EXHIBIT "A"
SCOPE OF SERVICES

City of Tampa
Streetcar Extension and Modernization
Feasibility Study
FDOT FPID #437608 1 14 01
City of Tamp RFQ 16-D-00002

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BACKGROUND INFORMATION

The Tampa Historic Streetcar System is a 2.7 mile long streetcar transportation system within the city limits of the City of Tampa, Florida, that provides a unique connection from downtown Tampa and the Channelside District to the Ybor City historic district. The system was originally designed and constructed as a heritage system in an effort to replicate the historic feel of Ybor City and to be more appealing to the tourism industry.

The TECO Line Streetcar was created as a joint project of both HART and the City of Tampa. The roles and responsibilities of each agency are described in two governing documents; Interlocal Agreement for the Tampa-Ybor Historic Electric Streetcar Project (1998) and The Streetcar Tri-Party Agreement (2001).

Phase I, a 2.4-mile-long segment having a western terminus at the Southern Transportation Plaza and its eastern terminus along 8th Avenue at 20th Street, was opened for service in 2002. Phase II, a 0.3-mile-long extension from its current terminus along Franklin Street at Whiting Street to the Southern Transportation Plaza, was procured through design-build and opened for service in December 2010.

The City of Tampa's Center City Plan completed in 2012 recognized the need to extend the streetcar facilities and expand its operations to better serve the local population and to function as more than just a tourist attraction.

With this objective in mind, the City of Tampa is seeking to conduct a public transportation feasibility study for the extension and modernization of the Tampa Historic Streetcar. The feasibility study will evaluate how to best modernize and extend the streetcar system to integrate it as a viable transportation option for future downtown development by increasing the service area, providing extended hours and increasing the frequency of service. It will also define environmental and economic impacts allowing for future construction opportunities.

The study area is described as follows:

- The existing 2.7-mile long TECO Line heritage streetcar system from its western terminus at Whiting Station in downtown Tampa (at Whiting Street and Franklin Street) to its eastern terminus at Centennial Park Station in Ybor City;
- Extension of the streetcar system from its current western terminus at Whiting Station (at Whiting Street and Franklin Street) through downtown to Marion Transit Center (MTC) and potentially to Tampa Heights.

The feasibility study's baseline services which entail the corridor concept development and feasibility analysis will consist of the following services:

- Review of potential alignments, station locations, technologies, costs, benefits, and feasibility for the extension the Tampa Historic Streetcar;
- Evaluation of options to recommend the appropriate technology for modernization of the existing heritage streetcar facilities, including -
    - solutions to address the additional at-grade crossing of the CSX rail along Polk Street;

  - consideration of connectivity to potential future rail facilities extending to Tampa International Airport; and,
  - modifications to existing streetcar tracks along Old Water Street between Franklin Street and Morgan Street;
- Preparation of request letter for submittal to Federal Transit Administration (FTA) requesting entry into Project Development Phase under the Capital Investment Grant (CIG) funding program;

The following services will be included, subject to FTA approval to enter into Project Development (PD) Phase:

- Public involvement to establish local community support;
- Completion of the final alignment analysis process for determining a locally preferred alternative (LPA);
- Completion of environmental study in conformance with NEPA class of action process;
- Development of finance plan for funding of anticipated capital, operations and maintenance expenses;
- Completion of FTA application to enter into Engineering Phase of the project; and,
- Completion of TIGER Grant application for concurrent modernization of existing Tampa Historic Streetcar facilities.

Services are to be in conformance with FTA's "Proposed Interim Policy Guidance Federal Transit Administration Capital Investment Grant Program" dated April 2015, the National Environmental Policy Act (NEPA), and local and state planning and regulatory practices.

The Project Study Management Team will consist of:

- City of Tampa (Project Owner);
- Hillsborough Area Regional Transit Authority (HART) (Operating Agency); and,
- Florida Department of Transportation (FDOT) (Project Sponsor).

Other key stakeholders will include:

- CSX Corporation;
- Hillsborough County;
- Hillsborough Metropolitan Planning Organization for Transportation (MPO);
- Tampa Downtown Partnership (TDP).
- Tampa Hillsborough Expressway Authority (THEA)

General Scope of Work – The following is the general scope of work to be provided by the Consultant. The services are divided into Baseline Tasks (Concept Development and Feasibility Analysis) and Optional Tasks (Project Development and Environmental Study).

CONCEPT DEVELOPMENT AND FEASIBILITY ANALYSIS

TASK 1 – Study Management Work Plan

The Consultant will prepare a study management work plan for integrating and coordinating all elements of this study and to assure delivery of submittals in a timely manner and in accordance with the needs and requirements of the Study Management Team. The plan will also ensure early identification of issues and their effective resolution. The Study Management Plan will include the following key elements:

- **Quality Assurance/Quality Control (QA/QC)** -- The Consultant will prepare a plan clearly defining an internal process for ensuring high quality in all deliverables.

- **Project Schedule** – This schedule will be at the task level, showing when each task is expected to begin and be completed. The schedule should show all major deliverables and major milestones for the entire study.

- **Agency Coordination –** The Consultant will prepare a coordination plan that will keep all applicable Study participants and stakeholders informed of study progress and issues and will provide them with ample opportunity for input and direction to the study. This will include regular meetings and presentations to the Project Study Management Team. These presentations will occur at major milestones in the study and at other key points.

- **Regular Progress Meetings** -- The Consultant will participate in regular monthly progress meetings with the Project Study Management Team. In addition to the monthly meetings, additional progress meetings may be scheduled as necessary.

- **FTA Coordination –** It is critical to the success of this study that close coordination be maintained with the Federal Transit Administration (FTA) from the onset. The purpose of this coordination is to keep FTA informed of study progress throughout the course of the study, and to seek guidance and direction from FTA both at the beginning of the study (in terms of overall scope and study process) and throughout the study. Key project deliverables will be shared with FTA for review and comment, including documents related to (1) Purpose and Need, (2) Alternatives Definition and Evaluation, (3) Travel Demand Forecasting, and (4) New Starts Evaluation Criteria. The Consultant will be required to advise the Project Study Management Team as to the appropriate level and type of coordination with FTA needed for this study, develop an overall schedule for coordination meetings and workshops with FTA, and assist representatives of the Project Study Management Team in conducting all coordination meetings with FTA, including preparing all necessary materials.

TASK 2 – Public Involvement

The Consultant will prepare a community outreach plan to ensure that the concerns and issues of those with a stake in the proposed transit corridor are identified and addressed. The public outreach program for this study will have two elements;

- **Public Involvement Plan** – The Consultant will create and implement a comprehensive Public Involvement Plan (Plan) for the project that is consistent with the requirements and expectations of FTA for a New Starts/Small Project Development. The Plan will detail efforts to communicate and involve passengers, residents and businesses, stakeholder groups, local communities along the proposed corridors, and other impacted local jurisdictions and agencies. The Consultant will conduct workshops at critical points in the study at the direction of the Project Study Management Team. At minimum there will be a workshop near the end of the study to present study findings and recommendations. The purpose of these workshops will be both to inform the public of study progress, findings and recommendations and to allow the public to provide feedback.

- **Agency Outreach** - Consultant will conduct or participate in a series of meetings and/or workshops with major public agencies impacted by the proposed transit corridor study. These will include CSX Corporation, Hillsborough County MPO, Tampa Downtown Partnership, Hillsborough County, and THEA. Presentations to other organizations may be required at the direction of Project Study Management Team. The Consultant will conduct or participate in a series of meetings and/or workshops with major public agencies impacted by the proposed transit corridor. The purpose of these meetings will be to inform the agencies of study progress, findings and recommendations, to solicit input about their issues, concerns, and opinions, to discuss unresolved issues, and to attempt to resolve potential conflicting opinions. For both the public workshops and the agency meetings, the Consultant will prepare all materials for the workshops. The Consultant will coordinate with all Project Study Management Team to ensure that agenda, presentations, and materials for distribution are all consistent with each agency's formats and practices.

TASK 3 – Existing and Future Conditions Documentation

The Consultant will document existing and future (2040) conditions in the study area to:

- provide a detailed understanding of the area around the corridor including its transportation problems and needs and opportunities;
- identify conditions that are conducive to, or an impediment to, implementation of transit service through the area; and,
- provide the necessary information for the evaluation of mobility, community, economic development, and environmental impacts of alternative alignments considered in this study.

- ♦ **Study Area Conditions and Characteristics** – The Consultant will gather, review and summarize all previous reports regarding transportation plans and issues, land use, and economic development in the area. Specific focus will be on the MPOs' 2035 LRTP, the TBARTA Master Plan, recent TDPs, and current comprehensive plans. The data to be compiled by the Consultant will include but is not limited to the following:

    - Base mapping for the study area.
    - Recent aerial photography and photo-imaging.
    - Existing and planned transportation facilities and services, including system characteristics, traffic volumes and transit ridership, park and ride lots and other major parking facilities, travel speeds, levels of service, and other congestion related issues.
    - Land use data, including current land use patterns, major activity generators, future land use plans, and major developments proposed by developers. The Consultant may identify additional data that needs to be compiled to successfully complete this study.
    - Socioeconomic data, including employment, population, households and demographic characteristics, and environmental justice constituencies (based on income and minority status)

    The Consultant may identify additional data that needs to be compiled to successfully complete this study.

- ♦ **Issues and Opportunities –**The Consultant will review the information and document transportation problems and needs in the area as well as potential opportunities within or near the corridor for improving transportation conditions.

TASK 4 – Purpose and Need Statement

The Consultant will develop a Purpose and Need Statement that establishes the problems to be addressed in the study, serves as a basis for developing goals and objectives and evaluation criteria for the study, and provides a framework for determining which alternatives should be considered. The Purpose and Need Statement must be consistent with FTA New/Small Starts criteria and must address current and future (2040) conditions, including:

- **Overall problem** – The Consultant will outline at a minimum some of the following issues which may need to be resolved and addressed such as:
  - Transportation conditions within or affected by the study area.
  - Land use and development issues contributing to the problem.
  - Mobility and access deficiencies for which solutions are being sought.
  - Economic development opportunities that may be enhanced by the transportation system.

- **Development of study objectives** – The Consultant will recommend a set of study goals and objectives consistent with the Purpose and Need Statement. These goals and objectives will serve as the benchmark against which the performance of each alternative alignment is measured. The Consultant will coordinate closely with the Project Study Management Team in the development of study goals and objectives. The goals and objectives should be specific to the Purpose and Need of this study. The goals and objectives must be approved by the Project Study Management Team. The Project Study Management Team will determine how the goals and objectives should be presented to the stakeholders and the level and method of involvement the stakeholders will have in approving the goals and objectives.

- **Evaluation Criteria –** Potential evaluation measures include, but are not limited to:
  - Estimates of potential ridership.
  - Environmental impacts.
  - Community and economic development impacts and opportunities.
  - Transit speed, efficiency and travel time savings.
  - Mobility and transportation system user benefits and impacts.

- **Framework for establishing alternatives –** The Consultant will prepare an analysis, consistent with the New/Small Starts Program, comparing the transportation, community, economic and environmental impacts of the alternatives to assist the Project Study Management Team in determining the alternative that best addresses the project goals and objectives.

- **New/Small Starts Criteria** – The evaluation of alternatives will utilize the information developed during the previous tasks to weigh each alternative alignment against the measures of effectiveness in the purpose and need statement. The end product of this evaluation will be to identify and reach consensus on the LPA to be carried into the New/Small Starts process.

TASK 5 – Initial Alternative Alignments Development

The Consultant will develop alternatives to be considered. Alternative scenarios will be ranked based on a number of criteria and evaluation factors, such as public interest, ridership, engineering, cost, effects on traffic operations, environmental justice considerations, future land use and economic development potential, and how well the alternatives meet the City's adopted long range goals. The alternatives will include:

- **No Build Alternative** – This alternative consists of the existing transit services and any currently committed improvements likely to exist in the forecast year.

- **Build Alternatives** – These include combinations of various north-south streets within the Central Business District to extend the streetcar system in the vicinity of the Marion Transit Center.

TASK 6 – Evaluation Plan

The Consultant will prepare an evaluation plan that defines the evaluation criteria and measurement tools to be utilized to evaluate the alternatives. The evaluation criteria should consider impacts and influences on transportation systems, mobility, and travel patterns as well as compatibility with, natural, manmade and social environments. The criteria should also consider the potentials for and influences on opportunities for transit oriented development. The categories of criteria for this evaluation should include, but not be limited to:

- Effectiveness – the extent to which alternatives solve the identified transportation problems in the corridor.
- Impacts – the extent to which alternatives impact, positively or negatively, nearby natural resources and neighborhoods, air quality, the adjacent transportation networks and facilities, land use, the local economy, transit oriented development, and other identified issues and concerns.
- Cost effectiveness – the extent to which the costs of the alternatives are commensurate with their benefits.
- Financial feasibility – the extent to which funds that are required to build and operate the alternatives are likely to be available.
- Equity – whether the costs and benefits of alternatives are distributed fairly across different population groups.

