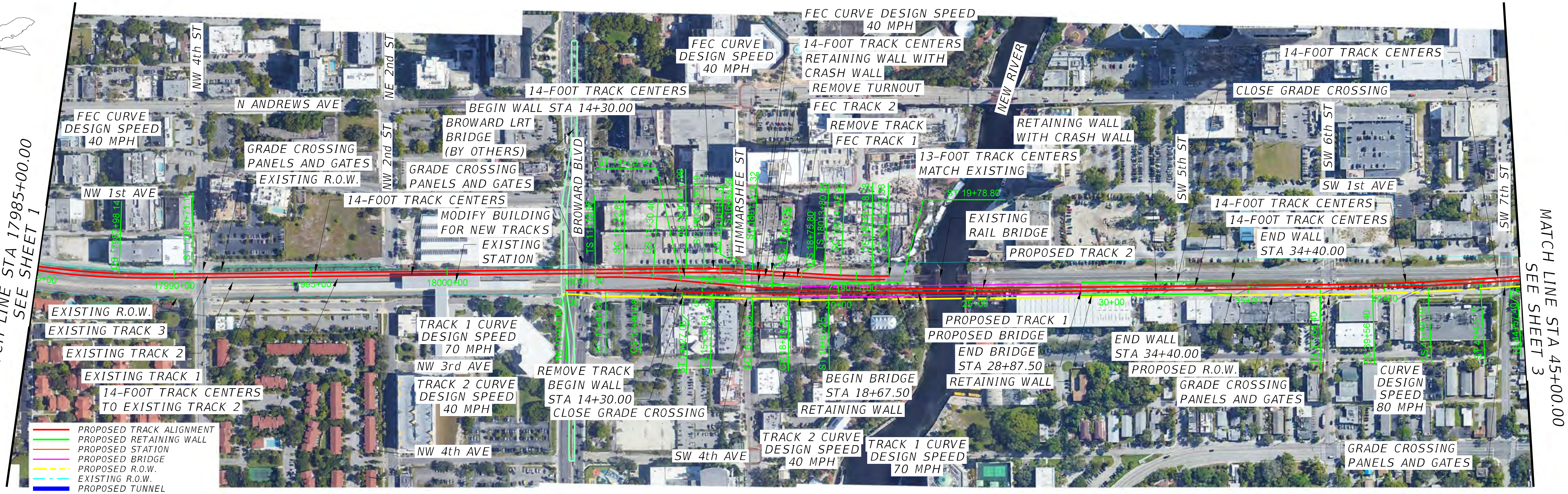
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

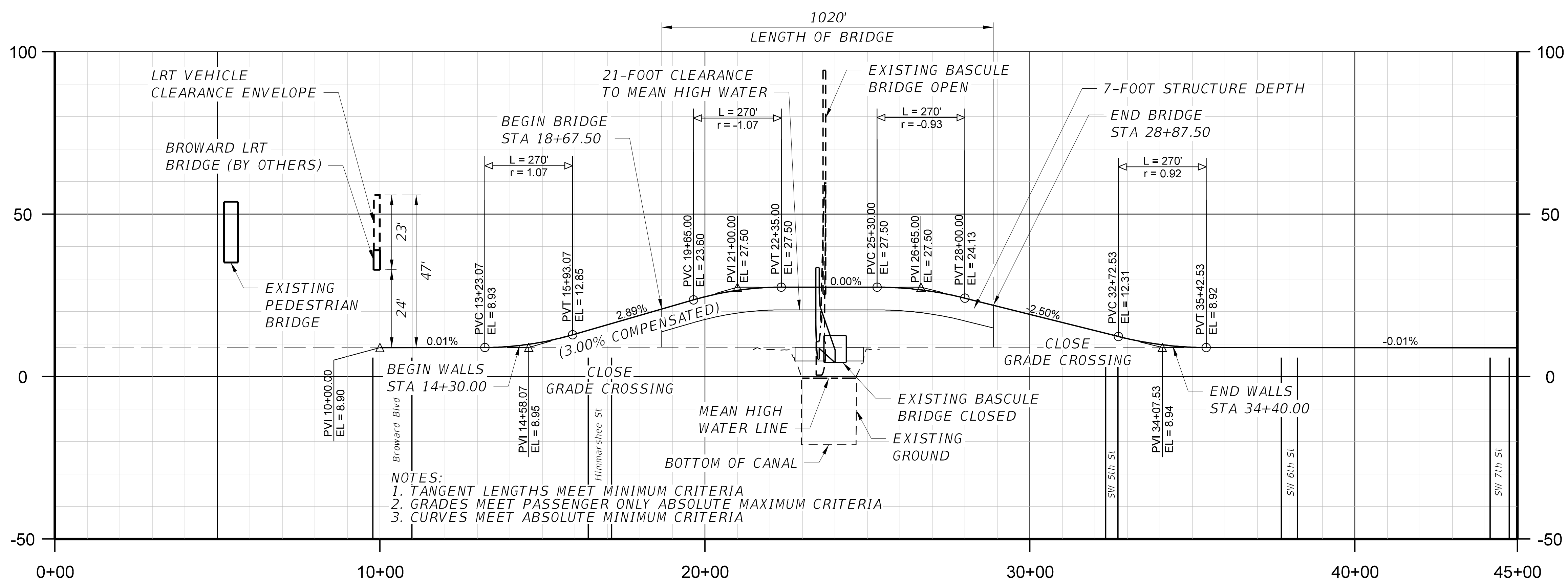
SHEET TITLE:
LOW LEVEL MOVABLE SPAN ALTERNATIVE
35-FOOT OFFSET TO EXISTING (SHEET 1 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
1





REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'
VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

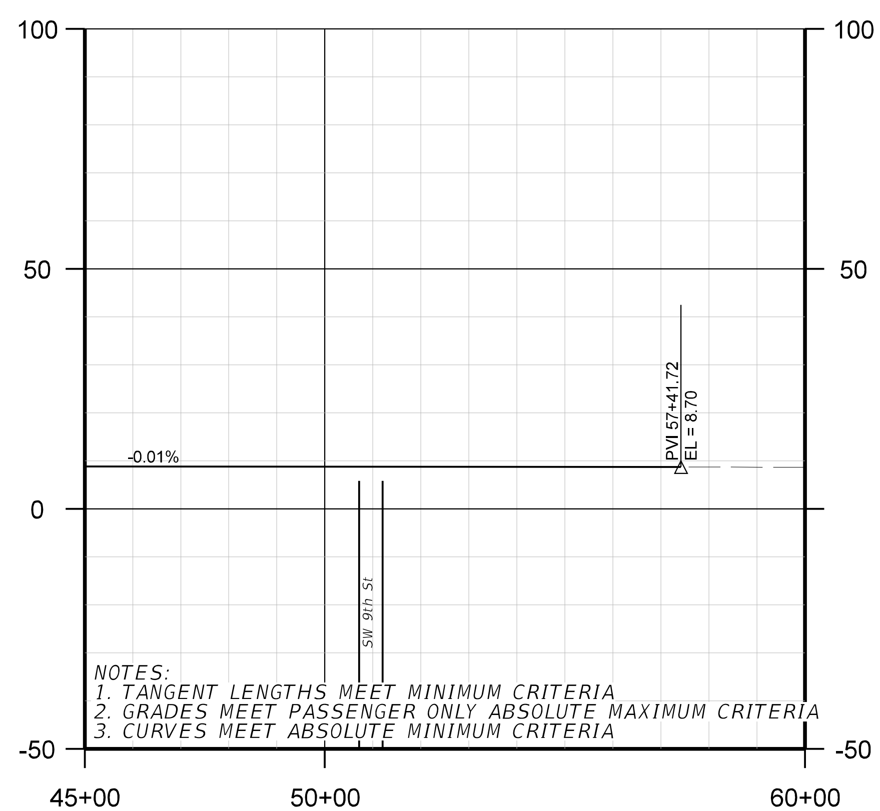
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE: LOW LEVEL MOVABLE SPAN ALTERNATIVE
35-FOOT OFFSET TO EXISTING (SHEET 2 OF 3)

PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO. 2



REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

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VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

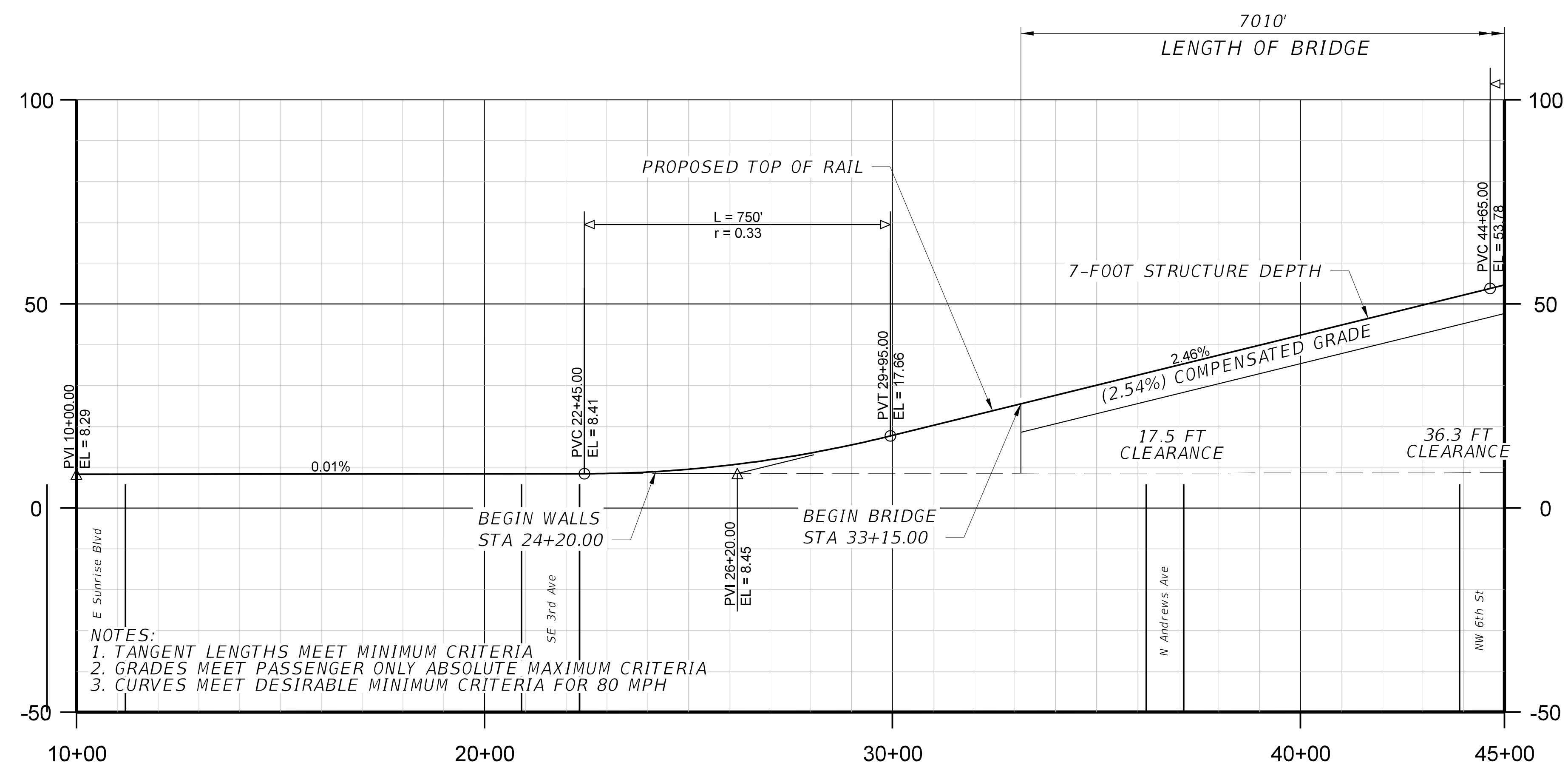
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
LOW LEVEL MOVABLE SPAN ALTERNATIVE
35-FOOT OFFSET TO EXISTING (SHEET 3 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
3



NOTES:
1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVES MEET DESIRABLE MINIMUM CRITERIA FOR 80 MPH

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

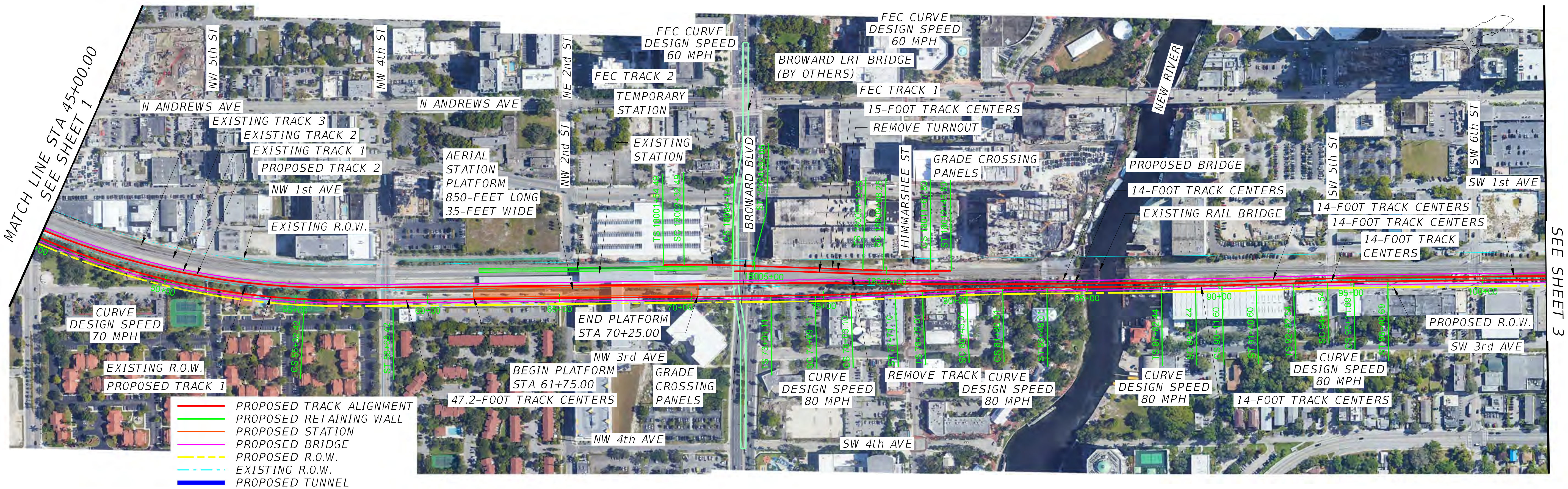
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

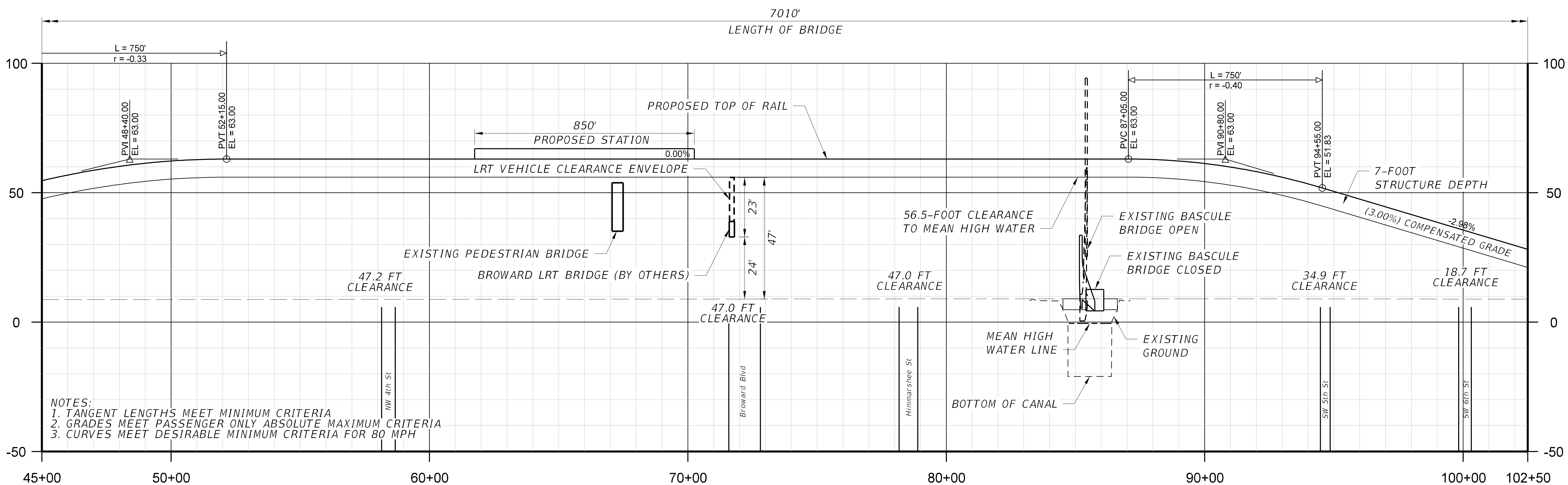
SHEET TITLE:
MID LEVEL MOVABLE SPAN ALTERNATIVE
40-FOOT OFFSET TO EXISTING TRACK (SHEET 1 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
1