Consultant will further refine the alternatives and the methods to be used in the analysis. The Evaluation Plan will include a clear definition of the criteria to be used in the detailed evaluation together with a clear explanation of the methodology to be used in applying the criteria and performing the evaluations. This step is to ensure that all participants in the process are in general agreement with the alignment alternatives and analytical methodologies before the technical analysis process is undertaken. Specific methodology reports/memoranda include:

- Travel Demand Forecasting
- Traffic Impact Analysis
- Noise and Vibration
- Air Quality
- Social and Economic Impact Assessment
- Environmental and Natural Resource Impact Assessment
- Land Use
- Capital Costing
- Operations and Maintenance Costing
- Financial Analysis
- Evaluation of Alternatives
- Public Participation

TASK 7 – Evaluation of Environmental and Community Issues

The Consultant will identify and describe the potential social, economic, and environmental impacts of each alternative. While the intent is not to conduct a full formal NEPA analysis, the Consultant will identify potential environmental and community impacts that most likely cannot be reasonably mitigated. The methodology used should be appropriate for eventual incorporation into the optional NEPA process.

- **Factors to include**
  - Air quality.
  - Hydrology/water quality.
  - Soils and unique geological features.
  - Noise, vibration, light and turbulence.
  - Wildlife habitat and vegetation.
  - Archeological and historic sites.
  - Land use --compatibility with existing land use and adopted land use and development plans and policies.
  - Neighborhood impacts and displacements.
  - Economic development.
  - Safety.
  - Energy Consumption.
  - Environmental Justice – impacts on low income and minority constituencies.
  - Traffic impacts – impacts on traffic operations and safety.

- **Transit Supportive Land Use and Future Patterns -** Measured by existing land use, transit supportive plans and policies, and the performance and impacts of policies.

TASK 8 – Conceptual Design

The Consultant will prepare a conceptual design for each alternative. The conceptual design should include, at minimum, the following items:

- A brief description and mapping of the alignment (horizontal and vertical)

- Typical cross sections
- Right-of-way requirements and impacts
- Station locations and characteristics (platform length and capacity, park and ride capacity, etc.)
- Identification of known utilities
- Key geometric constraints
- Trails and other significant pedestrian/bicycle amenities
- Feeder bus service

The level of detail for the conceptual designs should be sufficient to establish key differences among the alternatives, ensure an acceptable degree of confidence in the capital and operating/maintenance costs, and support assessment of environmental impacts. The intent is to provide a similar level of precision for all alternatives, but to avoid a level of detail more appropriate to project development.

TASK 9 – Evaluation of Existing System Modernization Options

The consultant will evaluate the design and right-of-way requirement options for upgrading of existing streetcar facilities and provide specific recommendations for the appropriate technology for modernization of the existing heritage streetcar facilities, including the following:

- Modern streetcar vehicle requirements;
- Modern streetcar vehicle options including preferred vehicle type, and number of vehicles required to provide increased levels and frequency of service,
- Technology options to address the additional at-grade crossing of the CSX rail along Polk Street;
- Compatibility with potential future rail system extending to Tampa International Airport;
- Right-of-way requirements for track upgrades to accommodate recommended modern streetcar vehicle;
- Modifications to existing streetcar tracks along Old Water Street between Franklin Street and Morgan Street to improve pedestrian facilities;
- Traction Power Systems Upgrades – including analysis and modeling to determine the appropriate traction power system for the streetcar extension and upgrades and upgrade to overhead contact system for the existing streetcar system;
- Station upgrades necessary to accommodate modern streetcar vehicles;
- Maintenance and storage facility renovation or replacement - including evaluation of potential locations and cost for property acquisition for new facilities, and;
- Updated capital costs.

TASK 10 – Preparation of Request Letter to FTA

At the conclusion of the Feasibility Study Consultant will prepare the Request Letter and supporting documentation for the City to submit to FTA's Office of Planning and Environment for approval to enter Project Development and Environmental Study Phase.

Upon receipt of complete information from the project sponsor, FTA will submit a letter within 45 days indicating the sufficiency of the information for entry into Project Development to both the project sponsor and Congress per the direction in MAP 21.

PROJECT DEVELOPMENT AND ENVIRONMENTAL STUDY (OPTIONAL)

TASK 11– Public Involvement (OPTIONAL)

The Consultant will conduct a number of public outreach meetings and stakeholder briefings to obtain feedback on the route alternatives. The Environmental Assessment will include a detailed description of the public outreach efforts. The following tasks will be provided under this service:

- Project newsletter
- Public workshop on refined alternative
- Technical support during Public Hearing

TASK 12 – Operational Plans (OPTIONAL)

The Consultant will develop detailed operational plans for all alternatives advanced from the initial screening process. The operational plans should include, at minimum, the following items:

- Station locations.
- Travel times (station to station).
- Headway frequency by time period.
- Fare structure.
- Hours of service.
- Type of vehicles.
- Number of vehicles required.
- Line-haul capacity.
- Number of vehicle miles travelled.
- Number of vehicle hours travelled.

The Consultant should coordinate with HART and Hillsborough MPO to obtain relevant information. The level of detail for the operational plans should be sufficient to establish key differences among the alternatives, ensure an acceptable degree of confidence in the operating/maintenance costs. The intent is to provide a similar level of precision for all alternatives, but to avoid a level of detail more appropriate to preliminary engineering and project development.

TASK 13 –Ridership Forecasts (OPTIONAL)

This task involves forecasting of travel demand for alternatives being analyzed in the work effort. The Consultant in cooperation with the Project Study Management Team, will refine the travel demand forecasting model to enable forecasts to be produced at the corridor level that are consistent with federal New/Small Starts requirements.

The work efforts to be undertaken in this task include development of a work program for the model effort, model input review, validation and calibration, preparation of forecasts for several alternatives and summarizing key performance data for each alternative. The TBRTM will be used as the model structure for all ridership forecasts for this study.

Very early in the study, the Consultant and representative members of the Project Study Management Team will meet with FTA to discuss the modeling efforts for this study and to obtain FTA's advice and guidance on any changes or improvements that need to be made to the model. The Consultant, using the Transit Modeling Team, will perform the necessary calibration and model validation for this study consistent with the guidance from FTA.

The Consultant will develop ridership forecasts for each alternative alignment advanced from the initial screening process. These ridership forecasts will be for the project opening year and for other years as directed by the Project Study Management Team. The Project Study Management Team, with advice from the Consultant, will determine the projected opening year and the future horizon year for forecasting ridership.

The Consultant may be required to develop an initial set of forecasts using FTA's Aggregate Rail Forecasting (AARF) Model. These forecasts will give an idea of the range of potential ridership that may be expected from rail transit in the study area and may provide some target ridership levels to aim for in the development of more detailed alternatives. The Consultant will then use the TBRTM model to prepare more detailed ridership forecasts for each alternative.

The Consultant will analyze the ridership for each alternative and determine if additional refinements and modifications need to be made to networks and operating characteristics in order to reasonably improve ridership. The objective is to optimize ridership forecasts for each alternative. Any refinements of modifications to the alternatives must be approved by the Project Study Management Team.

The Consultant will document the ridership forecast results for each alternative. The Consultant will report the following information:

- Total trips by mode, trip purpose and time period
- Total unlinked transit trips by trip purpose, time period, boarding/alighting by station, and mode of access and parking demand by station
- Number of vehicle miles traveled
- Passenger miles traveled
- Passenger revenues
- Travel time savings
- Reductions in vehicle miles traveled

In addition, FTA's Summit program will be run for each alternative. Summit is designed to provide critical information to estimate user benefits in terms of travel time and cost savings. The Summit reports together with thematic maps will serve as a diagnostic tool for review of the operating plan of each alternative and impact of each alternative on affected travel markets in terms of transit travel times and costs. The TBRTM is designed to provide the necessary inputs for Summit. The Transit Modeling Team will run the Summit program for each alternative and provide the information to the Consultant for review and reporting.

Throughout all phases of this effort the Consultant will work in close coordination with the Project Study Management Team, providing them with information about the ridership and performance of each tested alternative and obtaining their input and direction on how to better refine alternatives in order to improve ridership and performance.

TASK 14– Capital Costs Estimates (OPTIONAL)

The Consultant will provide capital cost estimates in accordance with FTA Standard Cost Category (SCC) estimate format. The Consultant will report both the present day costs (2015) and the projected opening year or earlier costs. The Consultant will document the method used for escalating costs (inflation rates, etc.). If a more specific estimated date of opening of service is determined, the Consultant may be required to escalate or back down the capital costs to the new date.

The Consultant will develop an opening year (developed for year 2010 and escalated to the opening year) capital cost estimate for all alternatives advanced beyond the initial screening. T he Project Study Management Team, with advice from the Consultant, will determine the projected opening year. At minimum the capital costs should include the following:

- Guideway.
- Stations.
- Vehicles.
- Utilities.
- Structures.
- Right-of-way.
- Electrification.
- Signals/communications.
- Maintenance facilities.
- Command Center.
- Contingencies.

TASK 15 – Operating and Maintenance Cost Estimates (OPTIONAL)

The Consultant will prepare and update an operating and maintenance cost model to incorporate recent service and financial data for the service area. The Consultant will determine the most applicable model, historical cost data for applicable transit modes and recommend revisions to the model to address the most recent New/Small Starts criteria and program changes to provide an informed monetary evaluation of the long term costs associated with each alternative.

- **Opening Year Annual Operating and Maintenance Costs** -- The Consultant will develop an opening year annual (developed for year 2015 and escalated to the opening year) estimate of operating and maintenance costs for all alternatives advanced beyond the initial screening. The Project Study Management Team, with advice from the Consultant, will determine the opening year. At minimum the capital costs should include the following:
    - Transit and streetcar operations;
    - Maintenance of equipment and facilities;
    - Insurance;
    - Administration; and,
    - Marketing.

- **Life cycle costs** – In addition to opening year costs, the Consultant will prepare and document 20-year life cycle costs (that is, escalated costs for each year from opening year to twenty years later). The Consultant will report both the Present Day Costs (2010) and the projected opening year costs. The Consultant will document the method used for escalating costs (inflation rates, etc.). If a more specific estimated date of opening of service is determined, the Consultant may be required to escalate or back down the capital costs to the new date.

- **Start-up Costs** – In addition, the Consultant will prepare estimates of start-up costs necessary to get the transit system operational. These may include costs for hiring and training of staff, system testing, marketing, safety reviews and testing, and other relevant start-up costs. The Consultant will develop estimates of start-up costs for the necessary time period leading up to and through the opening year for each alternative advanced beyond the initial screening,

TASK 16 – Evaluation of Alternatives and Selection of LPA (OPTIONAL)

The Consultant will prepare an analysis, consistent with the New Starts Program requirements, comparing transportation, social, economic, and environmental impacts for all alternatives evaluated. The analysis will summarize the benefits and costs of the alternatives against the stated study goals and objectives. To the extent possible, the evaluation measures should be quantitative, using such measurements as:

- Effectiveness in achieving the project's mobility and access goals.
- Efficiency in supporting and supplementing the total transportation system of the study area.
- Financial feasibility.
- Equity.
- Implied or required environmental and land use trade-offs.

The factors against which the Consultant will evaluate the alternatives include, but are not limited to:

- Capital costs.
- Operating and maintenance costs.
- Estimated ridership.
- Cost-effectiveness.
- Transit speed, efficiency and travel time savings.
- Overall impact on existing transit operations and other modes.
- The effectiveness and efficiency of a connection to future rail system to TIA.
- Environmental impacts.
- Impact on economic development.
- Impacts on roadway infrastructure and vehicular traffic.

The Consultant should consider but not limit the study's evaluation measures to those used by the FTA, which include:

- **Mobility Improvements** – Measured by travel time benefits per projected passenger mile, low income households served, and employment near stations.
- **Environmental Benefits** - Measured by change in regional pollution emissions, change in regional energy consumption, and EPA Air Quality Designation.
- **Cost Effectiveness** - Measured as cost per hour of travel time saved.
- **Operating Efficiencies** - Measured by system operating cost per passenger mile.
- **Transit Supportive Land Use and Future Patterns** - Measured by existing land use, transit supportive plans and policies, and the performance and impacts of policies.

TASK 17– Alternatives Analysis Study Report (OPTIONAL)

The Consultant will document the process leading to the selection of a LPA. The LPA report will include a summary of the Purpose and Need, study goals and objectives, identification of the transportation problems and opportunities in the corridor, alternatives considered, evaluation methodology and rationale for choosing the LPA. The LPA shall be described in sufficient detail, including information on the alignment, right-of-way requirements and impacts, vehicles, vehicle storage and maintenance facility, station and/or stop location, traffic impacts, ridership forecasts, capital and operating costs, and future connection opportunities.

The financial plan for the LPA should demonstrate how the City and HART will be able to construct, operate, and maintain the existing and future transit system. The financial plan should be developed in a manner consistent with FTA's Guidance for Transit Financial Plans and should document the recent financial history of the agency, describe its current financial health, document costs and revenues, and demonstrate the reasonableness of the key assumptions underlying these projections. The financial plans should include the capital, operating and maintenance cash flow requirements over a twenty-year horizon.

TASK 18 – Conceptual Engineering (OPTIONAL)

Consultant will prepare updated conceptual engineering plans for the recommended LPA and existing system upgrades including:

- Revised conceptual plans and costs
- Station area traffic analysis tech memo
- Drainage report
- Updated ridership projections
- Updated travel demand methodology tech memo
- Updated technology recommendations for modernization

TASK 19 – Environmental NEPA Process (OPTIONAL)

Consultant will prepare a draft environmental document to intiate the review process required by the National Environmental Policy Act of 1969 (NEPA). The environmental analysis will be performed in accordance with the National Environmental Policy Act (NEPA) – (40 CFR §§ 1500–1508) and will be consistent with the following:

- Council on Environmental Quality (CEQ) guidance document: Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.
- Section 106 – Section 106 of the National Historic Preservation Act (Federal historic preservation regulations)
- Title VI of the Civil Rights Act of 1964 regarding programs and activities receiving federal financial assistance.

The environmental impacts of the Tampa Streetcar LPA will be summarized for the following factors. The alternative of not constructing the project – the No Action Alternative will be considered in this phase as a baseline against which the Streetcar Extension and Modernization LPA is compared. For each resource evaluated, both the potential impacts of the Streetcar Extension LPA and the No Action Alternative are to be discussed. The following list summarizes the factors against which the LPA will be evaluated.

1. Social and Economic Factors
2. Land Use and Property Impacts
3. Economic Development
4. Environmental Justice
5. Historic and Archaeological Resources
6. Aesthetics
7. Section 4(f) Resources (Parks, Historic Lands, and Wildlife Refuges)
8. Safety and Security
9. Physical Factors
10. Air Quality
11. Noise and Vibration
12. Hazardous Materials
13. Traffic and Transportation
    a. Vehicular Traffic
    b. Transit
    c. Bikes and Pedestrians

   d. Parking
   e. Driveways
14. Construction Impacts
15. Utility Impacts
16. Energy Use
17. Stray Current and Corrosion
18. Livability and Sustainability Measures
19. Water Quality/Resources
20. Wetlands and Floodplains
21. Biological Impacts
22. Coastal Zone Management
23. Indirect Effects
24. Identification and Analysis of Indirect Effects
25. Consequences and Mitigation Measures
26. Cumulative Effects

TASK 20- Implementation Plan (OPTIONAL)

Consultant, in coordination with the Study Management Team, will develop an implementation plan for the LPA for the extension and the recommended modernization options including:

- Financial Plan
- Request inclusion in MPO Cost Feasible Plan
- Updated environmental tech memos
- Draft environmental documents

TASK 21 – New/Small Starts Application Submittal Package (OPTIONAL)

The Consultant will compile information prepared in previous tasks for submittal to FTA to enable FTA to evaluate and rate the Streetcar Extension among the Small/New Starts applications. The submittal documents shall be in conformance with "Reporting Instructions for the Section 5309 Small Starts Criteria" and will include:

- General Reporting Information
    - Project Background Information
        - Project Description (alignment, station locations, maintenance yard and shop, systems)
        - Project Narrative
        - Project Maps
    - Travel forecasts (user benefit forecasts).
    - Operations and Maintenance Costs Estimates.
    - Capital Costs Estimates using FTA Standard Cost Categories (SCC) worksheets in original formats.
- Project justification Criteria
    - Mobility Improvements
    - Cost Effectiveness (current year and horizon year index)
    - Congestion Relief

- Land Use (transit supportive existing and future patterns)
- Economic Development
- Environmental Benefits

- Local Financial Commitment Criteria
  - Current Condition (Capital and Operating)
  - Local Financial Commitment of Funds (Capital and Operating; 20 year cash flow, audited financial statements).
  - Reliability/Financial Capacity (Capital and Operating)

Any Tampa Bay Regional Transit Model (TBRTM) uncertainties will need to be addressed related to ridership estimates as a means of assessing the reliability of the forecasts which would require review with FTA to ensure compliance with proposed federal regulations.

TASK 22 – TIGER Grant Application Submittal Package (OPTIONAL)

The Consultant will compile information from studies, analysis, modeling and evaluation prepared in previous tasks for submittal to enable FTA to evaluate and rate the Existing Streetcar Modernization among the TIGER Grant applications.

PROJECT DELIVERABLES

Phase 1 Feasibility Analysis

Study Management Plan
Existing and Future Conditions Report
Purpose and Need Statement
Evaluation Criteria Technical Memorandum
Alternative Alignments Technical Memorandum
Evaluation Plan
Alignment Environmental Screening and Evaluation Report
Concept Plans
Request Letter to FTA

Phase 2 Optional Services

Operational Plans Technical Memorandum
Locally Preferred Alternative (LPA) Selection Report
Existing System Modernization Report
Conceptual Design Report
Maintenance Facility Technical Memorandum
Capital Cost Estimates Technical Memorandum
Operations and Maintenance Cost Estimates Technical Memorandum
Ridership Projections and Travel Demand Model Report
Environmental Justice Technical Memorandum
Cultural Resources Technical Memorandum
Socioeconomic and Land Use Technical Memorandum
Parks and Public Lands Tech
Final Study Report with final results and recommendations
Draft NEPA Document for Extension
TIGER Grant Application for Modernization
Application submittal package to Enter into Design/Engineering Phase

PROJECT SCHEDULE

The scope of work is to be completed within 18 months of notice to proceed for this contract. Following are key Milestone Activities:

Milestone	Est. Duration
Phase 1 Feasibility Analysis	
Concept Development and Feasibility Analysis	6 months
Submit Request Letter to FTA	tbd
FTA Review of Request Letter	45 days
FTA Approval to Enter Project Development and Class of Action Determination	tbd
Phase 2 LPA and NEPA Process (Optional Services)	
Selection of LPA and Modernization Technology and Completion of Draft NEPA Documents	8 months
Submit Draft NEPA Document and TIGER Grant Application for FTA Review	2 weeks
FTA Review of LPA and Draft NEPA Document	3 months
NEPA Public Hearing Process	tbd
Submit Application to FTA to Enter Engineering Phase	tbd

CITY OF TAMPA
FINAL TECO Streetcar Infrastructure Assessment
Traction Power and Overhead Contact Systems
Trackway Elements

Prepared by:

URS Corporation Southern

July 14, 2014

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EXECUTIVE SUMMARY

The scope of work and estimated costs associated with the capital maintenance for the TECO Line Streetcar System for the next 30 years are discussed below. The recommendations made are based on the 40-year life expectancy of the system, information gathered through field inspections, documentation reviews, employee interviews, past experience on similar projects, and rail industry suppliers.

The primary goal of the report is to estimate the capital expenditure required to maintain safe and efficient operation of the TECO Line Streetcar system for the next 30 years. In order to accomplish this goal, the recommended limited scope of work for the Capital Maintenance Budget includes:

- Reconditioning or replacing components exhibiting deterioration, damage or obsolescence.
- Rectifying known maintenance problems in the current system.
- Anticipating the life cycle of various specific components based on manufacturer recommendations and experience elsewhere.

Table 1 summarizes the estimated capital expenditures and **Table 2** summarizes the estimated operations and maintenance (O&M) expenditures for the infrastructure elements of the system. Figures are rounded throughout the tables and are based on 2014 dollars, escalated at 3% annually to the year of expected expenditure. Not included are estimates of Hillsborough Area Regional Transit (HART) costs for record searches, contract preparation, contract administration, engineering effort, inspection effort or travel. This budget does not include work which is covered under the routine maintenance that is currently performed by HART personnel. See Appendix C for complete cost estimates by discipline and type of expenditure.

TABLE 1
SUMMARY OF TECO LINE STREETCAR ESTIMATED CAPITAL EXPENDITURES

Component	Immediate <2 years	Mid-term 2-5 years	Long-term 6-30 years	Total
Guideway & Trackwork	$372,000.00	$259,840.00	$648,000.00	$1,279,840.00
Station & Pedestrian Facilities	$8,400.00	$1,531.20	$167,958.00	$177,889.20
Traction Power OCS	$757,000.00	$0.00	$0.00	$757,000.00
Capital Expenditures Total	**$1,137,400.00**	**$261,371,20**	**$815,958.00**	**$2,214,729.20**

TABLE 2
SUMMARY OF TECO LINE STREETCAR ESTIMATED O&M EXPENDITURES

Component	Immediate <2 years	Mid-term 2-5 years	Long-term 6-30 years	Total
Guideway & Trackwork	$48,500.00	$23,200.00	$158,400.00	$230,100.00
Station & Pedestrian Facilities	$4,180.00	$42,920.00	$61,290.00	$108,390.00
OCS	$30,000.00	$409,545.88	$12,779,489.14	$13,219,035.02
Traction Power	$0.00	$130,731.04	$9,644,612.41	$9,775,343.45
O&M Expenditures Total	**$82,680.00**	**$606,396.92**	**$22,643,791.55**	**$23,332,868.47**

1. INTRODUCTION AND BACKGROUND INFORMATION (TASK 1)

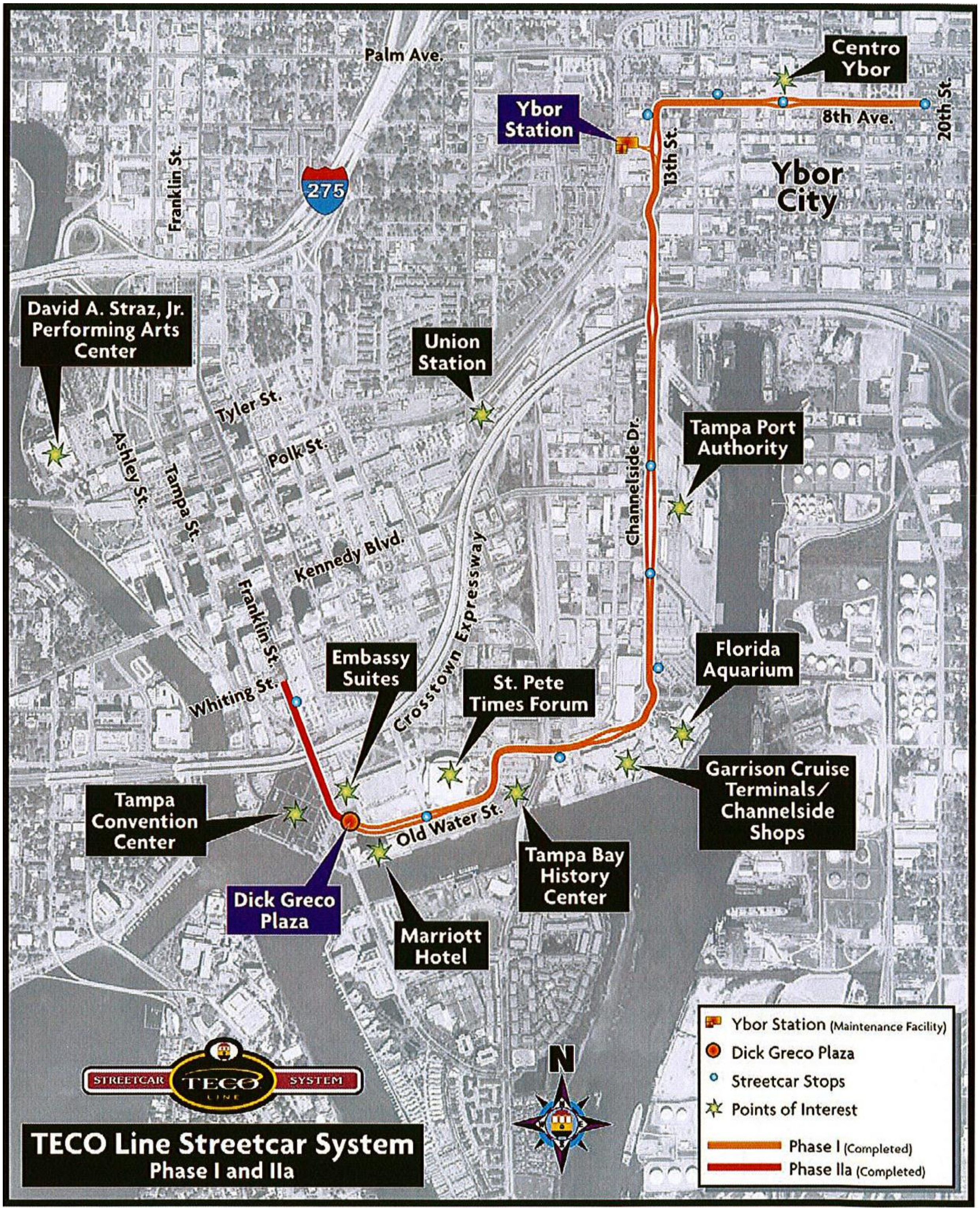
The TECO Line Streetcar System is a 2.7 mile long Light Rail Transit (LRT) transportation system within the city limits of the City of Tampa, Florida, that provides a unique connection from downtown Tampa and the Channelside district to the Ybor City historic district (see **Figure 1**). The system is revenue-producing and normally operates 7 days of the week, with extended service times on the weekend. The system was designed and constructed as a heritage system in an effort to replicate the historic feel of Ybor City and to be more appealing to the tourism industry, and it utilizes heritage-style streetcar vehicles that are of similar style to those in use during the early 20th century.