NOTES:
1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVES MEET DESIRABLE MINIMUM CRITERIA FOR 80 MPH

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

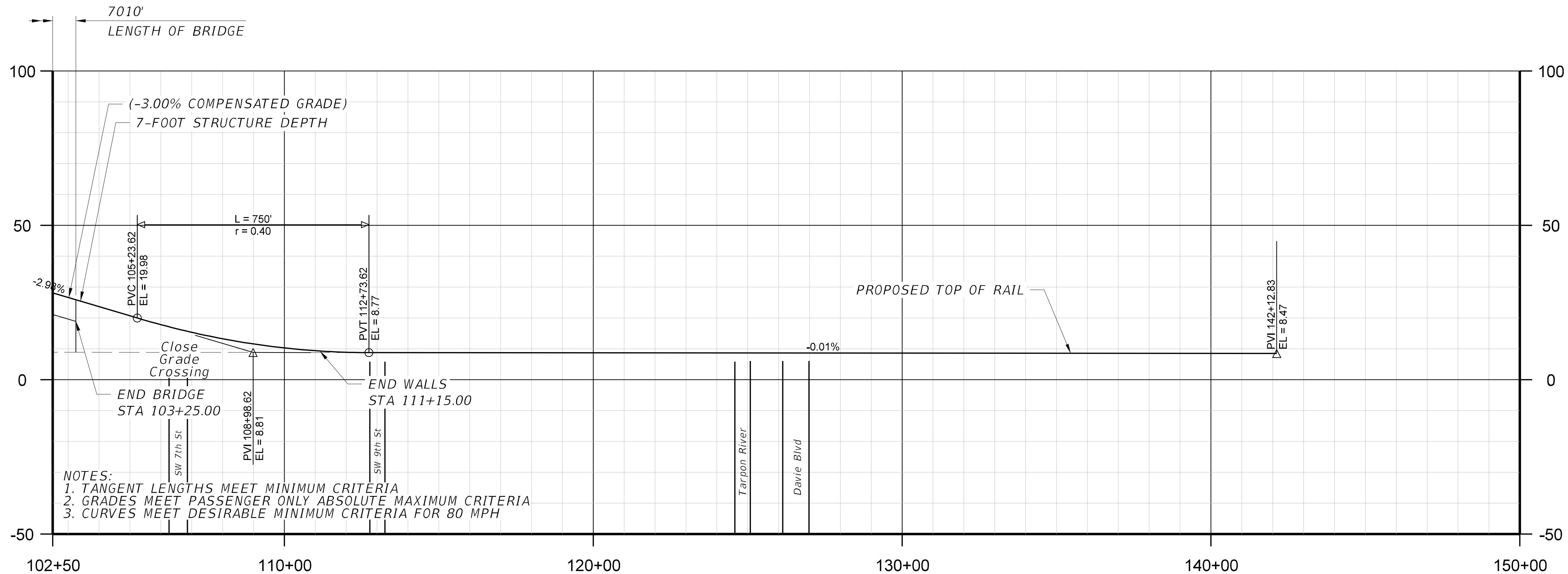
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
MID LEVEL MOVABLE SPAN ALTERNATIVE
40-FOOT OFFSET TO EXISTING TRACK (SHEET 2 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
2



NOTES:
1. TANGENT LENGTHS MEET MINIMUM CRITERIA
2. GRADES MEET PASSENGER ONLY ABSOLUTE MAXIMUM CRITERIA
3. CURVES MEET DESIRABLE MINIMUM CRITERIA FOR 80 MPH

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'
VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
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CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

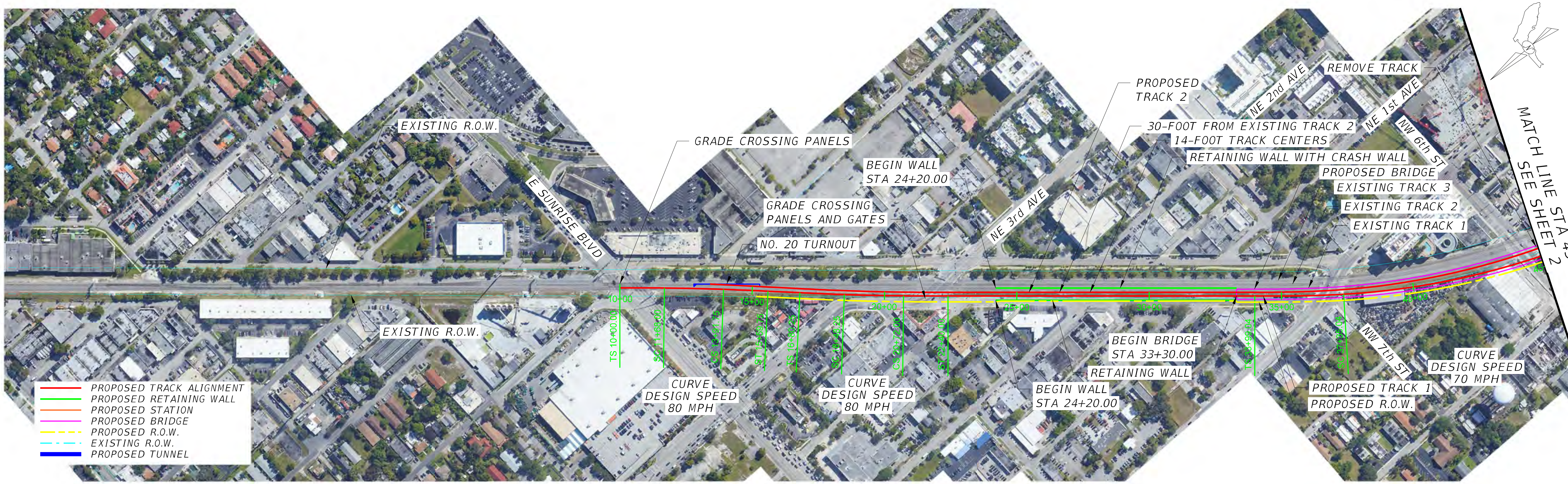
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

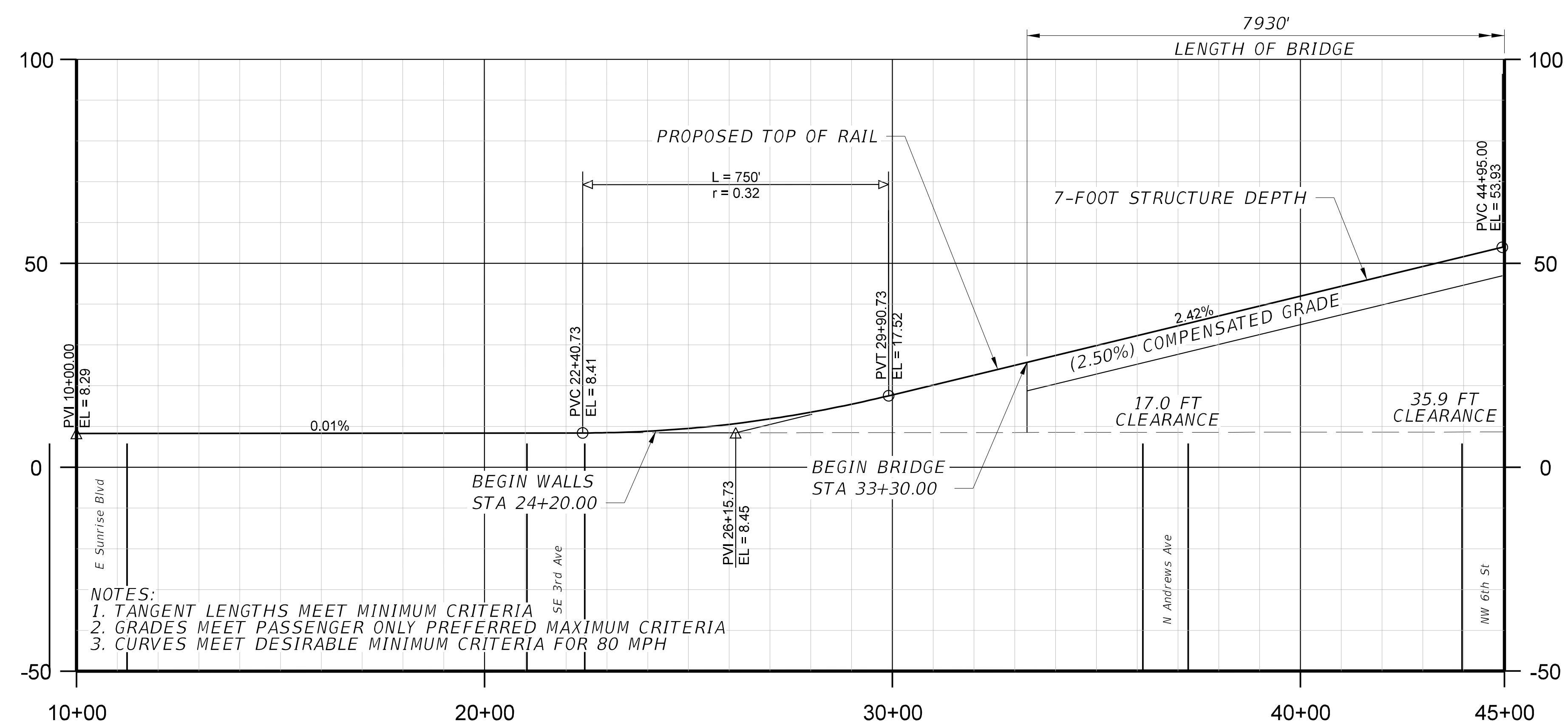
SHEET TITLE:
MID LEVEL MOVABLE SPAN ALTERNATIVE
40-FOOT OFFSET TO EXISTING TRACK (SHEET 3 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
3





REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

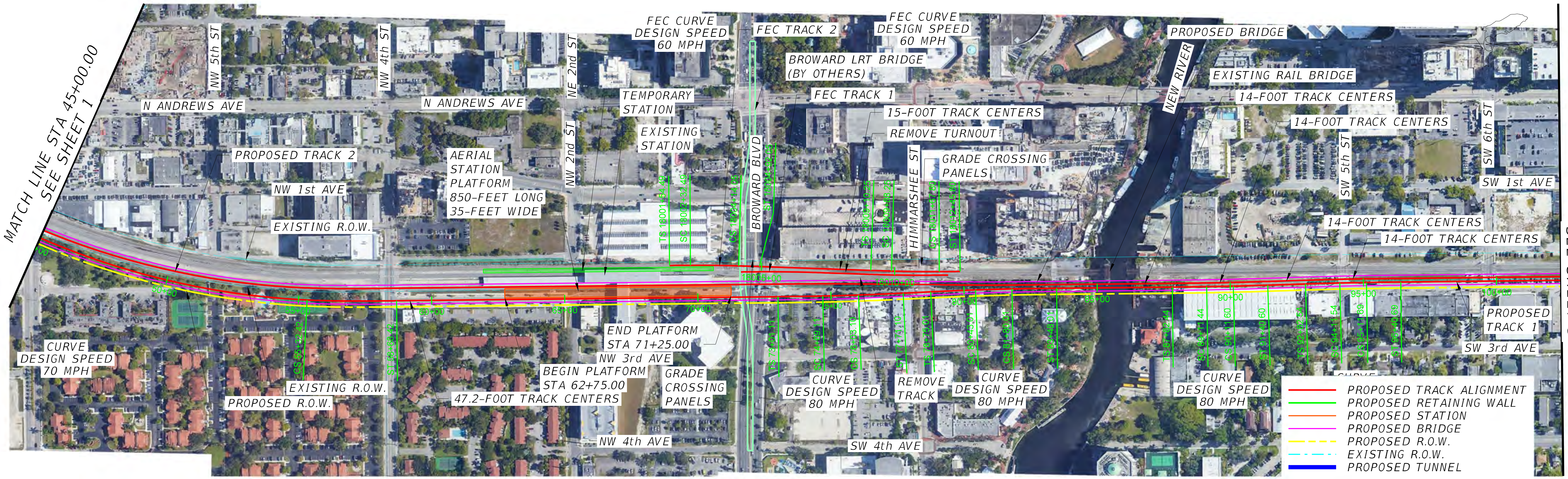
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

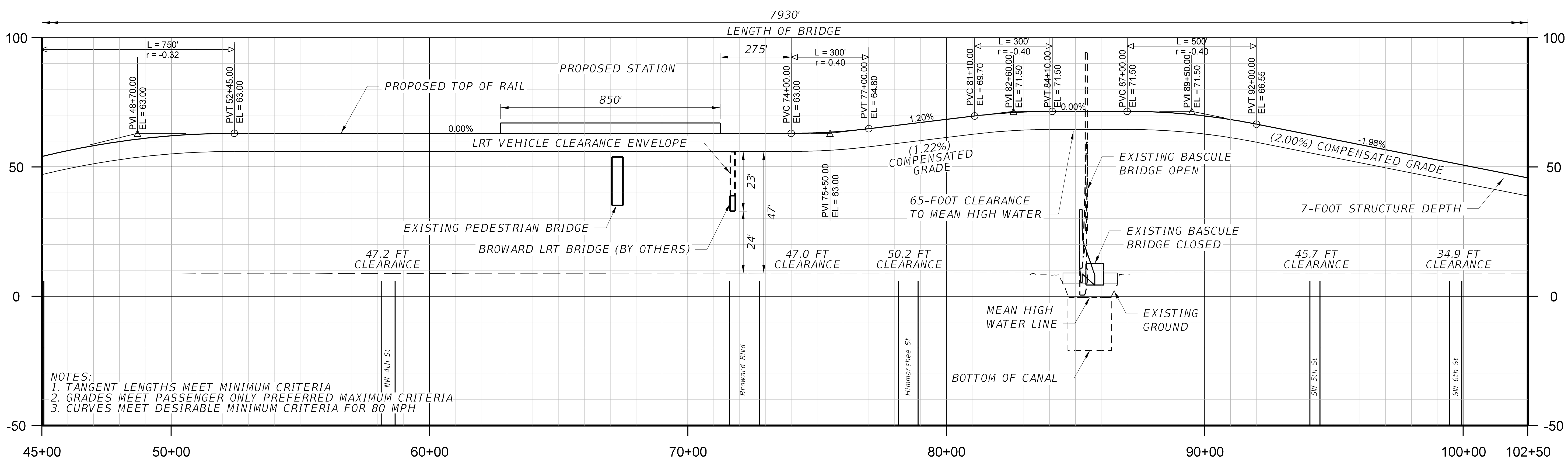
SHEET TITLE:
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
65-FOOT VERTICAL CLEARANCE (SHEET 1 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
1





NOTES:
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REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

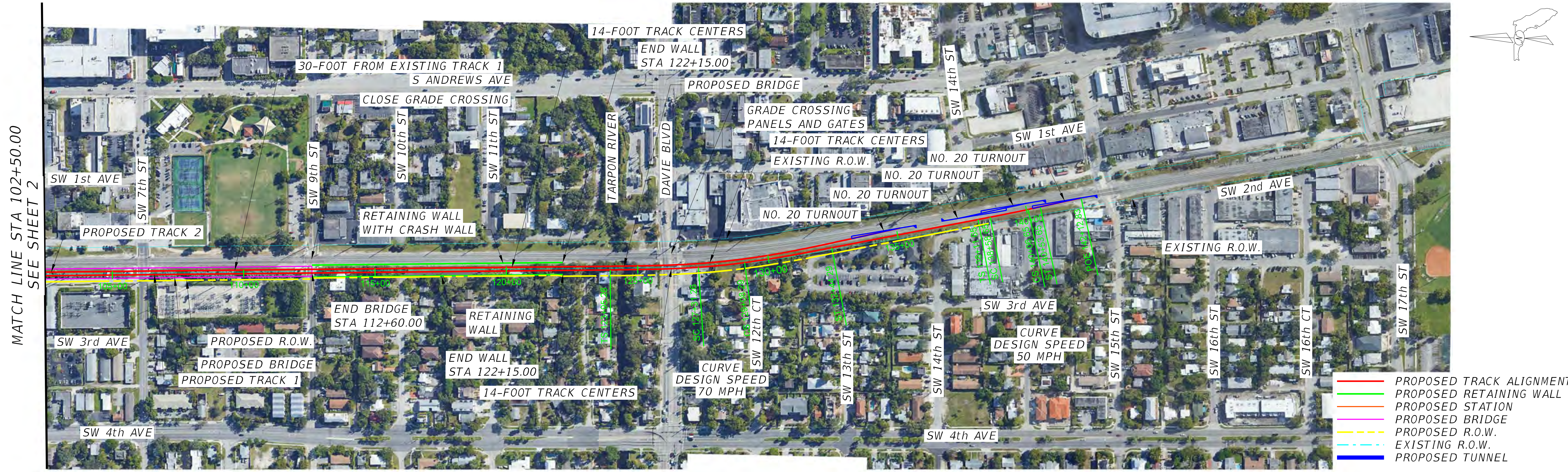
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