Phase I of the TECO Line Streetcar was opened for service in 2002. Phase I is a 2.4-mile-long segment that ended approximately east of the Southern Transportation Plaza. The eastern terminus of the Phase I portion is in Ybor City, along 8th Avenue at 20th Street. Phase II was procured through design-build and consists of a 0.3-mile-long extension from the Southern Transportation Plaza along Franklin Street to its current terminus at Whiting Street. Phase II opened for service in December 2010.

The TECO Line Streetcar was created as a joint project of both HART and the City of Tampa. The roles and responsibilities of each agency are described in two governing documents; *Interlocal Agreement for the Tampa-Ybor Historic Electric Streetcar Project* (1998) and *The Streetcar Tri-party Agreement* (2001).

The TECO Line Streetcar features 11 station stops, each complete with wheelchair lifts for American Disabilities Act (ADA)-compliant accessibility and architectural features matching the districts the stations reside in. The Southern Transportation Plaza, also known as the Dick Greco Plaza Transportation Center, is a large canopy station situated downtown at the corner of Franklin Street and Old Water Street. The Plaza is highly architectural, with landscaping and a plaza large enough for the streetcar vehicles to pass through.

FIGURE 1
STREETCAR SYSTEM MAP



This report examines the infrastructure of the entire TECO Line Streetcar System and documents the anticipated capital expenditures for the infrastructure elements system, currently operated by HART. URS was contracted by the City of Tampa to assess the TECO Line Streetcar System and to provide an estimation of immediate (less than 2 years), mid-term (between 2 and 5 years), and long-term (more than 5 years) expenditures anticipated for the continual service of the system. It is based on a Streetcar Facility Assessment that was conducted in January 2014, information obtained from HART staff, and industry reference.

In addition, the Florida Department of Transportation (FDOT) periodically conducts reviews of this system and publishes a report based on the safety and security aspects of the system. The most recently published document from the FDOT evaluation, the *FDOT 2012 Triennial Safety and Security Review Report*, was also used as an informational guide and reference for completing this infrastructure assessment.

In the assessment process the system right-of-way (ROW) and ancillary facilities were examined in detail. The observed condition of the system elements were combined with other available data that came from interviews with HART staff and managers, a review of the maintenance history, experience in the industry and guidance published by the American Public Transportation Association (APTA), the American Railway Engineering and Maintenance-of-Way Association (AREMA), the National Electric Code (NEC), and the National Electric Safety Code (NESC). The findings were used as the basis for the development of this report.

Several other data sources were used in the development of this report, including:

- Design criteria and technical specifications produced by the engineer of record for the Phase I segment,
- Record construction plan sets provided by City of Tampa and HART,
- Archived records and computer-aided drafting (CAD) files from the Engineer of Record for the Phase I segment,
- Miscellaneous repair and maintenance drawings and reports provided by HART maintenance staff.

This report presents the details summarized during the reviews, and is the precursor of construction documents that may or may not be required for the specific design of infrastructure rehabilitation. This report does not address contract terms or scheduling nor does it recommend an approach for division of work scope. Estimated costs are provided in Appendix C and are presented in 2014 dollars and escalated at 3% annually to the year of expected expenditure.

2. EXISTING CONDITIONS AND FIELD INSPECTION (TASK 2)

The field inspection was performed during the week of January 13, 2014, by a senior track engineer and a senior systems engineer. The entire line was walked and inspected visually with a HART maintenance staff member present to answer specific questions pertaining to the findings. Track measurements were routinely measured for construction tolerances and rail wear. During the inspection, a photograph log of the conditions found in the field was documented. A map of the locations and the photograph log of the conditions observed during the field inspection are included in Appendix A.

2.1 GUIDEWAY

The guideway is defined as the tracks, both ballasted and embedded, the special trackwork, and related physical elements that tie the tracks into the street cross section. The initial 2.4-mile-long streetcar system began revenue operation in October of 2002. A 0.3 mile downtown extension opened for service in December of 2010 for a total route length of approximately 2.7 miles. The entire system consists of both ballasted and embedded track sections. The system consists primarily of one bi-directional single track with seven passing track locations. The entire system operates in an exclusive transit lane with 27 at-grade street crossings along the line. An at-grade crossing of a CSX rail line exists that is signal controlled.

Available information gathered prior to the track inspection indicated a need for implementation of a uniform, regular trackway inspection program and a complete set of as-built track detail drawings and specifications including Phases I and II turnouts, old and new wheel profiles, and switch machine manuals. It is recommended that these two items be addressed as soon as possible.

During the field assessment, each major component of the guideway was observed for signs of physical damage, deterioration, operational adequacy, and wear (see Appendix B for the trackway inspection narrative and selected photos). For the purpose of explanation, the following subsections were identified:

- Trackway
- Special Trackwork
- At-Grade Crossings

A narrative of the track inspection is included in Appendix B of this report.

2.1.1 Trackway

2.1.1.1 Ballasted Track

Roughly 4,800 track feet of ballasted timber tie track exists within the system. During the field investigation, it was noted that the ballast appeared fouled at several of the interfaces between grade crossing panels and the ballasted track sections. No abnormalities in the track geometry were apparent, which would suggest a loss in structural integrity of the track structure as a whole. It appeared that storm drainage is spilling from the roadway surface into the ballast and depositing debris and sediment in the ballast stone.

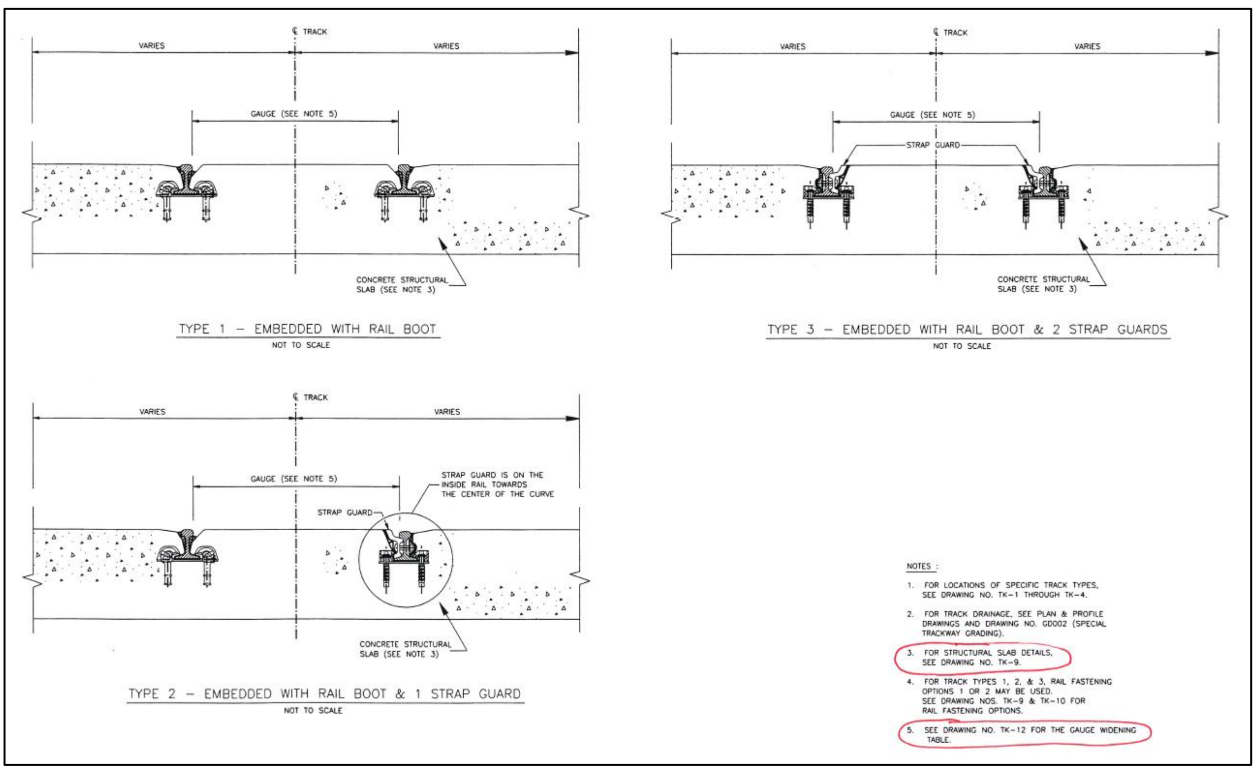
The ballasted track section consists of a reinforced concrete tub containing ballast, ties, and rail. Approximately 6-inches of ballast lie below timber ties and a perforated under drain runs the length of the section. It is not clear where the outfall locations for the underdrain system exist nor are there visible clean out locations.

2.1.1.2 Embedded Track

Roughly 13,500 track feet of embedded concrete trackway exists within the system. During the field review, there were no notable issues with deterioration of the trackway concrete, with the exception of areas around some turnouts, which are discussed in more detail in Section 2.1.1.4. A contributing factor to the relatively good condition of the embedded concrete track structure is the naturally favorable climate in Tampa that does not have the freeze thaw cycle that is experienced on most properties.

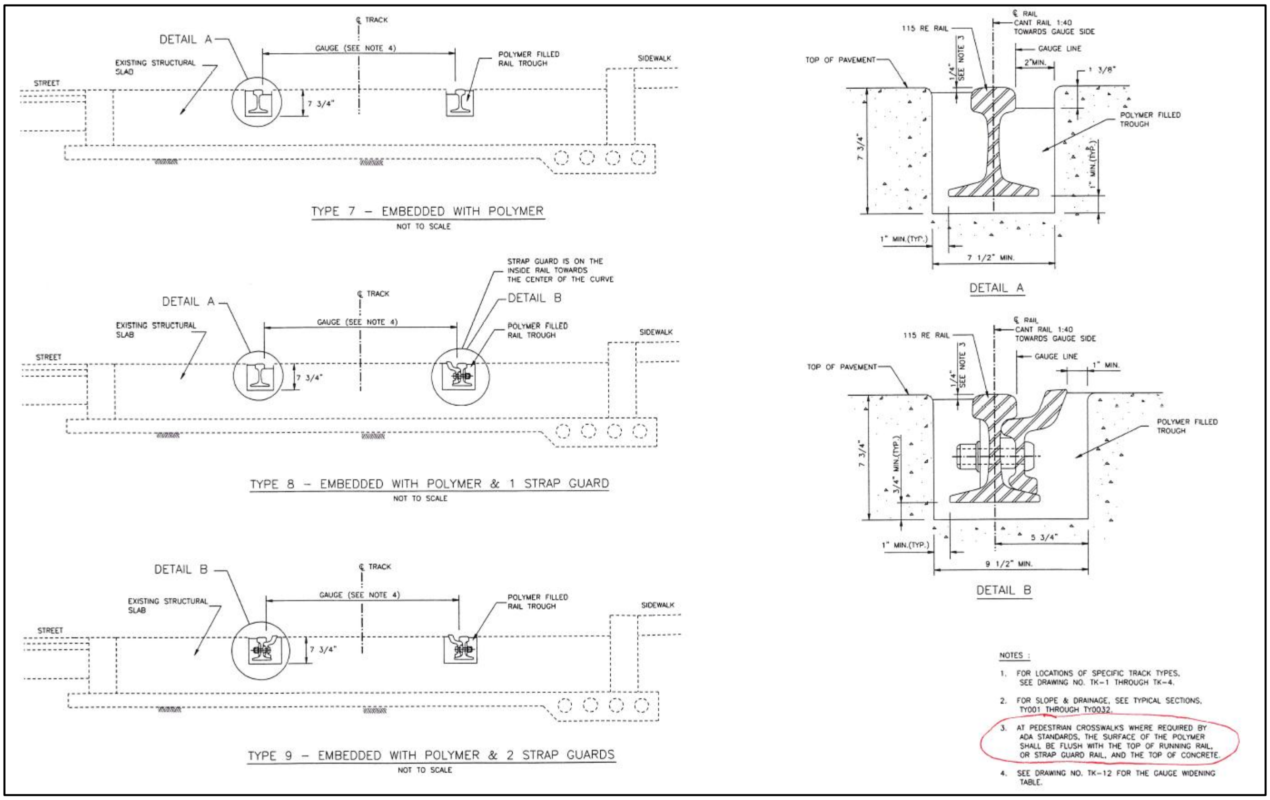
The track structure is understood to consist of "T" rail fixed to a 24-inch thick reinforced concrete sleeper slab which then had concrete poured up to top of rail elevation (see **Figure 2**). The rail is typically wrapped in an elastomeric boot to protect against stray current.