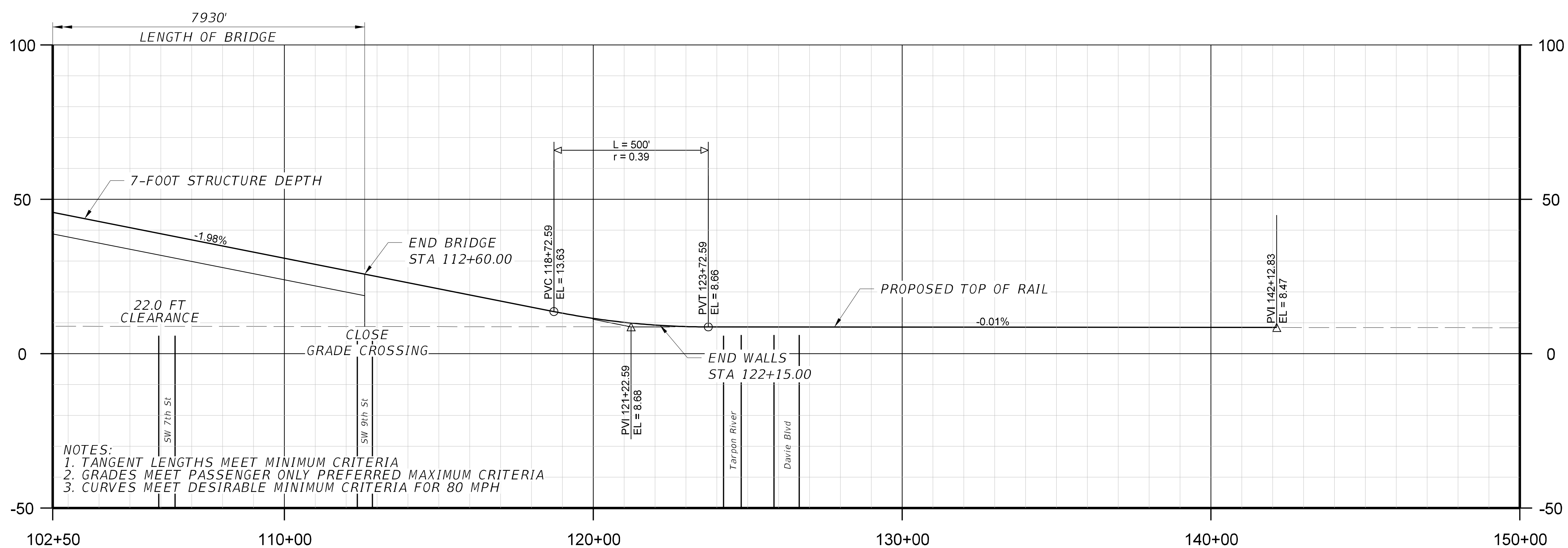
SHEET TITLE:
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
65-FOOT VERTICAL CLEARANCE (SHEET 2 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
2





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DEPARTMENT OF TRANSPORTATION

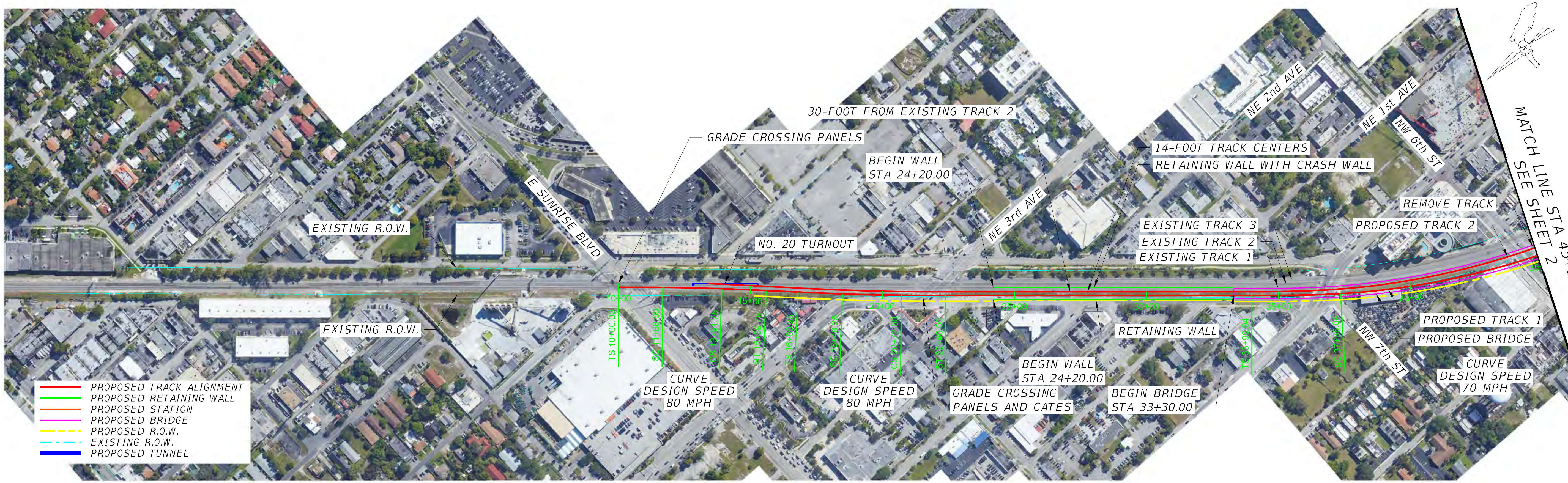
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

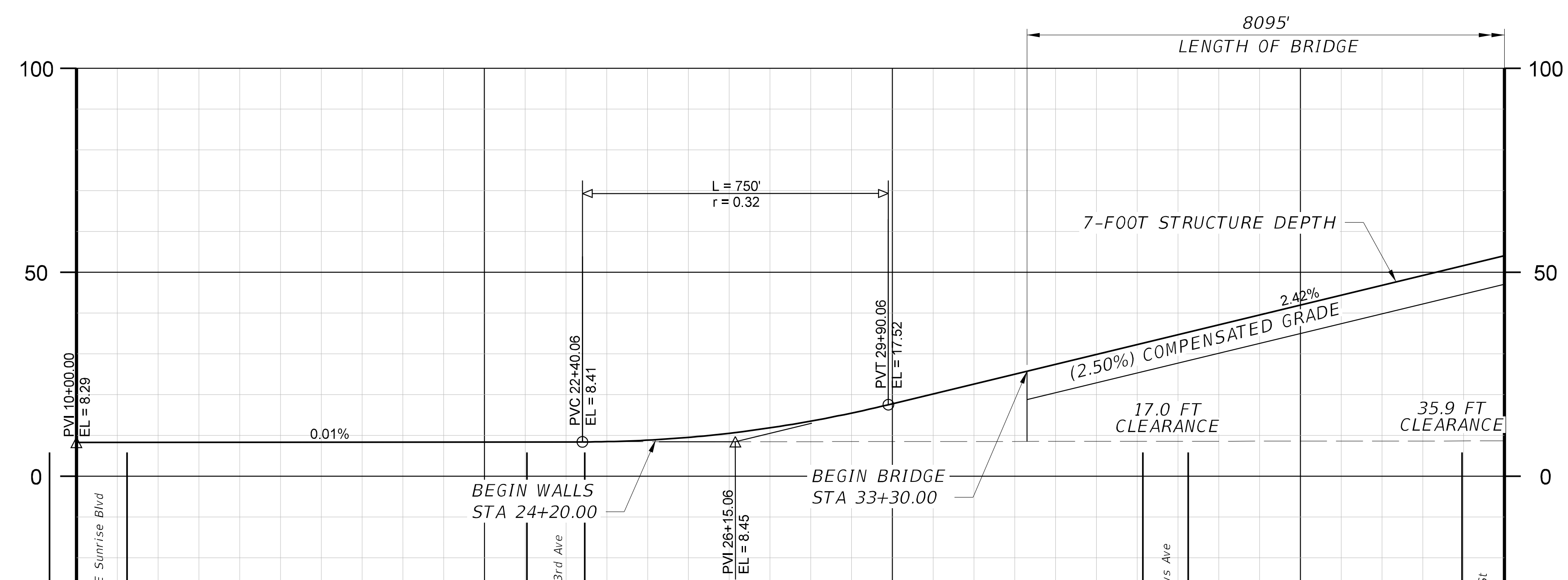
SHEET TITLE:
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
65-FOOT VERTICAL CLEARANCE (SHEET 3 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
3





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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

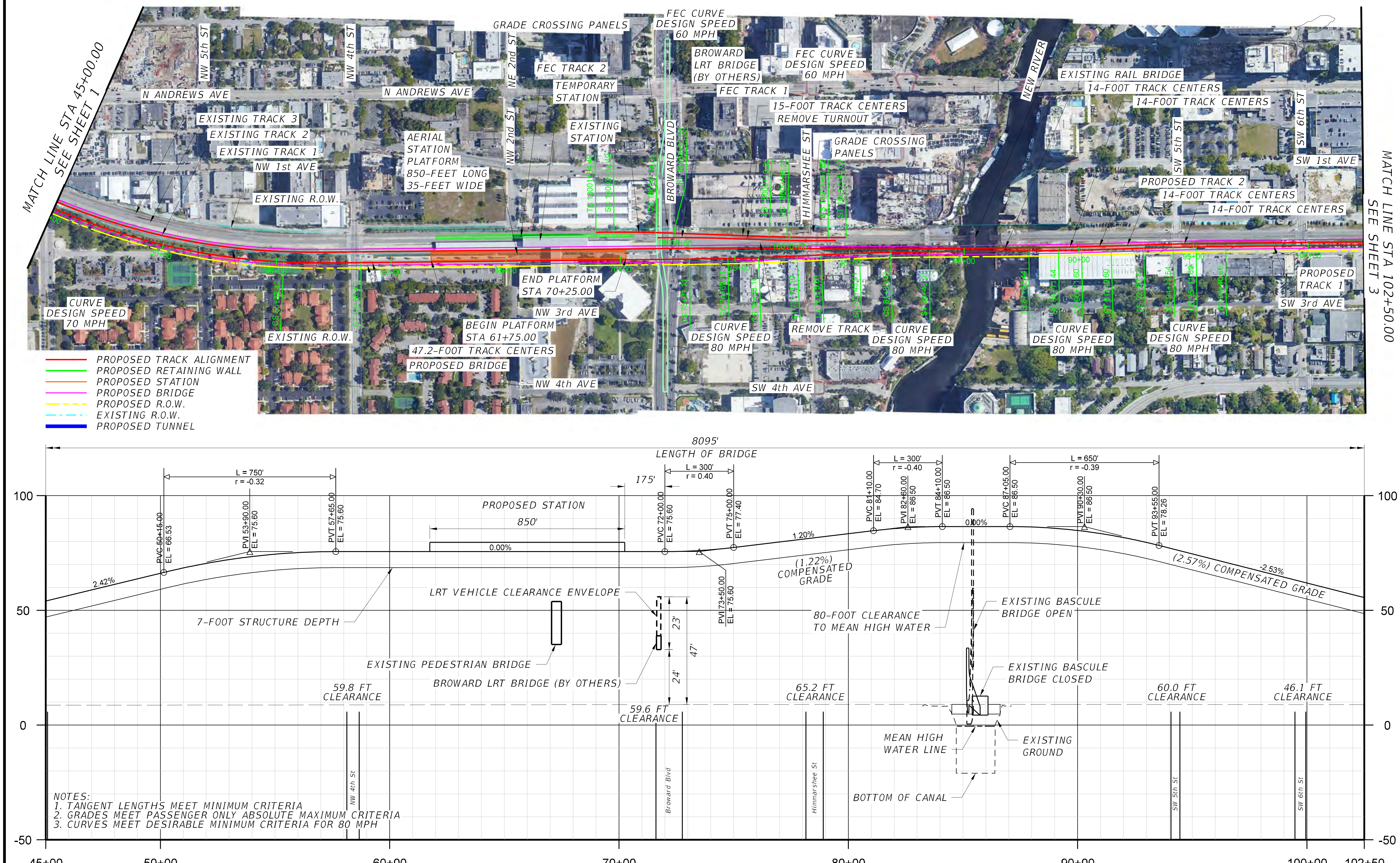
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
80-FOOT VERTICAL CLEARANCE (SHEET 1 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
1



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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:

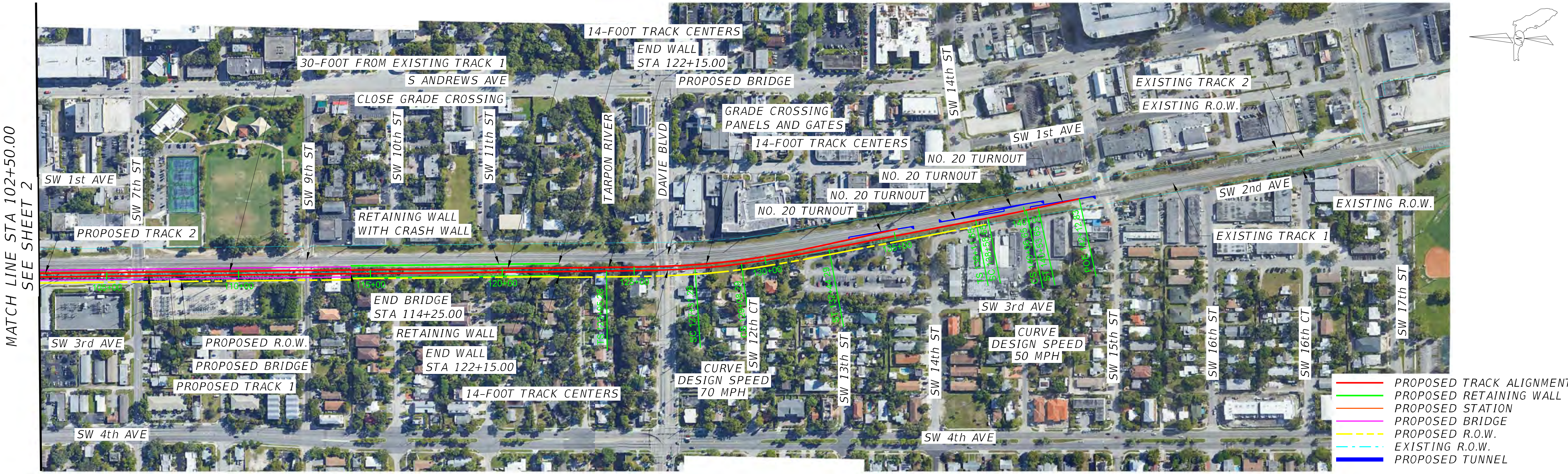
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
80-FOOT VERTICAL CLEARANCE (SHEET 2 OF 3)

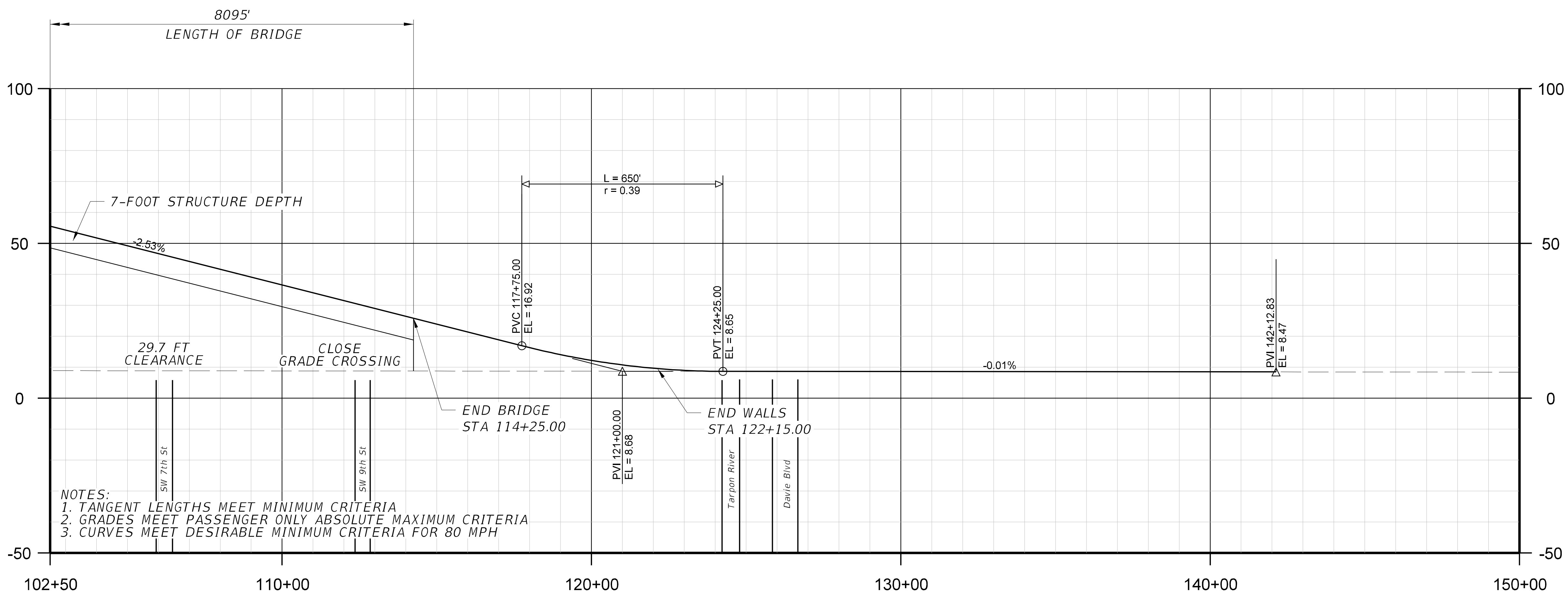
PROJECT NAME:

TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
2





REVISIONS					
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VERTICAL 0 10' 20' 30' 40' 50'

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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

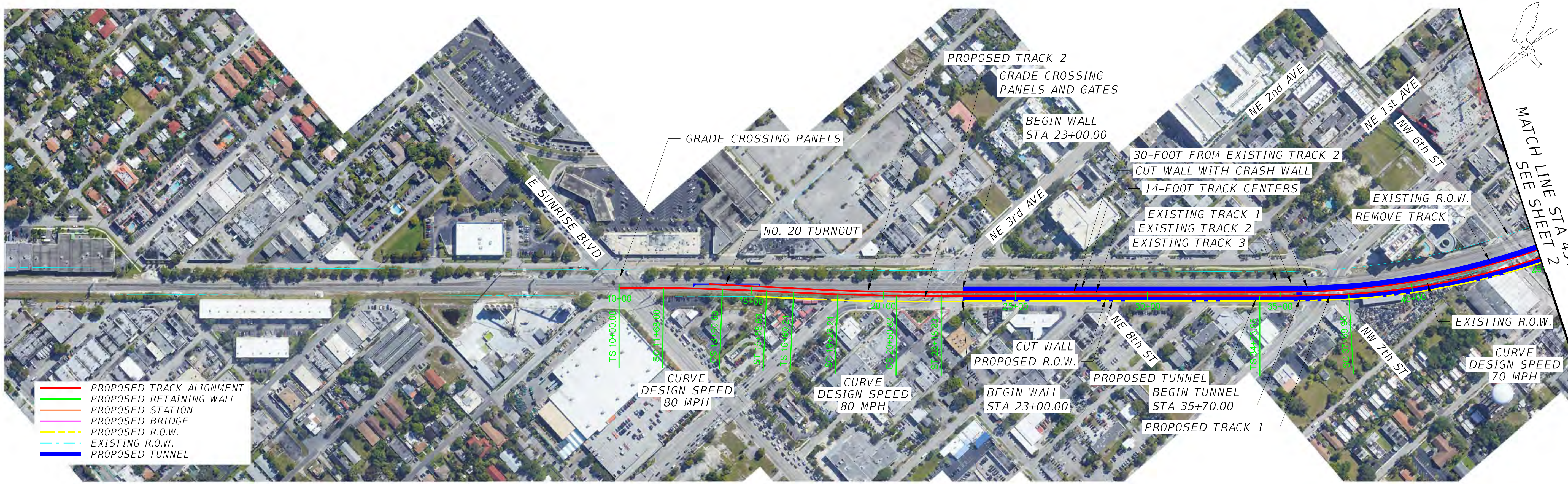
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

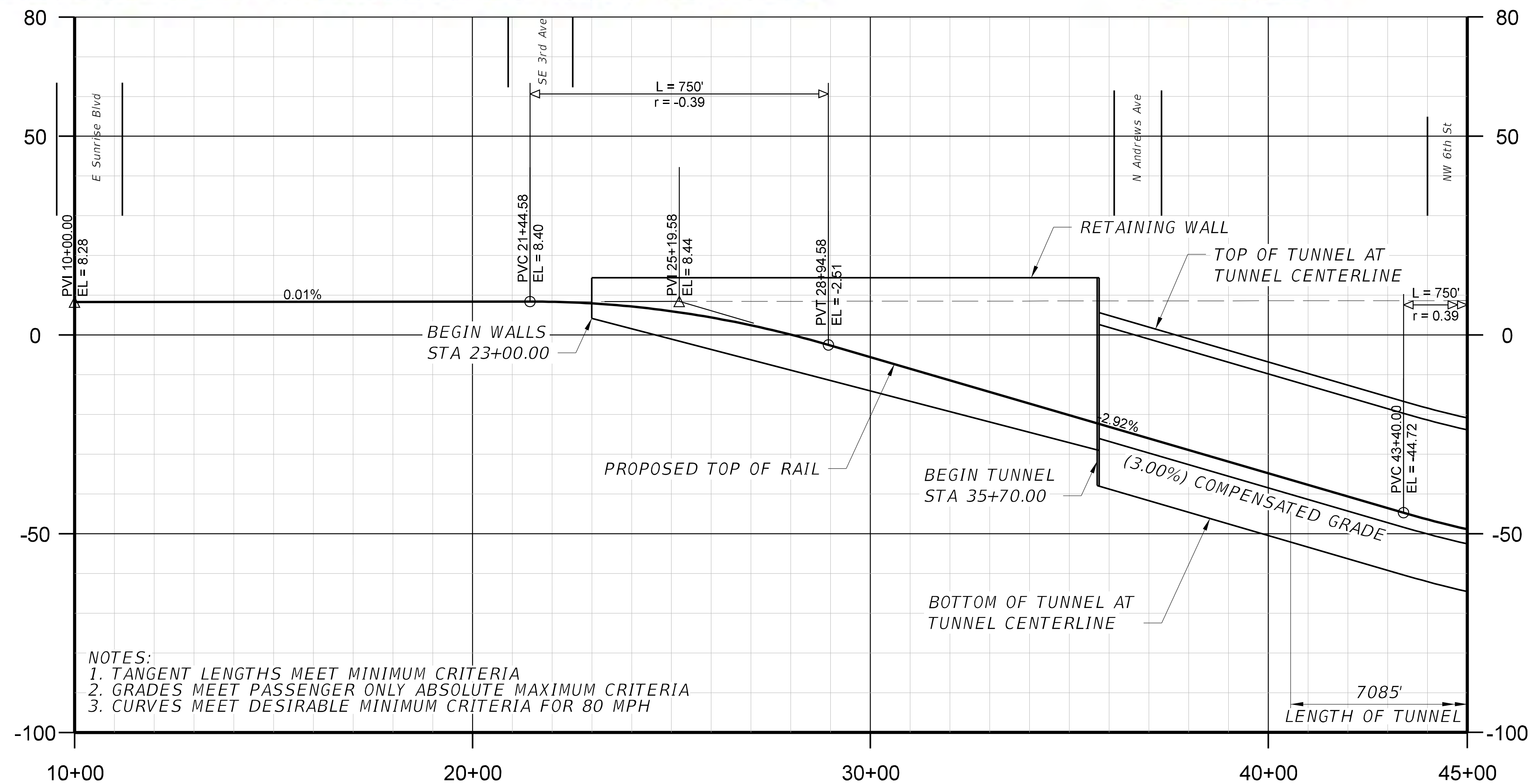
SHEET TITLE:
HIGH LEVEL FIXED STRUCTURE ALTERNATIVE
80-FOOT VERTICAL CLEARANCE (SHEET 3 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
3





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REVISIONS					
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HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

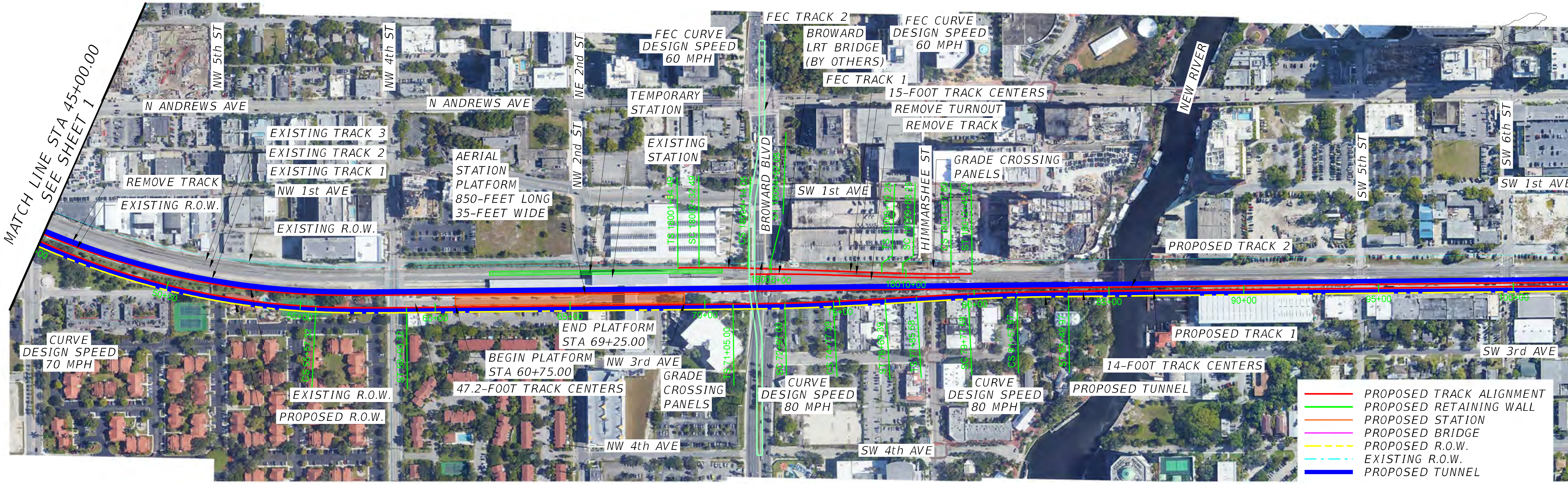
ROAD NO.	COUNTY	FINANCIAL PROJECT ID

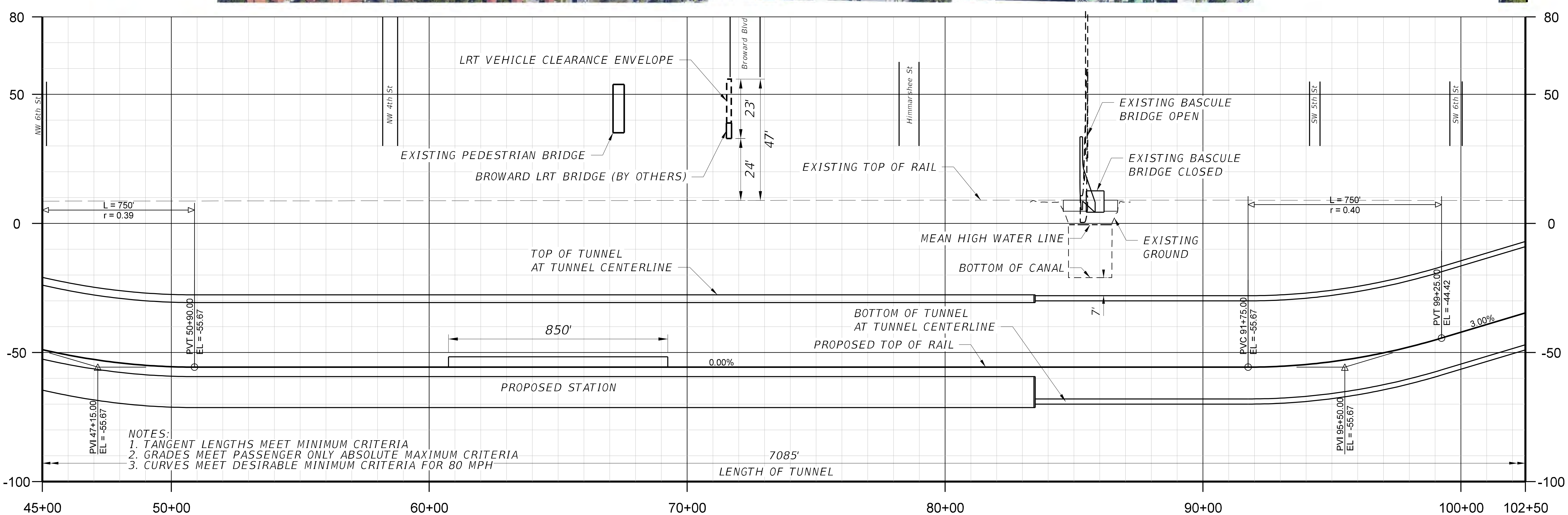
SHEET TITLE: BORED TUNNEL ALTERNATIVE UNDER ANDREWS AVE (SHEET 1 OF 3)

PROJECT NAME: TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO. 1





REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

HORIZONTAL 0 100' 200' 300' 400' 500'

VERTICAL 0 10' 20' 30' 40' 50'

DRAWN BY:
CHECKED BY:
DESIGNED BY:
CHECKED BY:

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
BORED TUNNEL ALTERNATIVE
UNDER ANDREWS AVE (SHEET 2 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
2

NOTES:
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REVISIONS

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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID

SHEET TITLE:
BORED TUNNEL ALTERNATIVE
UNDER ANDREWS AVE (SHEET 3 OF 3)

PROJECT NAME:
TRI RAIL COASTAL LINK NEW RIVER BRIDGE

REF. DWG. NO.

SHEET NO.
3

Appendix E – Right of Way Impact Assessment

Right of Way Impact Table

Appendix E

Parcel Number	Parcel Size (Acres)	Parcel Impact (Acres)
Alternative 1 - Low-Level Bascule Bridge		
504210010080	0.610	0.003
504210010160	0.185	0.000
504210015960	2.300	0.017
504210013680	2.707	0.449
504210013770	0.331	0.074
504210990010	0.138	0.113
504211000100	8.264	0.129
Total	**14.535**	**0.785**

Alternative 1

Right of Way Impact Table

Appendix E

Parcel Number	Parcel Size (Acres)	Parcel Impact (Acres)
Alternative 2 - Mid-Level Bascule Bridge		
494234057050	0.463	0.051
494234057200	0.607	0.010
494234057230	0.067	0.000
494234057290	0.217	0.070
494234059740	0.033	0.032
494234062280	0.308	0.129
494234062330	0.146	0.007
494234062340	0.126	0.050
494234062470	0.114	0.050
494234062480	0.396	0.088
494234062610	0.263	0.039
494234071200	0.251	0.006
494234071370	0.293	0.000
494234071390	0.315	0.009
494234071470	0.248	0.067
494234071500	0.418	0.096
494234076290	1.269	0.621
504203050010	1.304	0.867
504203100020	0.891	0.263
504203100030	0.034	0.034
504203170010	1.179	0.106
504203240010	27.746	1.167
504203240040	0.155	0.006
504203320010	0.253	0.030
504203320011	0.018	0.018
504203320020	0.019	0.004
504210010080	0.610	0.005
504210010080	0.251	0.007
504210010160	0.185	0.006
504210010190	0.185	0.022
504210010900	0.874	0.090
504210010900	0.143	0.143
504210010901	0.829	0.801
504210011710	0.425	0.069
504210011720	0.872	0.139
504210011722	1.442	0.192
504210011723	0.084	0.009
504210011724	0.003	0.003
504210012140	1.081	0.141
504210012141	0.270	0.033
504210012151	0.327	0.025
504210012170	0.436	0.035
504210012180	0.218	0.044
504210015940	3.252	0.056
504210015950	0.016	0.016
504210015960	2.300	0.109
504210013680	2.707	0.443
504210013770	0.331	0.066
504210015860	2.500	0.191
504210990010	0.138	0.109
504211000100	8.264	0.129
504215010830	0.257	0.046
504215010940	0.247	0.033
504215018040	6.395	0.013
504215018040	0.126	0.008
504215191800	1.833	0.012
Total	**73.734**	**6.814**

Alternative 2

Right of Way Impact Table

Appendix E

Parcel Number	Parcel Size (Acres)	Parcel Impact (Acres)
Alternative 3 - High-Level Fixed Bridge		
504210010190	0.185	0.022
504210012151	0.327	0.025
504215210190	0.228	0.001
494234057050	0.463	0.051
504210012140	1.081	0.141
504203240010	27.746	1.167
494234076290	1.269	0.621
494234057200	0.607	0.010
504210990010	0.138	0.109
504203100020	0.891	0.263
494234071370	0.293	0.000
504210015960	2.300	0.109
494234062470	0.114	0.050
504215010940	0.247	0.042
494234062340	0.126	0.050
504215191621	0.187	0.025
504210010080	0.610	0.005
504215191100	0.147	0.026
494234071200	0.251	0.006
504215018040	6.395	0.013
494234071500	0.418	0.096
494234062610	0.263	0.039
504210012141	0.270	0.033
494234062330	0.146	0.007
504210012180	0.218	0.044
504215010830	0.257	0.047
494234057290	0.217	0.070
494234071390	0.315	0.009
494234062280	0.308	0.129
504203100030	0.034	0.034
504215210010	0.222	0.010
504210010160	0.185	0.006
494234057230	0.067	0.000
504210015860	2.500	0.191
504210012170	0.436	0.035
494234062480	0.396	0.088
504210013770	0.331	0.066
504215191790	0.149	0.022
504203170010	1.179	0.106
504215190960	0.127	0.033
504210010080	0.251	0.007
504215191800	1.833	0.116
504210013680	2.707	0.443
504203050010	1.304	0.867
504215018040	0.126	0.013
504211000100	8.264	0.129
504215018050	2.880	0.008
504215018050	1.904	0.004
504203240040	0.155	0.006
504215191800	6.656	0.023
504210011710	0.425	0.069
504210011720	0.872	0.139
494234059740	0.033	0.032
504210011724	0.003	0.003
504210011722	1.442	0.192
504210011723	0.084	0.009
504210015950	0.016	0.016
504210015940	3.252	0.056
494234071470	0.248	0.067
504203320020	0.019	0.004
504203320010	0.253	0.030
504210010900	0.874	0.090
504210010901	0.829	0.801
504203320011	0.018	0.018
504210010900	0.143	0.143
Total	**86.236**	**7.086**

Alternative 3

Right of Way Impact Table
Appendix E

Parcel Number	Parcel Size (Acres)	Parcel Impact (Acres)	Subterrenean Impact (Acres)
Alternative 4 - Tunnel			
504215210740	0.240	0.003	
504210010190	0.185	0.014	0.014
504210012151	0.327	0.027	0.027
504215210190	0.228	0.017	
494234057050	0.463	0.049	
504210012140	1.081	0.181	0.181
504203240010	27.746	1.319	1.319
494234076290	1.269	0.596	0.596
494234057200	0.607	0.010	
504210990010	0.138	0.114	0.114
504203100020	0.891	0.265	0.265
494234071370	0.293	0.001	
504210015960	2.300	0.123	0.123
494234062470	0.114	0.051	
504215010940	0.247	0.075	
494234062340	0.126	0.049	
504215191621	0.187	0.054	
504215191100	0.147	0.054	
494234071200	0.251	0.003	0.003
504215018040	6.395	0.023	
494234071500	0.418	0.107	
504203010030	0.832	0.000	0.000
494234062610	0.263	0.044	
504210012141	0.270	0.038	0.038
494234062330	0.146	0.006	
504210012180	0.218	0.045	0.045
504215210750	0.263	0.000	
504215010830	0.257	0.083	
494234057290	0.217	0.071	
494234071390	0.315	0.007	
494234062280	0.308	0.125	
504203100030	0.034	0.034	0.034
504215210010	0.222	0.037	
504210010160	0.185	0.000	0.000
494234057230	0.067	0.000	
504210015860	2.500	0.381	
504210012170	0.436	0.032	0.032
494234062480	0.396	0.097	
504210013770	0.331	0.075	0.075
504215191790	0.149	0.050	
504203170010	1.179	0.104	0.104
504215190960	0.127	0.066	
504210010080	0.251	0.002	0.002
504215191800	1.833	0.217	
504210013680	2.707	0.413	0.413
504203050010	1.304	0.892	0.892
504215018040	0.126	0.024	0.024
504211000100	8.264	0.117	0.117
504215210760	5.972	0.002	
504215018050	2.880	0.022	
504215018050	1.904	0.011	
504203240040	0.155	0.007	0.007
504215191800	6.656	0.048	
504210011710	0.425	0.092	0.092
504210011720	0.872	0.186	0.186
494234059740	0.033	0.032	
504210011724	0.003	0.003	0.003
504210011722	1.442	0.262	0.262
504210011723	0.084	0.012	0.012
504210015950	0.016	0.016	0.016
504210015940	3.252	0.065	0.065
494234071470	0.248	0.068	
504203320020	0.019	0.006	0.006
504203320010	0.253	0.063	0.063
504210010900	0.874	0.202	0.202
504210010901	0.829	0.806	0.806
504203320011	0.018	0.018	0.018
504210010900	0.143	0.143	0.143
Total	**92.933**	**8.159**	**6.299**

Alternative 4

Appendix F – Basis of Estimate

1. Bored Tunnel and Underground Station

a. The cost estimate will be based on costs from recent projects including tunnel structures of similar size and built under similar conditions. The cost estimate does not provide a bottom-up estimate of the assumed tunneling work and is considered preliminary.

b. 7,085 ft. of TBM tunnels, 40ft OD, with a single pass, gasketed pre-cast concrete segmental lining; the TBM is assumed to be an EPB type. The tunnel depth is approximately 60 ft. from grade level

c. Approximately, 1,100 ft. of mined station including mezzanine level approximately 70 ft. wide, 60 ft. high; extensive ground improvement measures such as jet grouting is assumed to be required to enable cavern construction under the prevalent ground, and particularly, ground water conditions. Overburden to the cavern crown at the station is assumed to be minimum 30 ft. Platform width is assumed to be approximately 35 ft. Detailed space proofing of the cavern cross section is not provided at this stage.

d. The cost for the TBM tunnel is based on the quotation received from Dr. Sauer & Partners in 2016 and it was cost escalated to 2019 dollars.