FIGURE 2
TRACK TYPES 1, 2, AND 3



Two notable exceptions to this design are at the Channelside and Centro Ybor developments. At these locations, the street and track structure was put in place prior to the initial rail project. A slot was formed in the concrete and the rail set in place at a later date. The rail was set into place and embedded in elastomeric grout (see **Figure 3**).

FIGURE 3
TRACK TYPES 7, 8, AND 9



The construction tolerance for the slot and subsequent placement of grout was not fully met in the initial construction and there are locations where the rail either protrudes slightly above the concrete surface or it is slightly recessed. The variance in the worst locations is approximately ½-inch. This poses a concern at the pedestrian crossings where the lip could pose a tripping hazard.

2.1.1.3 Rail

Standard 115RE "T" rail is used exclusively throughout the length of the system. Visual inspection of the rail and checks of the rail head profile indicated light wear has occurred over 11 years and it appears the rail can be expected to provide service for 40 more years at its current level of service, if properly maintained. HART staff communicated a few isolated issues that have been encountered.

The tight radius horizontal curves at Channelside Drive and St. Pete Times Forum Drive intersection and the 13th Street and 8th Avenue intersection have caused interface issues between the doubly restrained rail and the wheel flanges. HART has remedied the situation by reprofiling the streetcar wheels and grinding the restraining rail. Although not ideal, the track through these curves is in adequate working condition, and with the new wheel profile can be expected to provide a safe running surface for at least 20 more years.

During the trackway inspection, two rail breaks were found in the running rail outside turnout areas; one at Channelside Drive just west of Cruise Terminal 2 and the other at Channelside Drive east of S. 12th Street. Both breaks were adjacent to original welds in the continuously welded rail and may have been caused by a combination of heat-induced changes in metallurgy from adjacent welding and stress from thermal contraction of the rail in cool winter weather. Because the rails are embedded in concrete, neither break was serious enough to interrupt service. HART instructed streetcar operators to reduce speed in these areas and has arranged to have the breaks repaired.

2.1.1.4 Special Trackwork

Special trackwork is the broad term used to describe any feature in the track design that differs from the standard track section such as turnouts, restraining rail, guard rail, bumping posts, and other miscellaneous track items. The special trackwork on the TECO Line is limited in scope and consists primarily of manually operated turnouts, the CSX at grade crossing diamond, restraining rail in the tight curves, and bumping posts at either end of the line.

Those items that may require attention over the next 20 years are presented in the sections below.

Turnouts

The primary maintenance concern identified over the past 11 years of operation regards the turnouts. The existing system has 23 total turnouts; 15 main line turnouts are embedded, three main line turnouts are ballasted, and five yard turnouts are ballasted.

During a previous field review performed in 2008, problems were identified in the rail profile at the interface between the castings for the turnout and the bolted-on standard rail section. The interface between the two components was not aligned perfectly causing the rail wheel to impact on the joint with every pass. The misalignment at the interface included a slight lateral offset and an expansion gap at the bolted butt joint joining the stock rail to the turnout casting. The impact from the misalignment was causing banging and vibrations and initiating cracks in the adjacent concrete.

Prior to the 2008 field review, HART staff identified a temporary solution to the turnout interface issue that involved closing the gap at the surface of the bolted butt joint, strengthening the bolted joint by welding the joint bar to the rail and switch casting, and matching the profile of the rail head and casting by profile grinding. Approximately 5 years ago, six locations with mismatched and moving butt joints were repaired per the procedure described above. Several more embedded turnouts had their gaps bridged with welding material and profiles matched by grinding.

During the 2014 inspection, it was found that most of the "gap bridging" welds had failed and in a few locations the wearing surface of the rail adjacent to the gaps had been damaged, potentially affecting the ride quality and causing banging when wheels cross the gaps. Additionally, there were rail breaks at two embedded turnouts adjacent to the gaps.

When the rail was exposed during subsequent repairs performed by a rail contractor (RW Summers), it was found that the rail had broken at the bolt hole through the rail web nearest the butt joint. This failure may have been caused by changes in the metallurgy of the rail due to the welding of the joint bars. Repairs were accomplished by grinding out the joint bar welds and removing the bar, and removing an approximately 8-foot-long section of stock rail. A section of new rail was then thermite-welded to the running rail and bolted to the switch casting at the original butt joint location. The repaired area was then re-embedded in high-strength concrete "MagnaGrout." This repair essentially matches the original turnout installation method. The repair was accomplished within the limits of the insulating "bathtub" so as to maintain the integrity of the electrical isolation materials.

The ballasted turnouts along Channelside Drive were found to be missing the insulating rail pads and clips found on the surrounding ballasted trackway. Also, a small number of broken clips and clip insulators were present in this area (see Appendix A for more details). These deficient items do not pose a safety risk but should be rectified in the near-term.

Switch Box Replacement

Numerous premature failures have occurred to the spring mechanisms that control the turnouts along the TECO Line. The switch boxes original installed are based on an antique design in an effort to preserve the historic nature of the streetcar (see **Photo 1**). Lack of drainage of the switch boxes has led to corrosion which has led to the failure of connecting rods. The poor drainage has also led to sedimentation within the switch box which can result in jamming and blocking of the mechanism.

Prior to the initiation of the field review and capital maintenance budgeting work, HART staff had initiated a replacement program for all 18 switch boxes on the main line system (see **Photo 2**). They selected a watertight mechanism supplied by Contec that is the current standard in the industry. Although not identified as necessary at this time, the new switch boxes can be fitted for powered operation at a future time.

PHOTO 1
OLD SWITCH MACHINE

PHOTO 2
NEW SWITCH MACHINE

At-Grade Crossings

There are 27 at-grade street crossings and five exclusive pedestrian crossings of the streetcar tracks on the TECO Line. Of the 27 street crossings, 22 simply consist of the embedded track section. The remaining five crossings are in the ballasted track sections and consist of precast crossing panels supported on top of standard ties and ballast. Four of the five exclusive pedestrian crossings also consist of precast concrete panels on ballast. The precast panel crossings are the subject of this section.

The condition of the precast concrete panels appeared good at the time of the field review and no problems had been reported by staff. Although the crossing panels are equipped with rubber rail seals, over time leaks may develop allowing moisture to seep into the ties and ballast below. The scope of the trackway inspection did not include removing any panels to assess the condition of their supporting ties but because they are better protected than the adjacent exposed ties they can be expected to be in better condition and provide adequate service for the next 20 years, or possibly longer.

However, because the system has been operating for 11 years, it is recommended that the condition of the crossing panel ties be monitored as part of the tie inspection and replacement program. More specifically, every 2 to 5 years (depending on conditions found previously), one crossing panel should be lifted off the ties and the underlying ties and fasteners inspected. The particular panel lifted should be selected by HART maintenance staff or track inspectors as one most likely to conceal degraded rail support based on surrounding conditions or other knowledge. Generally, it is best to minimize removal and replacement of crossing panels because the aging rubber seals between panel and rail don't seal as well after being disturbed.

2.1.2 Station Stops

2.1.2.1 Ybor City Station Stops

There are four station stops north and east of the vehicle maintenance facility (VMF), which are within the Ybor City historic district. These stations have a heritage-style painted wooden architectural canopy and pavers, consistent with the historic nature of the area. These stations are more susceptible to the elements and are made of materials less hardy than the Downtown stations; therefore, preventative maintenance is more important to these stations. The general condition of the Ybor City stops was good with a few minor exceptions. It was observed that the hand rails leading to the high block loading areas had come loose at a few locations. The paint on the wood framing of the canopies was flaking off in isolated areas. The painted wood station identification signage was beginning to show signs of wear. Concrete on the platform, the brick cladding on the high block and the tactile edge strip all appear to be in good repair.

2.1.2.2 Downtown and Channelside Station Stops

There are five station stops along Channelside Drive, constructed in Phase I, and one additional station stop downtown at Franklin Avenue/Whiting Street which was constructed in Phase II. These stations have a modern architectural design, with metal and concrete accenting the stations. These stations are made of hardy materials and by nature are less susceptible to weathering. The general condition of the downtown stops was good with a few minor exceptions. Several hand rails have loosened at the base, and some concrete cracking was noted. The tactile edge strips appeared to be in good repair.

2.1.2.3 Southern Transportation Plaza Stop

The general condition of the Southern Transportation Plaza stop was very good with minor maintenance issues. A roof leak was noted at one of the downspouts; however, due to the height of the roof the cause of the leak could not be determined and may be simply due to a clogged drain. Moderate pavement cracking was observed at some Overhead Contact System (OCS) pole foundations, which is identified further in the Systems section. Several tree planters surrounding the plaza showed skirts pushed up due to root overgrowth.

2.1.3 Vehicle Maintenance Facility (Trolley Barn)

The majority of the elements within the VMF are part of an on-going maintenance program and do not need to be considered for the capital maintenance budget. Major pieces of equipment typically have their own service schedule identified.

2.1.4 Signaling

Maintenance of the signal equipment and interlocking at the at-grade crossing with the CSX rail line are currently covered under an existing service and maintenance agreement. Traffic signals along the route are serviced and maintained by the City of Tampa. No provisions were made in the capital maintenance budget recommendations for these two elements of the project.

2.2 SYSTEMS

Overall, the streetcar electrical system is in fairly good condition due to the amount of time the system has been in continual service. The system overall is operating accordingly but there are some signs or conditions noted that need to be addressed and procedures to be put in place to ensure that the system will continue to remain in a state of good repair and operate as expected.

The traction power system is composed of three 600 volt direct current (DC) traction power substations (TPSS). There are two 1500KVA substations that feed 600 volts DC to the 2.7-mile OCS of the main line and the yard tracks outside of the VMF.

The South Substation is located adjacent to Channelside Drive in the Aquarium parking lot site and the North Substation is located on the corner of Channelside Drive and Adamo Drive on the Expressway site.

Both Substations are fed by 12.47KV, 3 Phase, 60 HZ from the local utility company. Power is transformed and rectified to 600 volts DC to feed the OCS at each of the Substations.

A parallel feeder runs underground in a duct bank along the side of the track on the entire length of the Phase 1, a 2.4-mile Traction Power System, and connects to feed the OCS at various points along the route to prevent a voltage drop at the far end of the line away from each of the substations. Phase 2, a 0.3-mile extension in 2010 at the southern end of the system, does not have a parallel feeder. Although a duct bank was installed, the cable was never pulled to provide a backup feed to the OCS and; therefore, it is fed strictly through the OCS to the end of the line.

The system is a single-track with passing sidings located at stations to allow for the streetcar to operate in both directions. The sidings are properly sectionalized to allow them to be individually de-energized to perform overhead maintenance. The main line OCS is divided into two basic sections to allow each of the two Traction Power Substations to feed half of the system. In the event that one substation fails or is taken out of service for repair or maintenance, the other has sufficient capacity to feed the entire system and run a normal operation.

The OCS inside the VMF is fed by a 100KVA Traction Power Substation with 480 volts alternating current (AC), 3 Phase, 60HZ delivered to the switchgear by the local utility company. The voltage is transformed and rectified to 600 volts DC to feed the six tracks with overhead contact wire (inside the VMF) and the 600 volt DC stinger system used to provide auxiliary power to the streetcar (see **Photos 3 and 4**).