2. Station Cavern:

a. Station Cavern: A similar project executed in NYC was the Northern Boulevard Crossing (NBX) for the East Side Access Project. Similar ground and groundwater conditions and the resulting similar ground improvement measures (jet grouting) make NBX a comparable tunnel structure.

b. The cost for the Station Cavern is based on the quotation received from Dr. Sauer & Partners in 2016 and it was cost escalated to 2019 dollars. The station cavern's waterproofing will be done by using NOH2O chemical and is included in the estimate.

3. Tunnel Portals and Drainage:

a. The length of tunnel portals retaining walls are 290 ft long and 42' wide one end and 260 ft long and 42' wide on the other end.

b. The estimate includes excavation for tunnel portal retaining walls and for the trackwork. The tunnel portal retaining walls assumed 2' reinforced concrete walls.

c. The tunnel portals include construction of stop and log post flood walls to prevent future flood water entering the tunnel.

d. Estimate includes lighting and power, including associated conduit and wires for tunnel and portal walls.

e. Estimate includes fiberglass catwalk and handrails on both sides of tunnel and along the retaining walls.

f. Estimate includes 12'' diameter drainage pipe in the middle of the tracks including inlets.

4. Tunnel Ventilation:

a. Estimate includes construction of two ventilation buildings, each building would 40’x40’ and 30’ high from above ground level.
b. Estimate includes two ventilation fans in each building including louvers and other mechanical equipment’s.
c. Estimate includes all electrical equipment such as motor control centers (MCC), disconnect switches, conduits and wires for ventilation fans and other mechanical equipment including controls.
d. Estimate includes power, lighting and communication system such as fire alarm, CCTV, telephone and intrusion access system for ventilation buildings.

5. Pump Room:

a. Estimate includes one pump room at track level in the middle of the tunnel with 15’x15’x15’ sump pit.
b. The pump room pit will have three sump pumps and associated pipes. The discharge line will be connected at city storm drainage at street level.
c. Estimate includes all electrical equipment such as motor control centers (MCC), disconnect switches, conduits and wires for pump room and other mechanical equipment including controls.
d. Estimate includes power, lighting and communication system such as fire alarm, telephone and intrusion access system for pump rooms.

6. Electrical Substation:

a. Estimate includes construction of one substation at grade level.
b. Estimate includes all electrical equipment such as Transformers, Circuit breakers, Disconnect switches, conduits and wires.
c. Estimate includes power, lighting and communication system such as fire alarm, telephone and intrusion access system for substation building.

7. Underground Platform:

a. Estimate includes construction of a concrete platform of approximately 1100’L x 35’W x 8’’THK slab with footings.
b. Estimate includes a mezzanine of 50’x60’ with all finishes.
c. Construction of platform edge includes 2’ wide tactile warning strip and 6’’THK rubbing board at the platform edge.
d. Estimate includes construction of two (2) 12’ wide concrete stairs from street level to mezzanine level.

e. Estimate includes construction of two (2) 12' wide concrete stairs from mezzanine level to platform level.
f. Estimate includes construction of 3,000 sf of Brightline facilities.
g. Estimate includes an allowance for flood hardening for street stairs etc.
h. Estimate includes two (2) escalators at street level and two (2) escalators and mezzanine level.
i. Estimate includes two (2) ADA elevators, one from street level to mezzanine level and one from mezzanine to platform level
j. Estimate includes all the plumbing work for employee facility and sewer ejector pump.
k. Estimate includes fire standpipe and HVAC for an employee facility, platform, and mezzanine area.
l. Estimate includes power and lighting for employee facility rooms, stairs, over the escalators, station platform and mezzanine area.
m. Estimate includes incoming power from the utility company and two electrical distribution rooms.
n. Estimate includes station Public Address, Customer Information Screen, telephone system, CCTV systems, fire alarm system, and fiber optic network systems.
o. Estimate includes station signs.

8. Temporary Passageway and Lounge Area:

a. Estimate includes underpinning of existing passageway structure foundation.
b. Estimate includes construction and demolition of temporary bridge/ passageway from the parking lot building (230'L x 10'W x 22'H) to the second floor of the lounge area.
c. Estimate includes construction of temporary stair from street level to temporary bridge.
d. Estimate includes demolition of existing lounge area floor and excavation of existing platform to new mezzanine.
e. Estimate includes to provide one elevator, two escalators and 12' wide stairs from lounge area (second floor) to new mezzanine area to flow traffic from lounge area to the platform level.

9. Elevated Station Platforms – Mid and High-Level Bridge Alternatives

a. Estimate includes excavation 10'x10'x8' for elevated station columns foundations.
b. Estimate includes disposal fee for excavated material and backfill and compact
c. Estimate includes 14'' diameter micro piles, 80'D, eight (8) piles per location for 28 locations.
d. Estimate includes 8'x8'x8' piles caps at 28 locations.
e. Estimate includes 28 columns 80' H and the size of the columns are W30X99.
f. Estimate includes 8 stringers, 1,100' length and the size of stringer would be W36x136.
g. Estimate includes floor beams every 10' and the size of floor beams are W24x55.
h. Estimate includes construction of a concrete platform which is 1100'L x 35'W x 8''THK slab at 60' high elevation.

i. Construction of platform edge includes 2’ wide tactile warning strip and 6’’THK rubbing board at the platform edge.
j. Estimate includes construction of one (1) 12’ wide concrete stairs from new elevated Platform level to existing lounge level.
k. Estimate includes two 2 escalators from new elevated platform level to existing lounge level.
l. Estimate includes one (1) ADA elevator, from new elevated platform level to existing lounge level.
m. Estimate includes standing seam roof for new elevated platform.
n. Estimate includes power and lighting for employee facility rooms, stairs, over the escalators, station platform.
o. Estimate includes incoming power from utility company and two construction of two electrical distribution rooms.
p. Estimate includes station Public Address, Customer Information Screen, Telephone system, CCTV systems, fire alarm system, fiber optic network systems.
q. Estimate includes station signs.

10. Trackwork

a. Unit costs based on average of several projects throughout the southeast with comparisons across the country for confirmation.
b. Track construction includes ballasted single track at grade, on structure, and in tunnel. All proposed track is assumed to be new construction for this conceptual study. Track includes ballast, sub-ballast, rails, ties, and other track materials.
c. Turnout #20 includes a single turnout. Crossovers consist of two turnouts.
d. Crash walls are placed in locations where the proposed retaining wall is less than 25 feet from the existing track. Wall is measured as linear foot of 3-foot thick wall.
e. Grade crossing includes panels at grade crossings of the track.
f. Excavation includes volume of material removed for track and walls leading down to tunnel. Volume of earthwork in tunnel is not included.
g. Embankment includes volume of material to raise track on retaining walls above existing grade.

11. Retaining Wall and Structures

a. Use FDOT cost estimating guidelines and historical cost data for highway bridge projects, modified for railroad structures.
b. Unit cost ($/sq. ft.) for walls is based on FDOT BDR cost estimating guidelines using an upper-bound value for all types.
c. Unit cost ($/sq. ft.) for concrete is taken from FDOT historical construction cost data (inflated to 2019)

d. Unit cost ($/sq. ft.) for steel spans is based on FDOT guidance for new construction (inflated to 2019).
e. Concrete, steel, and wall unit costs were increased by a factor of 2 to account for the heavier design load for railroads relative to highway structures.
f. Unit cost ($/sq. ft.) for movable spans is based on FDOT guidance for new construction, increased by 50 percent for railroad bridge. This unit cost includes structural, mechanical, electrical and architectural systems as part of the movable span.
g. FDOT unit price generally reflects costs associated with double-leaf, solid-deck bascule spans within fully enclosed piers. A railroad bridge for this project is expected to be a single-leaf, open deck span with an open pier configuration.

12. Roadway and Traffic Signaling

a. All roadway and signaling improvements will be based on standard FDOT unit price cost.

13. Railway Signaling

a. All railway signaling, temporary and permanent, will be based on historical cost data of similar projects.
b. Costs are based on typical cost estimates developed for commuter railroad. Costs are based on eight (8) types of typical locations: new interlocking, grade crossing replacement, crossings with DAXing and programming modifications, grade crossings with programming changes only, movable bridge interface replacement, tunnel station, signal interface modifications, and grade crossing removal.
c. Basis for costs include material, labor, shop wiring, design labor, factory testing, and field testing. Material and labor prices were escalated to 2019 prices. No other contingencies were added to pricing, no mobilization, no general conditions, and no railroad flagging included. Cost estimates include some railroad/signal shop/design additives which are specific to just signal field/office staff, there should not be an overlap of departmental work like track or structures. These costs include equipment inefficiency, labor + overhead, misc. expenses, unforeseen conditions, office engineer, signal construction manager costs, and signal testing manager. Labor rates and overhead rates can be adjusted.
d. Costs were developed based upon FEC signal standards for crossings and interlockings. Interlockings assume Main and Remote 10x10 signal houses with 8x8 adjacent junction box/signal bridge houses, and cab signaling. Fiber routing between all wayside locations at interlockings and grade crossings within the corridor. Grade crossing costs assume for utility pole, AC service, and generators. Interlocking locations assume that the Main location will have AC service, utility pole, and generator, and adjacent locations are wired from main for power feed.
e. Design engineering sheets are assumed for typical number of sheets.
f. Grade crossing locations with modifications to the geometry, number of tracks, or track arrangement will assume an all new factory wired location. Wayside devices like flashing light gate assemblies or cantilevers that are not affected by track changes will be salvaged in place. Wayside devices that will

require relocation or modifications are assumed to be replaced with all new devices to minimize track outages and interface issues.

g. Signaling for the above ground stations will not be assumed, signaling will accomplished at interlockings prior to stations.

h. No station communication or interface to signal system assumed, these costs will be assumed by station communications. Assume signal houses will have fiber patch panels and 12SMFO through corridor, communication at station can be interface virtually as needed.

14. General Conditions

a. Wage Rates:
   i. Estimate is based on local wage rates.
   ii. Shop Fabrication, engineering, and shop drawings wage rates based on local wages and or historical data.

b. Material Pricing:
   i. The cost of building materials is based on “historical data” from recent similar projects.

c. Equipment:
   i. Major Equipment pricing is based on the Bluebook of Construction Equipment rental cost and equipment watch book. Hourly operating cost (operating engineer’s cost) is included with labor cost whenever required.

d. Escalation:
   i. All cost is in 2019 dollars.

Appendix G – Cost Estimate Documentation

Summary by Federal Transit Administration (FTA) Standard Cost Categories (SCC)

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Low Level Moveable Span (21 feet)	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	$38,592,800	$7,718,560	$3,859,280	$50,170,640
			10.11	Track: Ballasted	$7,187,700	$1,437,540	$718,770	$9,344,010
			10.12	Track: Special (switches, turnouts)	$2,100,000	$420,000	$210,000	$2,730,000
		GUIDEWAY & TRACK ELEMENTS Total			**$47,880,500**	**$9,576,100**	**$4,788,050**	**$62,244,650**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	$582,266	$116,453	$58,227	$756,946
			40.02	Site Utilities, Utility Relocation	$1,063,000	$212,600	$106,300	$1,381,900
			40.05	Site structures including retaining walls, sound walls	$1,447,936	$289,587	$144,794	$1,882,316
			40.07	Automobile, bus, van accessways including roads, parking lot	$307,000	$61,400	$30,700	$399,100
			40.08	Temporary Facilities and other indirect costs during construc	$124,000	$24,800	$12,400	$161,200
		SITEWORK & SPECIAL CONDITIONS Total			**$3,524,201**	**$704,840**	**$352,420**	**$4,581,462**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	$12,759,924	$2,551,985	$1,275,992	$16,587,901
		SYSTEMS Total			**$12,759,924**	**$2,551,985**	**$1,275,992**	**$16,587,901**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	$3,208,231	$641,646	$320,823	$4,170,701
			80.02	Engineering	$5,774,816	$1,154,963	$577,482	$7,507,261
			80.03	Project Management for Design and Construction	$3,849,878	$769,976	$384,988	$5,004,841
			80.04	Construction Administration & Management	$8,983,048	$1,796,610	$898,305	$11,677,962
			80.05	Professional Liability and other Non-Construction Insurance	$160,412	$32,082	$16,041	$208,535
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	$320,823	$64,165	$32,082	$417,070
			80.07	Surveys, Testing, Investigation, Inspection	$320,823	$64,165	$32,082	$417,070
			80.08	Start up	$320,823	$64,165	$32,082	$417,070
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total			**$22,938,854**	**$4,587,771**	**$2,293,885**	**$29,820,510**
					$87,103,479	**$17,420,696**	**$8,710,348**	**$113,234,522**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Mid Level Moveable Span (55 feet)	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	$165,338,800	$33,067,760	$16,533,880	$214,940,440
			10.11	Track: Ballasted	$10,347,780	$2,069,556	$1,034,778	$13,452,114
			10.12	Track: Special (switches, turnouts)	$1,500,000	$300,000	$150,000	$1,950,000
		GUIDEWAY & TRACK ELEMENTS Total			**$177,186,580**	**$35,437,316**	**$17,718,658**	**$230,342,554**
	20	STATIONS, STOPS, TERMINALS, INTERMODAL	20.02	Aerial station, stop, shelter, mall, terminal, platform	$17,983,253	$3,596,651	$1,798,325	$23,378,228
		STATIONS, STOPS, TERMINALS, INTERMODAL Total			**$17,983,253**	**$3,596,651**	**$1,798,325**	**$23,378,228**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	$994,312	$198,862	$99,431	$1,292,606
			40.02	Site Utilities, Utility Relocation	$3,317,500	$663,500	$331,750	$4,312,750
			40.05	Site structures including retaining walls, sound walls	$4,210,995	$842,199	$421,099	$5,474,293
			40.07	Automobile, bus, van accessways including roads, parking lot	$2,133,000	$426,600	$213,300	$2,772,900
			40.08	Temporary Facilities and other indirect costs during construc	$1,483,000	$296,600	$148,300	$1,927,900
		SITEWORK & SPECIAL CONDITIONS Total			**$12,138,807**	**$2,427,761**	**$1,213,881**	**$15,780,449**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	$13,407,833	$2,681,567	$1,340,783	$17,430,183
		SYSTEMS Total			**$13,407,833**	**$2,681,567**	**$1,340,783**	**$17,430,183**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	$11,035,824	$2,207,165	$1,103,582	$14,346,571
			80.02	Engineering	$19,864,482	$3,972,896	$1,986,448	$25,823,827
			80.03	Project Management for Design and Construction	$13,242,988	$2,648,598	$1,324,299	$17,215,885
			80.04	Construction Administration & Management	$30,900,306	$6,180,061	$3,090,031	$40,170,398
			80.05	Professional Liability and other Non-Construction Insurance	$551,791	$110,358	$55,179	$717,329
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	$1,103,582	$220,716	$110,358	$1,434,657
			80.07	Surveys, Testing, Investigation, Inspection	$1,103,582	$220,716	$110,358	$1,434,657
			80.08	Start up	$1,103,582	$220,716	$110,358	$1,434,657
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total			**$78,906,139**	**$15,781,228**	**$7,890,614**	**$102,577,980**
					$299,622,611	**$59,924,522**	**$29,962,261**	**$389,509,394**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
High Level Fixed Span (80 feet)	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	$188,829,160	$37,765,832	$18,882,916	$245,477,908
			10.11	Track: Ballasted	$10,347,780	$2,069,556	$1,034,778	$13,452,114
			10.12	Track: Special (switches, turnouts)	$1,500,000	$300,000	$150,000	$1,950,000
		GUIDEWAY & TRACK ELEMENTS Total			**$200,676,940**	**$40,135,388**	**$20,067,694**	**$260,880,022**
	20	STATIONS, STOPS, TERMINALS, INTERMODAL	20.02	Aerial station, stop, shelter, mall, terminal, platform	$17,983,253	$3,596,651	$1,798,325	$23,378,228
		STATIONS, STOPS, TERMINALS, INTERMODAL Total			**$17,983,253**	**$3,596,651**	**$1,798,325**	**$23,378,228**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	$1,001,212	$200,242	$100,121	$1,301,576
			40.02	Site Utilities, Utility Relocation	$3,617,500	$723,500	$361,750	$4,702,750
			40.05	Site structures including retaining walls, sound walls	$3,944,499	$788,900	$394,450	$5,127,848
			40.07	Automobile, bus, van accessways including roads, parking lot	$2,133,000	$426,600	$213,300	$2,772,900
			40.08	Temporary Facilities and other indirect costs during construc	$1,485,000	$297,000	$148,500	$1,930,500
		SITEWORK & SPECIAL CONDITIONS Total			**$12,181,211**	**$2,436,242**	**$1,218,121**	**$15,835,574**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	$12,455,221	$2,491,044	$1,245,522	$16,191,787
		SYSTEMS Total			**$12,455,221**	**$2,491,044**	**$1,245,522**	**$16,191,787**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	$12,164,831	$2,432,966	$1,216,483	$15,814,281
			80.02	Engineering	$21,896,696	$4,379,339	$2,189,670	$28,465,705
			80.03	Project Management for Design and Construction	$14,597,797	$2,919,559	$1,459,780	$18,977,137
			80.04	Construction Administration & Management	$34,061,527	$6,812,305	$3,406,153	$44,279,986
			80.05	Professional Liability and other Non-Construction Insurance	$608,242	$121,648	$60,824	$790,714
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	$1,216,483	$243,297	$121,648	$1,581,428
			80.07	Surveys, Testing, Investigation, Inspection	$1,216,483	$243,297	$121,648	$1,581,428
			80.08	Start up	$1,216,483	$243,297	$121,648	$1,581,428
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total			**$86,978,543**	**$17,395,709**	**$8,697,854**	**$113,072,106**
					$330,275,167	**$66,055,033**	**$33,027,517**	**$429,357,718**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Tunnel	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	$1,319,200	$263,840	$131,920	$1,714,960
			10.06	Guideway: Underground cut & cover	$1,780,966,190	$356,193,238	$178,096,619	$2,315,256,047
			10.11	Track: Ballasted	$10,353,100	$2,070,620	$1,035,310	$13,459,030
			10.12	Track: Special (switches, turnouts)	$1,500,000	$300,000	$150,000	$1,950,000
		GUIDEWAY & TRACK ELEMENTS Total			**$1,794,138,490**	**$358,827,698**	**$179,413,849**	**$2,332,380,037**
	20	STATIONS, STOPS, TERMINALS, INTERMODAL	20.03	Underground station, stop, shelter, mall, terminal, platform	$38,178,966	$7,635,793	$3,817,897	$49,632,656
		STATIONS, STOPS, TERMINALS, INTERMODAL Total			**$38,178,966**	**$7,635,793**	**$3,817,897**	**$49,632,656**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	$206,386	$41,277	$20,639	$268,302
			40.02	Site Utilities, Utility Relocation	$8,201,250	$1,640,250	$820,125	$10,661,625
			40.07	Automobile, bus, van accessways including roads, parking lot	$829,500	$165,900	$82,950	$1,078,350
			40.08	Temporary Facilities and other indirect costs during construc	$4,600,000	$920,000	$460,000	$5,980,000
		SITEWORK & SPECIAL CONDITIONS Total			**$13,837,136**	**$2,767,427**	**$1,383,714**	**$17,988,277**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	$12,019,184	$2,403,837	$1,201,918	$15,624,939
			50.03	Traction power supply: substations	$1,332,640	$266,528	$133,264	$1,732,432
		SYSTEMS Total			**$13,351,824**	**$2,670,365**	**$1,335,182**	**$17,357,371**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	$92,975,321	$18,595,064	$9,297,532	$120,867,917
			80.02	Engineering	$167,355,577	$33,471,115	$16,735,558	$217,562,251
			80.03	Project Management for Design and Construction	$111,570,385	$22,314,077	$11,157,038	$145,041,500
			80.04	Construction Administration & Management	$260,330,898	$52,066,180	$26,033,090	$338,430,168
			80.05	Professional Liability and other Non-Construction Insurance	$4,648,766	$929,753	$464,877	$6,043,396
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	$9,297,532	$1,859,506	$929,753	$12,086,792
			80.07	Surveys, Testing, Investigation, Inspection	$9,297,532	$1,859,506	$929,753	$12,086,792
			80.08	Start up	$9,297,532	$1,859,506	$929,753	$12,086,792
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total			**$664,773,544**	**$132,954,709**	**$66,477,354**	**$864,205,607**
					$2,524,279,959	$504,855,992	$252,427,996	$3,281,563,947