PHOTO 3
600V DC STINGER SYSTEM

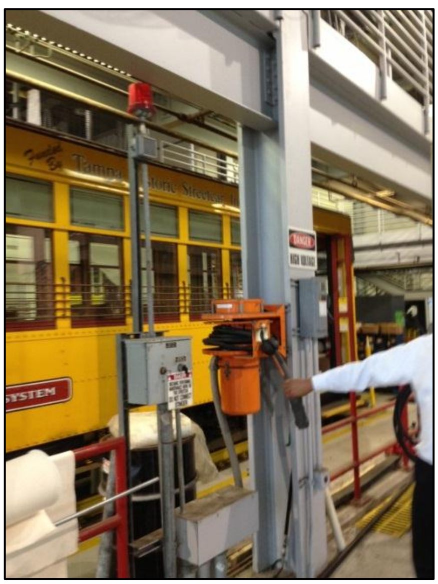
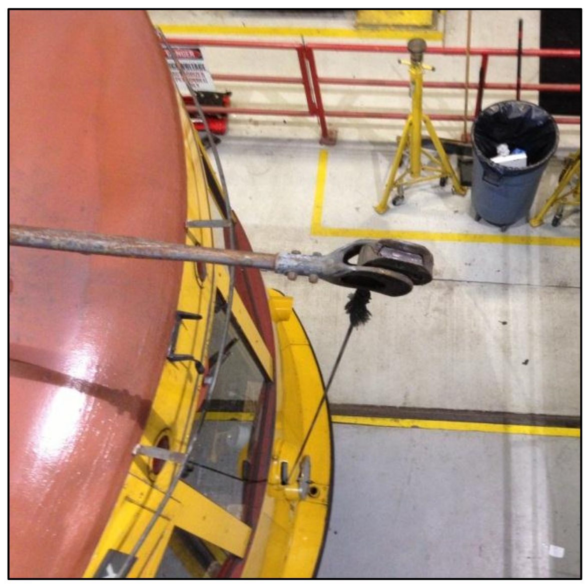


PHOTO 4
TROLLEY POLE CARBON SHOE



The OCS on the main line is a fixed tension system composed of two parallel 4/0 contact wires supported by OCS poles and registration arms. The catenary system is also in fairly good shape due to its age.

The contact wire has been visually noted from ground level by the naked eye to have minor wear and tear. This can possibly be attributed to less than normal street car operation during the previous years of operation. The trolley pole also contains a soft carbon saddle (see Photo 4), which prevents wear and the streetcars make use of the parallel contact system by riding on one wire in the northbound direction and the other trolley wire in the south bound direction by switching pole at each end of the line.

The negative return system is fed through an ungrounded rail system on the main line. Parallel 500Kcmil cables connect directly from the rail to each of the two traction power substations that feed the main line. The rail is insulated from earth to prevent DC stray current from causing corrosion to steel along the ROW, which can pose a hazard for underground utility equipment and facilities lines that cross or lie within the vicinity of the transit system.

The VMF negative return system is a grounded track system and is isolated or separated from the yard tracks negative return with insulated joints located on each track at the shop entrance. The purpose of a grounded system inside the VMF is to prevent injuries due to electric shock that can happen to workers while using electric tools on equipment that is not properly grounded. The negative return is connected via the shop rails back to the VMF negative bus of the substation located inside the facility.

2.2.1 Inspection of the Traction Power Substations

Inspection was performed on the three Traction Power Substations: VMF, North, and South Traction Power Substations.

2.2.1.1 VMF Traction Power Substation

At the VMF Substation switchgear, of the seven contactors that feed 600 volts DC to the VMF OCS and stinger system, it was noted that the contactor indication bulbs (see **Photos 5 through 9**) used to provide (open\closed) status of the contactor feeding the OCS were found to be burned out with the exception of K5 and K6 which feed the stinger equipment on track 2 and 3 pits.

PHOTO 5
CONTACTOR BULBS BURNT OUT

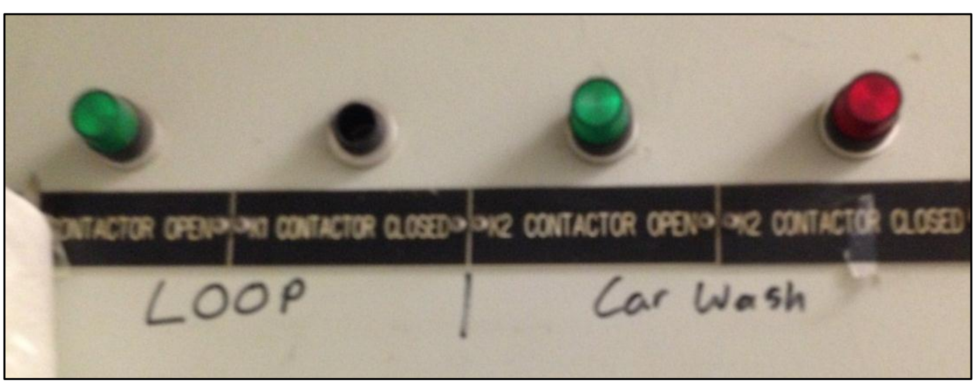


PHOTO 6
CONTACTOR BULBS BURNT OUT

PHOTO 7
CONTACTOR BULBS IN SERVICE

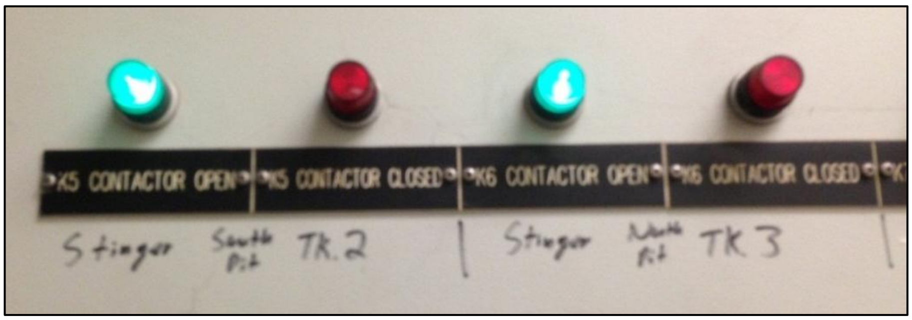


PHOTO 8
CONTACTOR BULBS IN SERVICE

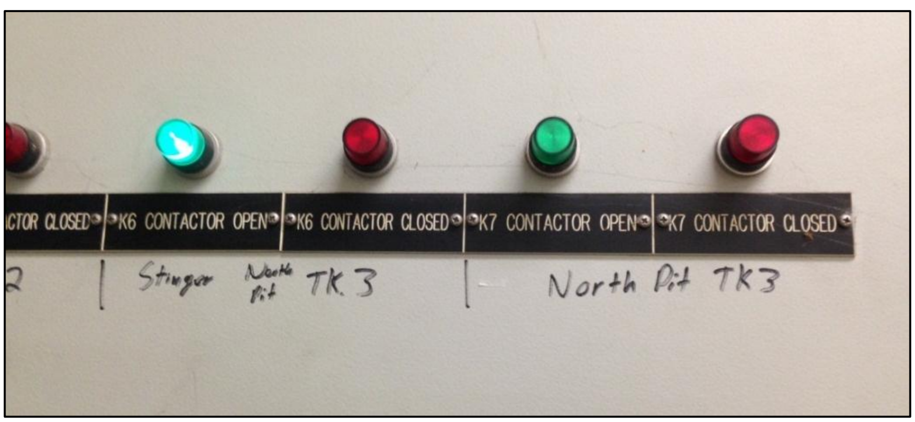


PHOTO 9
CONTACTOR PANEL

Two of the seven contactors were found open and out of service. The contactors were originally feeding track 1 and track 6 OCS outside in the yard which are now fed by the mainline North Substation. See **Photo 10** for view of yard tracks.

PHOTO 10
VIEW OF VMF YARD TRACKS

The relays on the control panel had no tags showing the last time they were tested and should be tested according to manufacturer recommendation on a regular basis.

There have been a number of electrical revisions made to the OCS system in the VMF tracks and yard such as the addition of sectionalizing and feeder switches but the OCS drawings do not reflect these changes. Having these changes not documented on plans can be a hazard to maintenance staff performing work on the OCS.

While inspecting the OCS inside the shop, some of the safety features available when working on top of the vehicle inside the VMF shop were noted. There is an interlock system for those tracks that have a platform to allow the employee to gain access to the roof of the vehicle to perform maintenance and repairs. The Catenary switch that feeds the OCS on each track contains a key interlock which allows access to the platform. Only when the Catenary switch is opened and grounded can the key be removed and used to open the access gate on the platform. Also, the platform has a gangway bridge from the platform to the streetcar roof which is also interlocked with the catenary switch. This very important safety feature prevents the employee from going on the roof of the vehicle with the Catenary energized (see **Photos 11 through 13**).

PHOTO 11
INTERLOCK PANEL

PHOTO 12
KEY INTERLOCK AT GANGWAY ENTRANCE

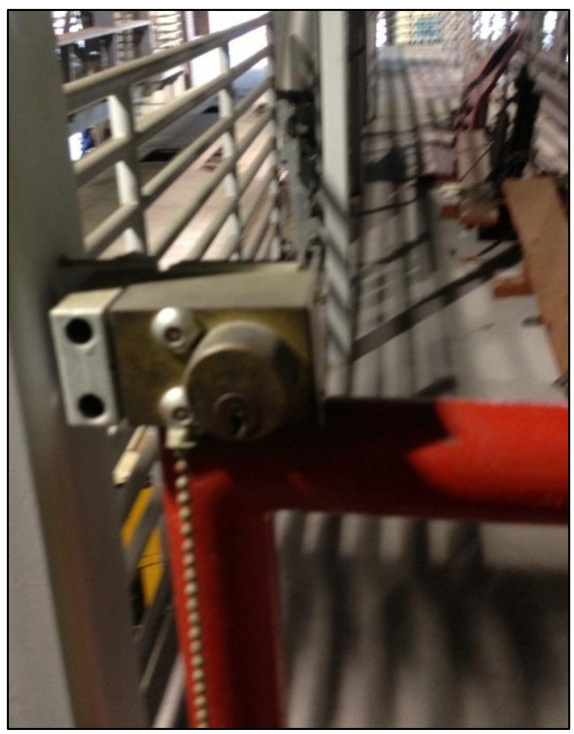
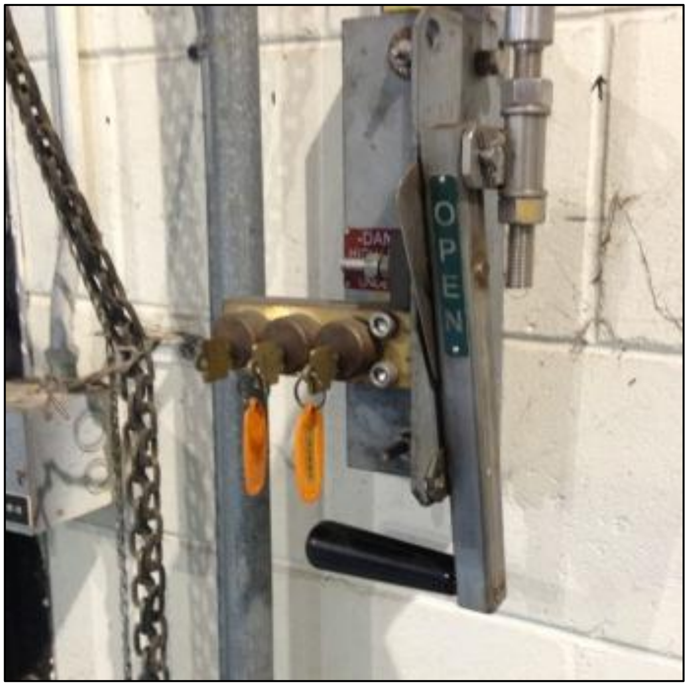


PHOTO 13
KEY INTERLOCK AT CATENARY SWITCH



Further inspection of the shop noted no fall protection hook up available to employees working on elevated places, such as while working on the roof of the vehicle. In particular, the open area where platforms and gangways are not available on tracks 4 and 5 in the shop.

2.2.1.2 North Traction Power Substation

The batteries that provide control power to the equipment were recently replaced (see **Photo 14**). The substation overall looks clean and is operating accordingly. The annunciator panel had no alarms and no sign of any ground alarm.

The protective relays had no tags showing the last time they were tested and should be tested according to manufacturer recommendation on a regular basis (see **Photo 15**). The protective relays are the brains of the substation, and in the event of a fault they control the tripping of the breakers, protection of over-temperature of the transformer and rectifier, ground protection and other equipment protective devices.

Feeder #2 was normally closed to feed the OCS and Feeder #1 was on standby. At the request of the Senior Systems Engineer, the HART maintenance staff attempted to swap the feeders to verify that Feeder #1 would hold the load accordingly, simulating the possibility of Feeder #2 would not be usable. The attempt to close Feeder #1 before opening Feeder #2 in order not to disturb the streetcar operation was unsuccessful and Feeder #1 failed to close numerous times. The breaker was racked out to inspect the cause of failure and racked back in place (see **Photos 16 and 17**). Feeder #1 breaker finally closed, which shows possible signs of misalignment.