Summary by Federal Transit Administration (FTA) Capital Cost Database Bid Items

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Bid Item	Activity	Unit Cost	Unit	Price Type	Sum of Quantity	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Low Level Moveable Span (21 feet)	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	10040010	Bridges: North Approach Spans - Concrete	$ 380.00	SF	Bid Item	15,640.0	$5,943,200	$1,188,640	$594,320	$7,726,160
					10040030	Bridges: North Flanking Span - Steel	$ 735.00	SF	Bid Item	1,280.0	$940,800	$188,160	$94,080	$1,223,040
					10040050	Bridges: South Flanking Span - Steel	$ 735.00	SF	Bid Item	1,280.0	$940,800	$188,160	$94,080	$1,223,040
					10040060	Bridges: South Approach Spans - Concrete	$ 380.00	SF	Bid Item	13,600.0	$5,168,000	$1,033,600	$516,800	$6,718,400
					10040070	Bridges: Movable Span - Movable	$ 10,000.00	SF	Bid Item	2,560.0	$25,600,000	$5,120,000	$2,560,000	$33,280,000
			10.11	Track: Ballasted	10110010	Ballasted Single Track	$ 380.00	TF	Bid Item	18,915.0	$7,187,700	$1,437,540	$718,770	$9,344,010
			10.12	Track: Special (switches, turnouts)	10120010	Turnout - #20	$ 300,000.00	EA	Bid Item	7.0	$2,100,000	$420,000	$210,000	$2,730,000
		GUIDEWAY & TRACK ELEMENTS Total								**53,282.0**	**$47,880,500**	**$9,576,100**	**$4,788,050**	**$62,244,650**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	40011010	Remove Track	$ 22.00	TF	Bid Item	8,174.0	$179,828	$35,966	$17,983	$233,776
					40011020	Remove Turnout	$ 7,000.00	EA	Bid Item	1.0	$7,000	$1,400	$700	$9,100
					10050010	Embankment	$ 15.00	CY	Bid Item	26,362.5	$395,438	$79,088	$39,544	$514,069
			40.02	Site Utilities, Utility Relocation	40028020	Provide new Roadway Lighting	$ 63,000.00	LS	Bid Item	1.0	$63,000	$12,600	$6,300	$81,900
					40020010	Utility Allowance	$ 1,000,000.00	LS	Bid Item	1.0	$1,000,000	$200,000	$100,000	$1,300,000
			40.05	Site structures including retaining walls, sound walls	10080010	Retaining Walls: North	$ 110.00	SF	Bid Item	5,531.6	$608,480	$121,696	$60,848	$791,025
					10080020	Retaining Walls: South	$ 110.00	SF	Bid Item	7,631.4	$839,455	$167,891	$83,946	$1,091,292
			40.07	Automobile, bus, van accessways including roads, parking lots	40071010	Mill existing roadway and repavement of existing Roadway Option 1 (21' Clearance) and	$ 15.35	SF	Bid Item	20,000.0	$307,000	$61,400	$30,700	$399,100
			40.08	Temporary Facilities and other indirect costs during construction	40080010	Allowance for MOT / Mobilization	$ 124,000.00	LS	Lump Sum	1.0	$124,000	$24,800	$12,400	$161,200
		SITEWORK & SPECIAL CONDITIONS Total								**67,703.6**	**$3,524,201**	**$704,840**	**$352,420**	**$4,581,462**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	50010010	Interlocking	$ 1,283,545.00	EA	Bid Item	2.0	$2,567,090	$513,418	$256,709	$3,337,217
					50020010	Grade Crossing Programming	$ 10,272.00	EA	Bid Item	2.0	$20,544	$4,109	$2,054	$26,707
					50020020	Grade Crossing DAXing & Programming	$ 55,414.00	EA	Bid Item	2.0	$110,828	$22,166	$11,083	$144,076
					50020030	Grade Crossing Replacement	$ 489,126.00	EA	Bid Item	7.0	$3,423,882	$684,776	$342,388	$4,451,047
					50020040	Grade Crossing Removal	$ 38,965.00	EA	Bid Item	2.0	$77,930	$15,586	$7,793	$101,309
					50020050	Crash Wall	$ 2,700.00	LF	Bid Item	659.0	$1,779,300	$355,860	$177,930	$2,313,090
					50020060	Grade Crossing Panels	$ 1,450.00	LF	Bid Item	1,181.0	$1,712,450	$342,490	$171,245	$2,226,185
					50020070	Grade Crossing Gates	$ 310,000.00	EA	Bid Item	8.0	$2,480,000	$496,000	$248,000	$3,224,000
					50010030	Movable Bridge Interface	$ 510,562.00	EA	Bid Item	1.0	$510,562	$102,112	$51,056	$663,731
					50010040	Signal Interface Modifications	$ 38,669.00	EA	Bid Item	2.0	$77,338	$15,468	$7,734	$100,539
		SYSTEMS Total								**1,866.0**	**$12,759,924**	**$2,551,985**	**$1,275,992**	**$16,587,901**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	80010000	Project Development	5.00%	%	Percentage	64,164,625.3	$3,208,231	$641,646	$320,823	$4,170,701
			80.02	Engineering	80020000	Engineering	9.00%	%	Percentage	64,164,625.3	$5,774,816	$1,154,963	$577,482	$7,507,261
			80.03	Project Management for Design and Construction	80030000	Project Management	6.00%	%	Percentage	64,164,625.3	$3,849,878	$769,976	$384,988	$5,004,841
			80.04	Construction Administration & Management	80040000	Construction Administration & Management	14.00%	%	Percentage	64,164,625.3	$8,983,048	$1,796,610	$898,305	$11,677,962
			80.05	Professional Liability and other Non-Construction Insurance	80050000	Professional Liability and Insurance	0.25%	%	Percentage	64,164,625.3	$160,412	$32,082	$16,041	$208,535
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	80060000	Legal; Permits; Review Fees by other agencies, cities, etc.	0.50%	%	Percentage	64,164,625.3	$320,823	$64,165	$32,082	$417,070
			80.07	Surveys, Testing, Investigation, Inspection	80070000	Surveys, Testing, Investigation, Inspection	0.50%	%	Percentage	64,164,625.3	$320,823	$64,165	$32,082	$417,070
			80.08	Start up	80080000	Start up	0.50%	%	Percentage	64,164,625.3	$320,823	$64,165	$32,082	$417,070
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total								**513,317,002.4**	**$22,938,854**	**$4,587,771**	**$2,293,885**	**$29,820,510**
										513,439,854.0	**$87,103,479**	**$17,420,696**	**$8,710,348**	**$113,234,522**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Bid Item	Activity	Unit Cost	Unit	Price Type	Sum of Quantity	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Mid Level Moveable Span (55 feet)	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	10040010	Bridges: North Approach Spans - Concrete	$ 380.00	SF	Bid Item	212,160.0	$80,620,800	$16,124,160	$8,062,080	$104,807,040
					10040020	Bridges: Station Spans - Concrete	$ 380.00	SF	Bid Item	77,000.0	$29,260,000	$5,852,000	$2,926,000	$38,038,000
					10040030	Bridges: North Flanking Span - Steel	$ 735.00	SF	Bid Item	1,280.0	$940,800	$188,160	$94,080	$1,223,040
					10040040	Bridges: Movable Span - Movable	$ 12,500.00	SF	Bid Item	2,560.0	$32,000,000	$6,400,000	$3,200,000	$41,600,000
					10040050	Bridges: South Flanking Span - Steel	$ 735.00	SF	Bid Item	1,280.0	$940,800	$188,160	$94,080	$1,223,040
					10040060	Bridges: South Approach Spans - Concrete	$ 380.00	SF	Bid Item	56,780.0	$21,576,400	$4,315,280	$2,157,640	$28,049,320
			10.11	Track: Ballasted	10110010	Ballasted Single Track	$ 380.00	TF	Bid Item	27,231.0	$10,347,780	$2,069,556	$1,034,778	$13,452,114
			10.12	Track: Special (switches, turnouts)	10120010	Turnout - #20	$ 300,000.00	EA	Bid Item	5.0	$1,500,000	$300,000	$150,000	$1,950,000
		GUIDEWAY & TRACK ELEMENTS Total								**378,296.0**	**$177,186,580**	**$35,437,316**	**$17,718,658**	**$230,342,554**
	20	STATIONS, STOPS, TERMINALS, INTERMODAL	20.02	Aerial station, stop, shelter, mall, terminal, platform	20021010	Construct new poured-in-place concrete platforms 1100 ft. long and 35' wide, 8'' THK with footings	$ 1,435.00	CY	Bid Item	1,129.3	$1,620,589	$324,118	$162,059	$2,106,765
					20021020	Provide platform canopy framing and columns	$ 59.45	SF	Bid Item	38,500.0	$2,288,825	$457,765	$228,883	$2,975,473
					20021030	Provide Standing Seam roof and fall arrest system	$ 44.25	SF	Bid Item	38,500.0	$1,703,625	$340,725	$170,363	$2,214,713
					20021040	Provide 1'' pressure treated plywood under metal standing seam roof	$ 8.00	SF	Bid Item	38,500.0	$308,000	$61,600	$30,800	$400,400
					20021050	Provide Metal Fisca/ flashing	$ 19.50	SF	Bid Item	38,500.0	$750,750	$150,150	$75,075	$975,975
					20021060	Provide Metal Gutter and leaders	$ 23.50	LF	Bid Item	4,270.0	$100,345	$20,069	$10,035	$130,449
					20021070	Platform Edge Tactile warning strip	$ 34.00	SF	Bid Item	4,400.0	$149,600	$29,920	$14,960	$194,480
					20021080	Platform Rubbing Board	$ 56.50	LF	Bid Item	2,200.0	$124,300	$24,860	$12,430	$161,590
					20021090	Provide Stainless steel wire mesh/ windsceen from existing station level to new elevated platform level	$ 55.00	SF	Bid Item	5,400.0	$297,000	$59,400	$29,700	$386,100
					20021100	Construct new steel street stairs (2-12 ft. rise, each 10 ft. wide and landings) including Aluminum threads,	$ 750,000.00	EA	Bid Item	2.0	$1,500,000	$300,000	$150,000	$1,950,000
					20021110	Egress Street Stairs up to platfrom level	$ 31.10	SF	Bid Item	3,640.0	$113,204	$22,641	$11,320	$147,165
					20021120	Construct ADA elevators from existing station to platform Level	$ 1,353,000.00	EA	Bid Item	1.0	$1,353,000	$270,600	$135,300	$1,758,900
					20021130	Provide Escalators from existing station to platform Level	$ 964,000.00	EA	Bid Item	2.0	$1,928,000	$385,600	$192,800	$2,506,400
					20021140	Provide Station Power (including incoming feeders, Power Panels, SEB, PLB, Distribution board for Normal	$ 697,500.00	EA	Bid Item	2.0	$1,395,000	$279,000	$139,500	$1,813,500
					20021150	Provide emergency lighting with battery backups, Normal and Reserve lighting system for stairs, Mezzanin	$ 52.50	SF	Bid Item	44,500.0	$2,336,250	$467,250	$233,625	$3,037,125
					20021160	Provide Public Address System and Customer Information System	$ 18.25	SF	Bid Item	44,500.0	$812,125	$162,425	$81,213	$1,055,763
					20021170	Communication / Telephone system with conduit	$ 94,500.00	LS	Lump Sum	1.0	$94,500	$18,900	$9,450	$122,850
					20021180	Provide CCTV system with conduit and wires	$ 7.75	SF	Bid Item	44,500.0	$344,875	$68,975	$34,488	$448,338
					20021190	Provide Fiber Optic work and Data Cabinet	$ 137,515.00	EA	Bid Item	1.0	$137,515	$27,503	$13,752	$178,770
					20021200	Provide station Sign/art work specialty	$ 86,250.00	LS	Lump Sum	1.0	$86,250	$17,250	$8,625	$112,125
					20021210	Station paint	$ 227,000.00	LS	Lump Sum	1.0	$227,000	$45,400	$22,700	$295,100
					20021220	Allowance for lead paint and asbestos abatement	$ 147,500.00	LS	Lump Sum	1.0	$147,500	$29,500	$14,750	$191,750
					20021230	Allowance for MPT	$ 165,000.00	LS	Lump Sum	1.0	$165,000	$33,000	$16,500	$214,500
		STATIONS, STOPS, TERMINALS, INTERMODAL Total								**308,552.3**	**$17,983,253**	**$3,596,651**	**$1,798,325**	**$23,378,228**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	40011010	Remove Track	$ 22.00	TF	Bid Item	9,646.0	$212,212	$42,442	$21,221	$275,876
					40011020	Remove Turnout	$ 7,000.00	EA	Bid Item	1.0	$7,000	$1,400	$700	$9,100
					10050010	Embankment	$ 15.00	CY	Bid Item	51,673.3	$775,100	$155,020	$77,510	$1,007,630
			40.02	Site Utilities, Utility Relocation	40028010	Provide new Roadway Lighting	$ 517,500.00	LS	Bid Item	1.0	$517,500	$103,500	$51,750	$672,750
					40020020	Utility Allowance	$ 2,800,000.00	LS	Bid Item	1.0	$2,800,000	$560,000	$280,000	$3,640,000
			40.05	Site structures including retaining walls, sound walls	10080010	Retaining Walls: North	$ 110.00	SF	Bid Item	19,683.6	$2,165,195	$433,039	$216,519	$2,814,753
					10080020	Retaining Walls: South	$ 110.00	SF	Bid Item	18,598.2	$2,045,800	$409,160	$204,580	$2,659,540
			40.07	Automobile, bus, van accessways including roads, parking lots	40071020	Mill and repavement of existing Roadway Option 2,3 and 4	$ 11.85	SF	Bid Item	180,000.0	$2,133,000	$426,600	$213,300	$2,772,900
			40.08	Temporary Facilities and other indirect costs during construction	40080020	Allowance for MOT / Mobilization	$ 1,483,000.00	LS	Lump Sum	1.0	$1,483,000	$296,600	$148,300	$1,927,900
		SITEWORK & SPECIAL CONDITIONS Total								**279,605.1**	**$12,138,807**	**$2,427,761**	**$1,213,881**	**$15,780,449**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	50010010	Interlocking	$ 1,283,545.00	EA	Bid Item	2.0	$2,567,090	$513,418	$256,709	$3,337,217
					50020010	Grade Crossing Programming	$ 10,272.00	EA	Bid Item	3.0	$30,816	$6,163	$3,082	$40,061
					50020020	Grade Crossing DAXing & Programming	$ 55,414.00	EA	Bid Item	4.0	$221,656	$44,331	$22,166	$288,153
					50020030	Grade Crossing Replacement	$ 489,126.00	EA	Bid Item	6.0	$2,934,756	$586,951	$293,476	$3,815,183
					50020040	Grade Crossing Removal	$ 38,965.00	EA	Bid Item	1.0	$38,965	$7,793	$3,897	$50,655
					50020050	Crash Wall	$ 2,700.00	LF	Bid Item	1,685.0	$4,549,500	$909,900	$454,950	$5,914,350
					50020060	Grade Crossing Panels	$ 1,450.00	LF	Bid Item	1,067.0	$1,547,150	$309,430	$154,715	$2,011,295
					50020070	Grade Crossing Gates	$ 310,000.00	EA	Bid Item	3.0	$930,000	$186,000	$93,000	$1,209,000
					50010030	Movable Bridge Interface	$ 510,562.00	EA	Bid Item	1.0	$510,562	$102,112	$51,056	$663,731
					50010040	Signal Interface Modifications	$ 38,669.00	EA	Bid Item	2.0	$77,338	$15,468	$7,734	$100,539
		SYSTEMS Total								**2,774.0**	**$13,407,833**	**$2,681,567**	**$1,340,783**	**$17,430,183**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	80010000	Project Development	5.00%	%	Percentage	220,716,472.2	$11,035,824	$2,207,165	$1,103,582	$14,346,571
			80.02	Engineering	80020000	Engineering	9.00%	%	Percentage	220,716,472.2	$19,864,482	$3,972,896	$1,986,448	$25,823,827
			80.03	Project Management for Design and Construction	80030000	Project Management	6.00%	%	Percentage	220,716,472.2	$13,242,988	$2,648,598	$1,324,299	$17,215,885
			80.04	Construction Administration & Management	80040000	Construction Administration & Management	14.00%	%	Percentage	220,716,472.2	$30,900,306	$6,180,061	$3,090,031	$40,170,398
			80.05	Professional Liability and other Non-Construction Insurance	80050000	Professional Liability and Insurance	0.25%	%	Percentage	220,716,472.2	$551,791	$110,358	$55,179	$717,329
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	80060000	Legal; Permits; Review Fees by other agencies, cities, etc.	0.50%	%	Percentage	220,716,472.2	$1,103,582	$220,716	$110,358	$1,434,657
			80.07	Surveys, Testing, Investigation, Inspection	80070000	Surveys, Testing, Investigation, Inspection	0.50%	%	Percentage	220,716,472.2	$1,103,582	$220,716	$110,358	$1,434,657
			80.08	Start up	80080000	Start up	0.50%	%	Percentage	220,716,472.2	$1,103,582	$220,716	$110,358	$1,434,657
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total								**1,765,731,777.6**	**$78,906,139**	**$15,781,228**	**$7,890,614**	**$102,577,980**
										1,766,701,005.0	**$299,622,611**	**$59,924,522**	**$29,962,261**	**$389,509,394**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Bid Item	Activity	Unit Cost	Unit	Price Type	Sum of Quantity	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
High Level Fixed Span (80 feet)	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	10040010	Bridges: North Approach Spans - Concrete	$ 380.00	SF	Bid Item	178,100.0	$67,678,000	$13,535,600	$6,767,800	$87,981,400
					10040060	Bridges: South Approach Spans - Concrete	$ 380.00	SF	Bid Item	96,900.0	$36,822,000	$7,364,400	$3,682,200	$47,868,600
					10040080	Bridges: North Approach Spans - Steel	$ 735.00	SF	Bid Item	31,200.0	$22,932,000	$4,586,400	$2,293,200	$29,811,600
					10040090	Bridges: Station Spans - Steel	$ 735.00	SF	Bid Item	77,000.0	$56,595,000	$11,319,000	$5,659,500	$73,573,500
					10040100	Bridges: Main Span - Steel, Main	$ 1,177.00	SF	Bid Item	4,080.0	$4,802,160	$960,432	$480,216	$6,242,808
			10.11	Track: Ballasted	10110010	Ballasted Single Track	$ 380.00	TF	Bid Item	27,231.0	$10,347,780	$2,069,556	$1,034,778	$13,452,114
			10.12	Track: Special (switches, turnouts)	10120010	Turnout - #20	$ 300,000.00	EA	Bid Item	5.0	$1,500,000	$300,000	$150,000	$1,950,000
		GUIDEWAY & TRACK ELEMENTS Total								**414,516.0**	**$200,676,940**	**$40,135,388**	**$20,067,694**	**$260,880,022**
	20	STATIONS, STOPS, TERMINALS, INTERMODAL	20.02	Aerial station, stop, shelter, mall, terminal, platform	20021010	Construct new poured-in-place concrete platforms 1100 ft. long and 35' wide, 8" THK with footings	$ 1,435.00	CY	Bid Item	1,129.3	$1,620,589	$324,118	$162,059	$2,106,765
					20021020	Provide platform canopy framing and columns	$ 59.45	SF	Bid Item	38,500.0	$2,288,825	$457,765	$228,883	$2,975,473
					20021030	Provide Standing Seam roof and fall arrest system	$ 44.25	SF	Bid Item	38,500.0	$1,703,625	$340,725	$170,363	$2,214,713
					20021040	Provide 1" pressure treated plywood under metal standing seam roof	$ 8.00	SF	Bid Item	38,500.0	$308,000	$61,600	$30,800	$400,400
					20021050	Provide Metal Fisca/ flashing	$ 19.50	SF	Bid Item	38,500.0	$750,750	$150,150	$75,075	$975,975
					20021060	Provide Metal Gutter and leaders	$ 23.50	LF	Bid Item	4,270.0	$100,345	$20,069	$10,035	$130,449
					20021070	Platform Edge Tactile warning strip	$ 34.00	SF	Bid Item	4,400.0	$149,600	$29,920	$14,960	$194,480
					20021080	Platform Rubbing Board	$ 56.50	LF	Bid Item	2,200.0	$124,300	$24,860	$12,430	$161,590
					20021090	Provide Stainless steel wire mesh/ windsceen from existing station level to new elevated platform level	$ 55.00	SF	Bid Item	5,400.0	$297,000	$59,400	$29,700	$386,100
					20021100	Construct new steel street stairs (2-12 ft. rise, each 10 ft. wide and landings) including Aluminum threads,	$ 750,000.00	EA	Bid Item	2.0	$1,500,000	$300,000	$150,000	$1,950,000
					20021110	Egress Street Stairs up to platfrom level	$ 31.10	SF	Bid Item	3,640.0	$113,204	$22,641	$11,320	$147,165
					20021120	Construct ADA elevators from existing station to platform Level	$ 1,353,000.00	EA	Bid Item	1.0	$1,353,000	$270,600	$135,300	$1,758,900
					20021130	Provide Escalators from existing station to platform Level	$ 964,000.00	EA	Bid Item	2.0	$1,928,000	$385,600	$192,800	$2,506,400
					20021140	Provide Station Power (including incoming feeders, Power Panels, SEB, PLB, Distribution board for Normal	$ 697,500.00	EA	Bid Item	2.0	$1,395,000	$279,000	$139,500	$1,813,500
					20021150	Provide emergency lighting with battery backups, Normal and Reserve lighting system for stairs, Mezzanin	$ 52.50	SF	Bid Item	44,500.0	$2,336,250	$467,250	$233,625	$3,037,125
					20021160	Provide Public Address System and Customer Information System	$ 18.25	SF	Bid Item	44,500.0	$812,125	$162,425	$81,213	$1,055,763
					20021170	Communication / Telephone system with conduit	$ 94,500.00	LS	Lump Sum	1.0	$94,500	$18,900	$9,450	$122,850
					20021180	Provide CCTV system with conduit and wires	$ 7.75	SF	Bid Item	44,500.0	$344,875	$68,975	$34,488	$448,338
					20021190	Provide Fiber Optic work and Data Cabinet	$ 137,515.00	EA	Bid Item	1.0	$137,515	$27,503	$13,752	$178,770
					20021200	Provide station Sign/art work specialty	$ 86,250.00	LS	Lump Sum	1.0	$86,250	$17,250	$8,625	$112,125
					20021210	Station paint	$ 227,000.00	LS	Lump Sum	1.0	$227,000	$45,400	$22,700	$295,100
					20021220	Allowance for lead paint and asbestos abatement	$ 147,500.00	LS	Lump Sum	1.0	$147,500	$29,500	$14,750	$191,750
					20021230	Allowance for MPT	$ 165,000.00	LS	Lump Sum	1.0	$165,000	$33,000	$16,500	$214,500
		STATIONS, STOPS, TERMINALS, INTERMODAL Total								**308,552.3**	**$17,983,253**	**$3,596,651**	**$1,798,325**	**$23,378,228**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	40011010	Remove Track	$ 22.00	TF	Bid Item	9,646.0	$212,212	$42,442	$21,221	$275,876
					40011020	Remove Turnout	$ 7,000.00	EA	Bid Item	1.0	$7,000	$1,400	$700	$9,100
					10050010	Embankment	$ 15.00	CY	Bid Item	52,133.3	$782,000	$156,400	$78,200	$1,016,600
			40.02	Site Utilities, Utility Relocation	40028030	Provide new Roadway Lighting	$ 517,500.00	LS	Bid Item	1.0	$517,500	$103,500	$51,750	$672,750
					40020030	Utility Allowance	$ 3,100,000.00	LS	Bid Item	1.0	$3,100,000	$620,000	$310,000	$4,030,000
			40.05	Site structures including retaining walls, sound walls	10080010	Retaining Walls: North	$ 110.00	SF	Bid Item	20,040.0	$2,204,402	$440,880	$220,440	$2,865,723
					10080020	Retaining Walls: South	$ 110.00	SF	Bid Item	15,819.1	$1,740,097	$348,019	$174,010	$2,262,126
			40.07	Automobile, bus, van accessways including roads, parking lots	40071020	Mill and repavement of existing Roadway Option 2,3 and 4	$ 11.85	SF	Bid Item	180,000.0	$2,133,000	$426,600	$213,300	$2,772,900
			40.08	Temporary Facilities and other indirect costs during construction	40080030	Allowance for MOT / Mobilization	$ 1,485,000.00	LS	Lump Sum	1.0	$1,485,000	$297,000	$148,500	$1,930,500
		SITEWORK & SPECIAL CONDITIONS Total								**277,642.4**	**$12,181,211**	**$2,436,242**	**$1,218,121**	**$15,835,574**
	50	SYSTEMS	50.02	Traffic signals and crossing protection	50010010	Interlocking	$ 1,283,545.00	EA	Bid Item	2.0	$2,567,090	$513,418	$256,709	$3,337,217
					50020010	Grade Crossing Programming	$ 10,272.00	EA	Bid Item	3.0	$30,816	$6,163	$3,082	$40,061
					50020020	Grade Crossing DAXing & Programming	$ 55,414.00	EA	Bid Item	4.0	$221,656	$44,331	$22,166	$288,153
					50020030	Grade Crossing Replacement	$ 489,126.00	EA	Bid Item	6.0	$2,934,756	$586,951	$293,476	$3,815,183
					50020040	Grade Crossing Removal	$ 38,965.00	EA	Bid Item	1.0	$38,965	$7,793	$3,897	$50,655
					50020050	Crash Wall	$ 2,700.00	LF	Bid Item	1,700.0	$4,590,000	$918,000	$459,000	$5,967,000
					50020060	Grade Crossing Panels	$ 1,450.00	LF	Bid Item	948.0	$1,374,600	$274,920	$137,460	$1,786,980
					50020070	Grade Crossing Gates	$ 310,000.00	EA	Bid Item	2.0	$620,000	$124,000	$62,000	$806,000
					50010040	Signal Interface Modifications	$ 38,669.00	EA	Bid Item	2.0	$77,338	$15,468	$7,734	$100,539
		SYSTEMS Total								**2,668.0**	**$12,455,221**	**$2,491,044**	**$1,245,522**	**$16,191,787**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	80010000	Project Development	5.00%	%	Percentage	243,296,624.3	$12,164,831	$2,432,966	$1,216,483	$15,814,281
			80.02	Engineering	80020000	Engineering	9.00%	%	Percentage	243,296,624.3	$21,896,696	$4,379,339	$2,189,670	$28,465,705
			80.03	Project Management for Design and Construction	80030000	Project Management	6.00%	%	Percentage	243,296,624.3	$14,597,797	$2,919,559	$1,459,780	$18,977,137
			80.04	Construction Administration & Management	80040000	Construction Administration & Management	14.00%	%	Percentage	243,296,624.3	$34,061,527	$6,812,305	$3,406,153	$44,279,986
			80.05	Professional Liability and other Non-Construction Insurance	80050000	Professional Liability and Insurance	0.25%	%	Percentage	243,296,624.3	$608,242	$121,648	$60,824	$790,714
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	80060000	Legal; Permits; Review Fees by other agencies, cities, etc.	0.50%	%	Percentage	243,296,624.3	$1,216,483	$243,297	$121,648	$1,581,428
			80.07	Surveys, Testing, Investigation, Inspection	80070000	Surveys, Testing, Investigation, Inspection	0.50%	%	Percentage	243,296,624.3	$1,216,483	$243,297	$121,648	$1,581,428
			80.08	Start up	80080000	Start up	0.50%	%	Percentage	243,296,624.3	$1,216,483	$243,297	$121,648	$1,581,428
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total								**1,946,372,994.4**	**$86,978,543**	**$17,395,709**	**$8,697,854**	**$113,072,106**
										1,947,376,373.1	**$330,275,167**	**$66,055,033**	**$33,027,517**	**$429,357,718**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Bid Item	Activity	Unit Cost	Unit	Price Type	Sum of Quantity	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Tunnel	10	GUIDEWAY & TRACK ELEMENTS	10.04	Guideway: Aerial structure	40070010	Construction of Temporary Bridge over intersection including removal atfer construction	$ 329.80	SF	Bid Item	4,000.0	$1,319,200	$263,840	$131,920	$1,714,960
			10.06	Guideway: Underground cut & cover	10071010	Excavation for Retaining walls on both sides of the Tunnel	$ 20.25	CY	Bid Item	240,889.0	$4,878,002	$975,600	$487,800	$6,341,403
					10071020	Disposal fee for excavated material	$ 295.00	Trucks	Bid Item	20,479.6	$6,041,470	$1,208,294	$604,147	$7,853,911
					10071030	Build Retaining walls at portal x 546LF, 25 High average 2' TH including, backfill, rebar's, form work & Conc	$ 835.00	CY	Bid Item	5,906.9	$4,932,236	$986,447	$493,224	$6,411,907
					10071040	Provide Flood gates on both sides of the Tunnel with Stop and log wall incl. testing and commissing	$ 628.32	SF	Bid Item	3,200.0	$2,010,609	$402,122	$201,061	$2,613,791
					10071050	Portal wall Light fixtures	$ 1,792.50	EA	Bid Item	362.0	$648,885	$129,777	$64,889	$843,551
					10071060	4'' RGS Conduit and wire for lighting	$ 51.25	LF	Bid Item	19,830.0	$1,016,288	$203,258	$101,629	$1,321,174
					10072010	Construction of Tunnel 40' OD (2 Tracks)	$ 166,372.89	LF	Bid Item	5,485.0	$912,555,326	$182,511,065	$91,255,533	$1,186,321,924
					10072020	Construction of Station Structure 1600'Lx68'Wx68'D including mezzanine Level	$ 800,000,000.00	EA	Bid Item	1.0	$800,000,000	$160,000,000	$80,000,000	$1,040,000,000
					10072030	Furnish & Install 12'' Dia pipe for Track Drainage in the middle of tracks	$ 69.00	LF	Bid Item	19,600.0	$1,352,400	$270,480	$135,240	$1,758,120
					10072040	Fiberglass Cat walk on both side of tunnel	$ 227.50	LF	Bid Item	19,600.0	$4,459,000	$891,800	$445,900	$5,796,700
					10072050	Connections to main Sewer System	$ 32,700.00	EA	Bid Item	6.0	$196,200	$39,240	$19,620	$255,060
					10072060	Provide Railing over the High bench both sides of the Tunnel	$ 1,462.50	LF	Bid Item	19,600.0	$28,665,000	$5,733,000	$2,866,500	$37,264,500
					10072070	Tunnel Lighting and power (Light fixture every 20' Zig ZAG and 80' Power receptacles)	$ 1,144.90	EA	Bid Item	710.0	$812,879	$162,576	$81,288	$1,056,743
					10073010	Excavation	$ 20.25	CY	Bid Item	4,740.7	$96,000	$19,200	$9,600	$124,800
					10073030	Construction of building structure 50'H above ground with floors and roof including rebar's, form work & (	$ 1,435.00	CY	Bid Item	191.3	$274,458	$54,892	$27,446	$356,796
					10073040	Finishes (inside and outside face brick) to Ventilization Shaft/ Building including flood gates	$ 1,995,085.00	LOC	Bid Item	2.0	$3,990,170	$798,034	$399,017	$5,187,221
					10073050	Provide Ventilization fans and other mechanical equipment	$ 1,600,000.00	LOC	Bid Item	2.0	$3,200,000	$640,000	$320,000	$4,160,000
					10073060	Provide MCC, Disconnect switches, conduit and wiring for ventilization fans and other mechanical equipme	$ 1,275,000.00	LOC	Bid Item	2.0	$2,550,000	$510,000	$255,000	$3,315,000
					10073070	Power and lighting for Ventilization building	$ 74.75	SF	Bid Item	5,000.0	$373,750	$74,750	$37,375	$485,875
					10073080	Communication work (fire alarm, CCTV, Telephone and introssion Acces Control System)	$ 192.50	SF	Bid Item	5,000.0	$962,500	$192,500	$96,250	$1,251,250
					10073100	Excavation for Pump Room pit 15'X15'x15'	$ 20.25	CY	Bid Item	125.0	$2,531	$506	$253	$3,291
					10073120	Construction of Pump room Pit walls (1.5' THK), floor (2') and roof including rebar's, form work & Concrete	$ 1,435.00	CY	Bid Item	75.0	$107,625	$21,525	$10,763	$139,913
					10073130	Finishes to Pump room including flood gate	$ 68,685.00	LOC	Bid Item	1.0	$68,685	$13,737	$6,869	$89,291
					10073140	Provide Sump Pumps, Pipes and Valves	$ 234,200.00	EA	Bid Item	3.0	$702,600	$140,520	$70,260	$913,380
					10073150	Provide MCC, Disconnect switches, conduit and wire for sump pumps	$ 1,005,000.00	LS	Lump Sum	1.0	$1,005,000	$201,000	$100,500	$1,306,500
					10073160	Power and lighting for Pump Room	$ 74.75	SF	Bid Item	300.0	$22,425	$4,485	$2,243	$29,153
					10073170	Communication work (fire alarm, Telephone and introssion Acces Control System)	$ 140.50	SF	Bid Item	300.0	$42,150	$8,430	$4,215	$54,795
			10.11	Track: Ballasted	10110010	Ballasted Single Track	$ 380.00	TF	Bid Item	27,245.0	$10,353,100	$2,070,620	$1,035,310	$13,459,030
			10.12	Track: Special (switches, turnouts)	10120010	Turnout - #20	$ 300,000.00	EA	Bid Item	5.0	$1,500,000	$300,000	$150,000	$1,950,000
		GUIDEWAY & TRACK ELEMENTS Total								**402,662.4**	**$1,794,138,490**	**$358,827,698**	**$179,413,849**	**$2,332,380,037**
	20	STATIONS, STOPS, TERMINALS, INTERMODAL	20.03	Underground station, stop, shelter, mall, terminal, platform	20031010	Construct new poured-in-place concrete platforms 1100 ft. long and 35' wide, 8'' THK with footings	$ 1,435.00	CY	Bid Item	1,223.4	$1,755,636	$351,127	$175,564	$2,282,327
					20031020	Platform Edge Tactile warning strip	$ 34.00	SF	Bid Item	4,400.0	$149,600	$29,920	$14,960	$194,480
					20031030	Platform Rubbing Board	$ 56.50	LF	Bid Item	2,200.0	$124,300	$24,860	$12,430	$161,590
					20031040	Station Platform and station Mezzanine Finishes	$ 55.00	SF	Bid Item	61,800.0	$3,399,000	$679,800	$339,900	$4,418,700
					20031050	Under pinning existing foundations including removals	$ 187,500.00	EA	Bid Item	4.0	$750,000	$150,000	$75,000	$975,000
					20031060	Construct four new concrete street stairs (2-12 ft. rise, each 10 ft. wide and landings) including Granite thr	$ 332,500.00	EA	Bid Item	2.0	$665,000	$133,000	$66,500	$864,500
					20031070	Construct four new concrete stairs from Mezzanine to Platform (3 -12 ft. rise, each 10 ft. wide and landing:	$ 557,500.00	EA	Bid Item	3.0	$1,672,500	$334,500	$167,250	$2,174,250
					20031080	Employee Facility (10 rooms) CMU block wall, including finishes	$ 1,025.00	SF	Bid Item	3,000.0	$3,075,000	$615,000	$307,500	$3,997,500
					20031090	Allowance for flood hardning for Egress Stairs, Vent Covers, Street Stairs etc.	$ 2,000,000.00	LS	Lump Sum	1.0	$2,000,000	$400,000	$200,000	$2,600,000
					20031100	Construct ADA elevators from Street Level to Mezz. (1) and Mezzanine to platform Level (1)	$ 1,353,000.00	EA	Bid Item	2.0	$2,706,000	$541,200	$270,600	$3,517,800
					20031110	Provide Escalators from street level to mezzanine level (2) and from mezzanine level to platform level (2)	$ 964,000.00	EA	Bid Item	4.0	$3,856,000	$771,200	$385,600	$5,012,800
					20031120	Provide plumbing work such as employes rest rooms, platform drainage and sewer ejector pumps	$ 19.25	SF	Bid Item	38,500.0	$741,125	$148,225	$74,113	$963,463
					20031130	Provide Fire Stand Pipe for Platfrom and mezzanine areas	$ 19.25	SF	Bid Item	41,500.0	$798,875	$159,775	$79,888	$1,038,538
					20031140	Provide HVAC system including duct work	$ 22.30	SF	Bid Item	41,500.0	$925,450	$185,090	$92,545	$1,203,085
					20031150	Provide Station Power (including incoming feeders, Power Panels, SEB, PLB, Distribution board for Normal	$ 697,500.00	EA	Bid Item	2.0	$1,395,000	$279,000	$139,500	$1,813,500
					20031160	Provide emergency lighting with battery backups, Normal and Reserve lighting system for stairs, Mezzanin	$ 52.50	SF	Bid Item	47,500.0	$2,493,750	$498,750	$249,375	$3,241,875
					20031170	Provide Public Address System and Customer Information System	$ 18.25	SF	Bid Item	44,500.0	$812,125	$162,425	$81,213	$1,055,763
					20031180	Communication / Telephone system with conduit	$ 94,500.00	LS	Lump Sum	1.0	$94,500	$18,900	$9,450	$122,850
					20031190	Provide CCTV system with conduit and wires	$ 7.75	SF	Bid Item	44,500.0	$344,875	$68,975	$34,488	$448,338
					20031200	Provide Fiber Optic work and Data Cabinet	$ 137,515.00	EA	Bid Item	1.0	$137,515	$27,503	$13,752	$178,770
					20031210	Provide Fire Alarm System	$ 23.25	SF	Bid Item	47,500.0	$1,104,375	$220,875	$110,438	$1,435,688
					20031220	Provide ticket vending machines	$ 34,400.00	EA	Bid Item	2.0	$68,800	$13,760	$6,880	$89,440
					20031230	Provide station Sign/art work specialty	$ 86,250.00	LS	Lump Sum	1.0	$86,250	$17,250	$8,625	$112,125
					20031240	Station paint	$ 227,000.00	LS	Lump Sum	1.0	$227,000	$45,400	$22,700	$295,100
					20031250	Allowance for Dewatering durning constuction	$ 10,800.00	Mos.	Bid Item	84.0	$907,200	$181,440	$90,720	$1,179,360
					20031260	Allowance for MOT	$ 10,300.00	Mos.	Bid Item	120.0	$1,236,000	$247,200	$123,600	$1,606,800
					20032010	Construction of a temoprary bridge from parking building to lounge area (230’L x 10’W x 22’H) and Stairs	$ 270.00	SF	Bid Item	2,300.0	$621,000	$124,200	$62,100	$807,300
					20032020	Demolition of temporary bridge atfer construction	$ 129.00	SF	Bid Item	2,300.0	$296,700	$59,340	$29,670	$385,710
					20032030	Excavation for new stairs, ADA elevators and escalators from Lounge Area (40'Lx30'Wx20'D)	$ 41.50	CY	Bid Item	888.9	$36,889	$7,378	$3,689	$47,956
					20032040	Disposal fee for excavated material	$ 295.00	Trucks	Bid Item	74.1	$21,851	$4,370	$2,185	$28,406
					20032050	Construct ADA elevators from Lounge are to Mezzanine Level	$ 1,353,000.00	EA	Bid Item	1.0	$1,353,000	$270,600	$135,300	$1,758,900
					20032060	Provide Escalators from Lounge area level to mezzanine level	$ 964,000.00	EA	Bid Item	2.0	$1,928,000	$385,600	$192,800	$2,506,400
					20032070	Construct of concrete stairs from Lounge area to Mezzanine (3 -12 ft. rise, each 10 ft. wide and landings) ir	$ 485,000.00	EA	Bid Item	1.0	$485,000	$97,000	$48,500	$630,500
					20032080	Emergency Generator Set 500KW	$ 616,000.00	EA	Bid Item	2.0	$1,232,000	$246,400	$123,200	$1,601,600
					20032090	Provide 4'' PVC Schedule 80 conduits in Duct Banks (5 conduits tunnel)	$ 13.85	LF	Bid Item	49,000.0	$678,650	$135,730	$67,865	$882,245
		STATIONS, STOPS, TERMINALS, INTERMODAL Total								**432,920.4**	**$38,178,966**	**$7,635,793**	**$3,817,897**	**$49,632,656**
	40	SITEWORK & SPECIAL CONDITIONS	40.01	Demolition, Clearing, Earthwork	40011010	Remove Track	$ 22.00	TF	Bid Item	9,063.0	$199,386	$39,877	$19,939	$259,202
					40011020	Remove Turnout	$ 7,000.00	EA	Bid Item	1.0	$7,000	$1,400	$700	$9,100
			40.02	Site Utilities, Utility Relocation	40028040	Provide new Roadway Lighting	$ 201,250.00	LS	Bid Item	1.0	$201,250	$40,250	$20,125	$261,625
					40020040	Utility Allowance	$ 8,000,000.00	LS	Bid Item	1.0	$8,000,000	$1,600,000	$800,000	$10,400,000
			40.07	Automobile, bus, van accessways including roads, parking lots	40071030	Mill and repavement of existing Roadway Tunnel Option	$ 11.85	SF	Bid Item	70,000.0	$829,500	$165,900	$82,950	$1,078,350
			40.08	Temporary Facilities and other indirect costs during construction	40080040	Allowance for MOT / Mobilization	$ 4,600,000.00	LS	Lump Sum	1.0	$4,600,000	$920,000	$460,000	$5,980,000
		SITEWORK & SPECIAL CONDITIONS Total								**79,067.0**	**$13,837,136**	**$2,767,427**	**$1,383,714**	**$17,988,277**