PHOTO 14
CONTROL POWER BATTERIES

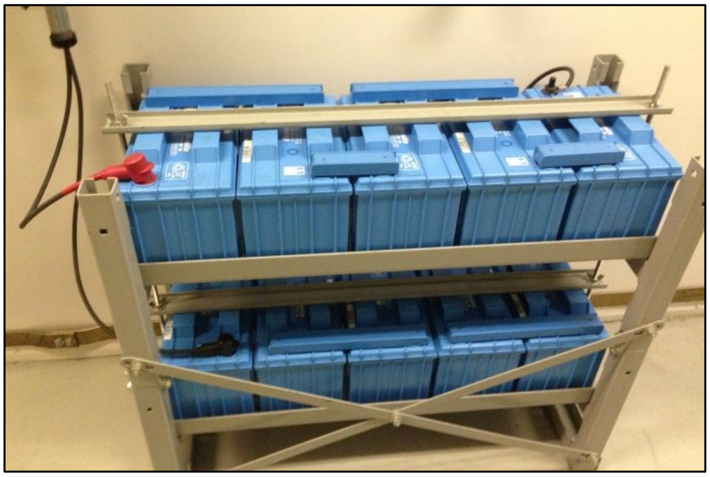
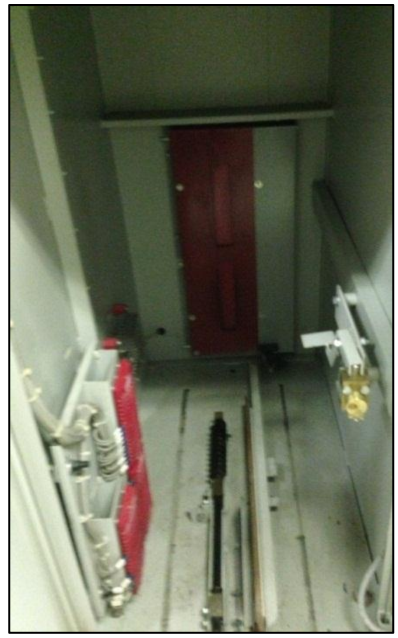


PHOTO 15
PROTECTIVE RELAYS

PHOTO 16
FEEDER #1 RACKED TO INSPECT CAUSE OF FAILURE

PHOTO 17
FEEDER #1



Inspection of the negative drainage cubicle could not be made at the time of inspection without disrupting the streetcar operation because the compartments doors are interlocked with the breakers, which would cause the breakers to trip. The negative return cables at the track level are properly connected back to the North Substation.

The electrical supervisor examined the negative drainage compartment at a later date when no streetcar was running and advised that the Floating Neutral Automatic Grounding Switch (FNAGS) had no cables connected at the bottom of the switch (see **Photo 18**). This immediate hazard was corrected by URS Traction Power Engineers working via telephone with the HART maintenance staff to ensure that the FNAGS was wired properly and placed back into service safely and efficiently.

The purpose of the FNAGS equipment is to monitor the rails voltage to ground on the main tracks and to protect the public from receiving an electric shock by becoming the current path to ground when stepping on the rail. The FNAGS monitors the amount of voltage flowing to earth and if it reaches a value normally 50 volts or more, it will automatically close the FNAG switch, which will prevent the flow of current from going to ground but rather back to the substation negative bus, thus, preventing the public from being injured.

PHOTO 18
FNAG SWITCH WITH NO CONNECTING CABLES

2.2.1.3 Inspection of the South Traction Power Substation

The batteries were found to have been recently replaced. The South Substation was found to be clean and operating accordingly (see **Photo 19**), similarly to the North and VMF Substations. No alarms were noted on the annunciator panel. DC Feeder #2 was found to be in service feeding the OCS, while DC Feeder #1 is on standby. DC Feeder #3 is not connected or in service and slated for future use.

The alignment of DC Feeder #1 was inspected due to issues in closing the feeder, which were experienced during the inspection of the North Substation. After attempting to duplicate the failure, the breaker closed properly twice without issue.

The protective relays had no tags showing the last time they were tested and should be tested according to manufacturer recommendation on a regular basis.

The negative return cables were connected accordingly at track level and back to the substation. Similar to the North Substation, the FNAGS was improperly connected. This immediate issue was also corrected by HART maintenance staff in conjunction with URS Traction Power Engineers via telephone.

PHOTO 19
SOUTH TRACTION POWER SUBSTATION

2.2.2 Systems from Vehicle Maintenance Facility to the Eastern Terminus

Several cantilever arms (see **Photo 20**) starting north of Cadrecha Plaza Station and along 8th Avenue are slightly pointing north and should be perpendicular to the track at the temperature encountered during the inspection (60 degrees Fahrenheit). This could be caused by cantilever arms that were not constructed entirely perpendicular to the track and should be adjusted. The plans of the existing system indicate that pole number 101+84 is at a location where the cantilever is not properly aligned. However, during the inspection, this pole was found to be labeled 101+85 (see **Photo 21**).

At 17th Street and 8th Avenue, at the north siding turnout switch the rail welds have broken off (see **Photo 22**) and the concern is that the negative return circuit may been broken unless there is an electrical continuity jumpers under the rail completing the return circuit.

Continuing the inspection north and east along 8th Avenue, many of the cantilever arms installed on the utility poles show signs of bowing due to the contact wire load (see **Photo 23**). With time, the wire will become slack and sag which may cause entanglement with the streetcar trolley pole.

PHOTO 20
CANTILEVER ARM SHOWN NOT PERPENDICULAR TO THE TRACK NORTH OF CADRECHA PLAZA STATION

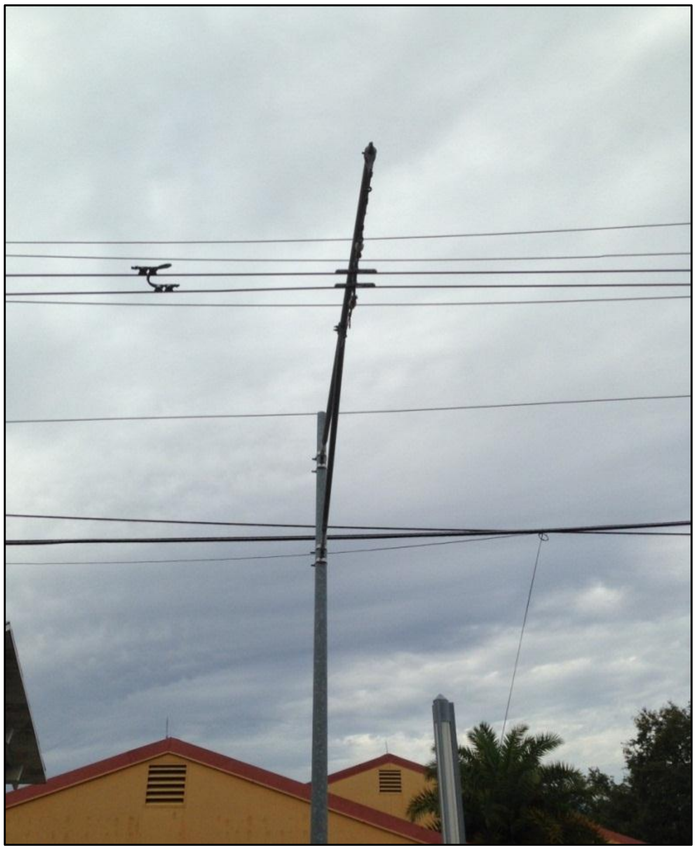


PHOTO 21
MISLABELED OCS POLE

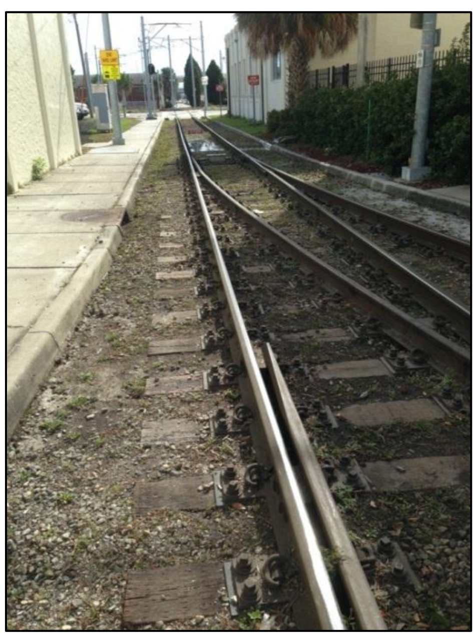
PHOTO 22
BROKEN RAIL WELD AT 17TH STREET AND 8TH AVENUE

PHOTO 23
CANTILEVER ARM BOWING

2.2.3 Systems from Vehicle Maintenance Facility to the Western Terminus

Just south of the VMF, the track is insulated from earth with rubber boots but there is evidence of flooding which can cause current to leak to ground and can be hazardous to the public nearby while the vehicle is operating in the vicinity (see **Photo 24**).

PHOTO 24
RAILS INSULATED WITH RAIL BOOTS, FLOODING PRESENT



Continuing south from the VMF there are a number of locations where the rail is not properly insulated from earth and there is evidence of flooding creating a public hazard and greater potential for stray current corrosion subsurface utilities and rail fasteners (see **Photos 25 and 26**).

PHOTO 25
RAIL WITHOUT INSULATING BOOT

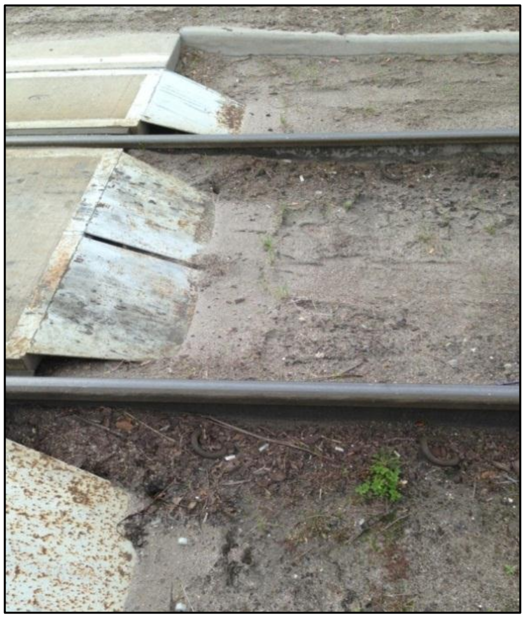


PHOTO 26
TRACKS WITHOUT RAIL BOOT INSULATION

Where the CSX railroad crosses the streetcar track, the design in the plans shows multiple parallel 500 kcmil cables to provide continuity for the negative return circuit around the insulated joints installed by the CSX rail road. During the inspection, cable connections to the rail could not be located that allow the negative return current to get around the insulated joints at the CSX rail road crossing. The impedance bonds installed by CSX on the streetcar tracks contain neutral cable connections to the track that provides a current path around the insulated joint but this cable is too small to support the traction power negative return current and it is totally exposed to the public (see **Photo 27**).

An OCS pole and cantilever arm assembly along with its insulation and contact wire was found totally covered with construction cement spray under the Florida 618/Selmon Expressway toll road overhead bridge. It appears that when work was performed under the bridge, the OCS pole and associated hardware including the contact wire was not properly protected from the overhead construction work (see **Photo 28**).

PHOTO 27
NEUTRAL RETURN CABLES AT CSX CROSSING

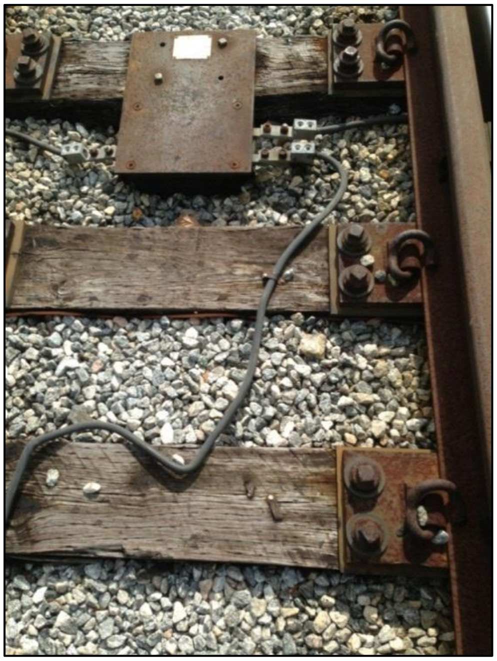


PHOTO 28
OCS POLE UNDERNEATH BRIDGE

At East Twiggs Street and Channel Drive the track, ties and ballast are subject to frequent flooding. This situation causes the sidewalk to crack at the OCS pole locations in this area (see **Photo 29**). Also, the tracks are not insulated from ground and the clips are not insulated, which causes stray current to leak to ground.

PHOTO 29
SIDEWALK DAMAGE DUE TO FLOODING AT TRACK LEVEL

At station 53+02, no insulating boots were found under the track to insulate the track from earth. This situation was found at multiple locations along Channelside Drive during the inspection.

The switch points, frogs, and turnout at sidings and at the VMF yard are not visibly cross-bonded. During the inspection, many OCS poles were observed to have no Station ID number.

The train stations do not appear to be properly grounded (unable to locate ground rods or ground cables) and although there have been no incidents, there is a potential for the public to be exposed to elevated voltages from step and touch potential and from an energized wire coming into contact with the railing or any other steel station structures.