Segment Name	SCC Major No	SCC Major Name	SCC Code	SCC Minor Name	Bid Item	Activity	Unit Cost	Unit	Price Type	Sum of Quantity	Sum of Total Construction Cost	Sum of BY Allocated Contingency	Sum of BY UnAllocated Contingency	Sum of BY Budget Cost
Tunnel	50	SYSTEMS	50.02	Traffic signals and crossing protection	50010010	Interlocking	$ 1,283,545.00	EA	Bid Item	2.0	$2,567,090	$513,418	$256,709	$3,337,217
					50010020	Tunnel Station	$ 764,305.00	EA	Bid Item	1.0	$764,305	$152,861	$76,431	$993,597
					50020010	Grade Crossing Programming	$ 10,272.00	EA	Bid Item	4.0	$41,088	$8,218	$4,109	$53,414
					50020020	Grade Crossing DAXing & Programming	$ 55,414.00	EA	Bid Item	3.0	$166,242	$33,248	$16,624	$216,115
					50020030	Grade Crossing Replacement	$ 489,126.00	EA	Bid Item	6.0	$2,934,756	$586,951	$293,476	$3,815,183
					50020040	Grade Crossing Removal	$ 38,965.00	EA	Bid Item	1.0	$38,965	$7,793	$3,897	$50,655
					50020050	Crash Wall	$ 2,700.00	LF	Bid Item	1,270.0	$3,429,000	$685,800	$342,900	$4,457,700
					50020060	Grade Crossing Panels	$ 1,450.00	LF	Bid Item	952.0	$1,380,400	$276,080	$138,040	$1,794,520
					50020070	Grade Crossing Gates	$ 310,000.00	EA	Bid Item	2.0	$620,000	$124,000	$62,000	$806,000
					50010040	Signal Interface Modifications	$ 38,669.00	EA	Bid Item	2.0	$77,338	$15,468	$7,734	$100,539
			50.03	Traction power supply: substations	50031010	Excavation for Substation room foundation (20'Lx30'Wx25'D)	$ 20.25	CY	Bid Item	118.5	$2,400	$480	$240	$3,120
					50031020	Disposal fee for excavated material	$ 295.00	Trucks	Bid Item	9.9	$2,915	$583	$291	$3,789
					50031030	Construction of Substation Walls (1.0' THK concrete), floor (1.5') and roof including rebar's, form work & (	$ 1,435.00	CY	Bid Item	74.1	$106,290	$21,258	$10,629	$138,178
					50031040	Finishes to substation room including flood gate	$ 68,685.00	LOC	Bid Item	1.0	$68,685	$13,737	$6,869	$89,291
					50031050	Provide Louvers, small Sump Pumps, Pipes and Valves and AC system	$ 261,000.00	EA	Bid Item	1.0	$261,000	$52,200	$26,100	$339,300
					50031060	Provide Transformers (2), Circuit breakers (4), Disconnect switches, conduit and wire for sump pumps	$ 731,000.00	LS	Lump Sum	1.0	$731,000	$146,200	$73,100	$950,300
					50031070	Power and lighting for Ventilization building	$ 74.75	SF	Bid Item	600.0	$44,850	$8,970	$4,485	$58,305
					50031080	Communication work (fire alarm, CCTV, Telephone and introssion Acces Control System)	$ 192.50	SF	Bid Item	600.0	$115,500	$23,100	$11,550	$150,150
		SYSTEMS Total								**3,648.5**	**$13,351,824**	**$2,670,365**	**$1,335,182**	**$17,357,371**
	80	PROFESSIONAL SERVICES (applies to Cats. 10-50)	80.01	Project Development	80010000	Project Development	5.00%	%	Percentage	1,859,506,415.8	$92,975,321	$18,595,064	$9,297,532	$120,867,917
			80.02	Engineering	80020000	Engineering	9.00%	%	Percentage	1,859,506,415.8	$167,355,577	$33,471,115	$16,735,558	$217,562,251
			80.03	Project Management for Design and Construction	80030000	Project Management	6.00%	%	Percentage	1,859,506,415.8	$111,570,385	$22,314,077	$11,157,038	$145,041,500
			80.04	Construction Administration & Management	80040000	Construction Administration & Management	14.00%	%	Percentage	1,859,506,415.8	$260,330,898	$52,066,180	$26,033,090	$338,430,168
			80.05	Professional Liability and other Non-Construction Insurance	80050000	Professional Liability and Insurance	0.25%	%	Percentage	1,859,506,415.8	$4,648,766	$929,753	$464,877	$6,043,396
			80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	80060000	Legal; Permits; Review Fees by other agencies, cities, etc.	0.50%	%	Percentage	1,859,506,415.8	$9,297,532	$1,859,506	$929,753	$12,086,792
			80.07	Surveys, Testing, Investigation, Inspection	80070000	Surveys, Testing, Investigation, Inspection	0.005	%	Percentage	1,859,506,415.8	$9,297,532	$1,859,506	$929,753	$12,086,792
			80.08	Start up	80080000	Start up	0.005	%	Percentage	1,859,506,415.8	$9,297,532	$1,859,506	$929,753	$12,086,792
		PROFESSIONAL SERVICES (applies to Cats. 10-50) Total								**14,876,051,326.2**	**$664,773,544**	**$132,954,709**	**$66,477,354**	**$864,205,607**
										14,876,969,624.5	**$2,524,279,959**	**$504,855,992**	**$252,427,996**	**$3,281,563,947**