According to maintenance staff, a number of OCS poles have to found to have ground wires not connected to the ground rod at the base of the pole. Connection to the ground rod was corrected at those locations when encountered, but there may be others that have not been inspected.

3. ANALYSIS AND RECOMMENDATIONS (TASK 3)

Based on the conditions noted during the field inspection and the information collected, recommendations were analyzed and provided based on the anticipated timeline for the maintenance need. For the purposes of this report, the scope identified three timelines to be utilized:

- Immediate (less than 2 years in the future)
- Mid-term (between 2 and 5 years)
- Long-term (more than 5 years into the future)

The expected lifetime of the system was used to determine the long-term costs associated with full replacement of system components, especially electrical systems components, which can be expected to require replacement in the long-term. **Table 3** summarizes the estimated capital expenditures and **Table 4** summarizes the estimated O&M expenditures for the infrastructure elements of the system. A full and detailed tabulated estimate is provided in Appendix C.

TABLE 3
SUMMARY OF TECO LINE STREETCAR SYSTEM ESTIMATED CAPITAL EXPENDITURES

<table>
<tr><th>Component</th><th>Immediate
<2 years</th><th>Mid-term
2-5 years</th><th>Long-term
6-30 years</th><th>Total</th></tr>
<tr><td>Guideway & Trackwork</td><td>$372,000.00</td><td>$259,840.00</td><td>$648,000.00</td><td>$1,279,840.00</td></tr>
<tr><td>Station & Pedestrian Facilities</td><td>$8,400.00</td><td>$1,531.20</td><td>$167,958.00</td><td>$177,889.20</td></tr>
<tr><td>Traction Power</td><td rowspan="2">$757,000.00</td><td rowspan="2">$0.00</td><td rowspan="2">$0.00</td><td rowspan="2">$757,000.00</td></tr>
<tr><td>OCS</td></tr>
<tr><td>Capital Expenditures Total</td><td>$1,137,400.00</td><td>$261,371,20</td><td>$815,958.00</td><td>$2,214,729.20</td></tr>
</table>

TABLE 4
SUMMARY OF TECO LINE STREETCAR SYSTEM ESTIMATED O&M EXPENDITURES

Component	Immediate <2 years	Mid-term 2-5 years	Long-term 6-30 years	Total
Guideway & Trackwork	$48,500.00	$23,200.00	$158,400.00	$230,100.00
Station & Pedestrian Facilities	$4,180.00	$42,920.00	$61,290.00	$108,390.00
OCS	$30,000.00	$409,545.88	$12,779,489.14	$13,219,035.02
Traction Power	$0.00	$130,731.04	$9,644,612.41	$9,775,343.45
O&M Expenditures Total	**$82,680.00**	**$606,396.92**	**$22,643,791.55**	**$23,332,868.47**

3.1 GUIDEWAY AND TRACKWAY

It is assumed that City of Tampa and HART will develop an inspection program. As-built plans and specifications should be expanded and updated by performing a thorough search of documents in agency libraries and by requesting documents from the designers, installers, and suppliers of all elements of the streetcar system. It is assumed that City of Tampa and HART would be best equipped to accomplish this. It is likely that after compiling all available documents there will be gaps in system information that will need to be filled by qualified engineers, designers and drafters. An allowance has been included in the cost estimate for these services.

3.1.1 Ballasted Track

The recommendation for capital maintenance on the ballasted track includes periodic inspection and replacement of timber ties and removal of sediment and debris from the ballast. This operation may prove more difficult and labor intensive than for a typical ballast track bed due to the limited working area within the concrete tub. At the same time, the areas where sediment is being deposited in the ballast is limited to the grade crossing locations, and the concrete tub that contains the ballast prevents any upward migration sediment into the ballast.

3.1.2 Embedded Track

The general recommendation for maintenance on the embedded track is that routine inspection and maintenance of the embedded track, as is currently being employed, will be adequate for the next 20 years.

It is recommended that ADA non-compliant pedestrian crossings be improved. Designs for the improvements will be on a case by case basis and could include removal of adjacent concrete and elastomeric grout, grinding of restraining rail, and installation of concrete/grout to appropriate grades. The capital cost estimate includes an allowance for each of the three worst crossings found during the inspection. City of Tampa DOT should inspect all of the pedestrian crossings in the vicinity of the trackway and correct deficiencies as they are found.

3.1.3 Rail

The recommendation is that in the near-term, a full ultrasonic rail inspection be conducted to help determine where there may be future rail breaks or other problems. Sperry Rail Services is one qualified contractor which performs this service in the Tampa area, but there are others. Future deficiencies found and repairs required by such an inspection are not included in the scope or cost estimate of this report.

Otherwise, routine inspection and maintenance of the rail, as is currently being employed, will be adequate for the next 20 years. Because these and a few other rail breaks have occurred over the past 11 years, more scattered breaks can be expected to occur occasionally. The capital estimate in this report includes budget for one broken rail repair every 2 years after the current repairs.

3.1.4 Turnouts

The repaired joint areas should be carefully monitored along with the original and modified joints to confirm that the rails are rigidly locked in place by surrounding concrete. Any slight movement of the rail will expand over time as the surrounding concrete degrades, allowing the joint bolts to loosen. If any movement is detected, especially in the repaired joints, it is recommended that the situation be examined by a track design or construction professional and appropriate measures be taken. Further repairs could include exposing the entire rail in the vicinity of the joint bar, retightening the bolts, and encasing the exposed areas with a two-part elastomeric grout formulated specifically for rail support. Proper grout encasement will help absorb shock and vibration, support the rail and grip the nuts and bolts.

3.1.5 Switch Box Replacement

URS concurs with the approach for mainline switch box replacement that HART has initiated and has included budget for a phased program in the recommended capital maintenance budget. It should be noted that the Contec CSV34 switch machines are shipped from Europe so it is more economical to order multiple units at one time for future installation. Also, the price can vary substantially depending on the foreign currency exchange rate.

Although the new switch machine boxes are water tight, it is recommended that each switch location be examined before replacement and new drainage facilities installed for the switch area as practicable as part of the replacement program. This approach will reduce maintenance needs and increase the service life of the new and existing switch components.

Design of the drain retrofits will vary depending on location. One conceptual installation could be as follows:

- Core drill 8-inch diameter hole through track slab at desired location and open a shallow trench from proposed cleanout location at edge of slab to the drain hole.
- Install minimum 6-inch diameter PVC pipe from cleanout to drain hole and from cleanout to nearest existing drainage facility (e.g., catch basin).

- Install minimum 6-inch drain, fittings, and access boxes as required. Good cleanouts are important. Rim of drain lip should match local low point of adjacent concrete.
- Backfill trench under slab with controlled density fill or other material to provide uniform support for the track slab. Pour elastomeric grout to fill void between drain pipe and slab hole for full depth of track slab. Grout seal must be water tight and electrically non-conductive.

3.2 STATION & PEDESTRIAN FACILITIES

3.2.1 Ybor Station Stops

The wood framing on the Ybor canopies will require routine painting to maintain a good appearance and prevent deterioration of the structure. Wooden supports should be monitored and replaced if the deterioration inhibits the function of the supports. The slate shingle roofing will likely require replacement approximately 15 years from now. The station identification signage will also require replacement or repainting, and should be performed with station painting to have uniformity and efficient use of resources. Most immediate, the washed-out and undermined planters and pavers at these stations should be re-graded and the railings should be re-grouted because these components can create hazardous conditions streetcar users. The wheelchair lifts will need to be replaced in the long-term.

3.2.2 Downtown Station Stops

Damaged station signage should be repaired, and cracked sidewalks should be repaired in the near future. Additional pavement markings should be placed for warnings at the pedestrian crossings until proper safety modifications to the tracks can be performed for ADA compliancy. The landscaping grates along Channelside Drive and at the Southern Transportation Plaza should be re-seated as necessary to prevent tripping hazards, which may require an arborist to cut back overgrown roots underneath. In the mid-term, concrete sidewalks are expected to crack and shift due to soils and drainage, so they should be monitored and replaced when tripping hazards become apparent. The wheelchair lifts will need to be replaced in the long-term.

3.3 SYSTEMS

In general, the following recommendations should be considered immediate needs, or implemented within 2 years. Traction power and overhead contact systems rely on high voltage electric circuitry in public ROW; therefore, the most appropriate maintenance approach to these systems is to ensure the proper working condition of all parts and safety features, and in the mid- and long-terms following standard procedures for inspection and routine replacement of components as they become functionally obsolete.

3.3.1 Traction Power

Inside the VMF building, establish a design for tracks 4 and 5 to allow employees to properly hook up their fall protection equipment when working in elevated places such as the roof of the vehicle.

The duct bank for Phase 2 extension was installed without the OCS positive feeder cable. It is important to have this cable installed and connected to the OCS especially at the end of the line in the event of a substation outage, it will increase the voltage drop, provide additional capacity to the streetcar and can back feed the OCS in case of an OCS outage.

Establish a 5-year capital program for the Traction Power Substations and associated equipment. Both Positive and Negative Feeders need to be electrically megger tested every 3 years. Perform a negative return continuity test of the rail on the entire system. Perform periodic testing of Rail to ground resistance at locations where flooding occurs and where corrosion activity is visible.

Verify that the multiple parallel 500 kcmil cables are installed around the insulated joints at the CSX rail road crossing and if not ensure that it is installed to prevent hazard to the public and to allow continuity of the traction power negative return current back to the substation. Install insulating boots and insulating rail clips at those locations that the track is not insulated to earth ground. Install continuity jumpers and cross bonding at turnout switch points, frogs, at sidings and yard tracks.

3.3.2 OCS

Properly re-tension contact wire and adjust cantilever arms so that they are perpendicular to the track at 60 degree temperatures. Install a cantilever sag brace or a top tie wire to relieve some of the contact wire load on the cantilevers attached to the utility poles along 8th Avenue.

The platform Hi-Rail vehicle used to maintain the OCS has been out of service and requires replacement or repair (see **Photo 30**). In addition, there should be a Hi-Rail insulated bucket truck to use to repair and maintain the overhead wires for locations where they are out of reach with the platform vehicle.

Establish a 5-year capital program for replacement of OCS components and maintenance equipment. Inspect the base of all OCS poles to ensure that the ground cable is properly connected to the ground rod and test the voltage and impedance to ground to insure it complies with the NEC requirements (25 Ohms or less and 50 volts or less).

Label all OCS feeder and sectionalizing switches with proper identification. Clean off the cement spray coating from the pole and associated hardware including the insulators and contact wire under the SR 618 overhead bridge. Re-install OCS Pole ID’s that are missing and establish a pole ID naming convention.

PHOTO 30
HI-RAIL VEHICLE IN NEED OF REPAIR

3.3.3 General Improvements to Complete System (Traction Power and OCS)

The Substation and the Catenary system with all the associated equipment have a normal life span of 40 to 50 years, depending on the frequency of Streetcar operating on the system. In order to keep the system in a state of good repair, operating as it is today and to prevent it from deteriorating, a 30-year capital program needs to be established along with Standard Operating and Maintenance Procedure (SOP). It is URS' understanding that the SOP is currently being developed by HART management for maintaining the TP Substation and for the Overhead Contact System. Develop As-Built drawings of the Traction Power system and the Overhead Contact System.

As noted above, the existing conditions currently do not match the latest plan set. Establish policy and procedures to prevent future changes or revisions to the electrical system without approval from the authorities and to maintain a written and design record of those changes with explanation as to why they were done. Update plans on a yearly basis and distribute new plans to employees whose responsibility is to repair and maintain the system.

Develop, training and implement an Electrical Operating Instruction for the employees that operate, repair and maintain the Electrical, Electric Traction and Overhead Contact System. The instructions are required for the protection and safety of the Streetcar personnel. The Protection Devices need to be tested according to manufacturer recommendation on a periodic interval.

Provide proper water drainage to prevent track from being flooded and causing safety hazard to the public. There are a number of locations along Channel Drive and north of the CSX crossing that the flooding is causing the track insulation to earth to be compromised creating stray currents to ground. Provide proper water drainage to prevent track from being flooded and causing safety hazard to the public. Ensure that all train stations steel structures and hand railings are properly grounded to earth.

APPENDIX A – LOCATION REFERENCE MAP AND PHOTOGRAPH LOG

TECO Streetcar Track Inspection Location Reference Map

URS
7650 West Courtney Campbell
Suite 700
Tampa, FL 33607
Ph: (813) 286-1711 Fax: (813) 286-6587
Florida Engineering Number r:000002

City of Tampa Florida

DRWN:	
DSGN:	
CHKD:	
APVD:	
DATE:	
JOB NO.	

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APPENDIX B – NARRATIVE OF TRACK INSPECTION

CITY OF TAMPA

TECO STREETCAR INFRASTRUCTURE ASSESSMENT

NARRATIVE OF TRACK INSPECTION

This document presents a narrative of the TECO Streetcar track inspection of January, 2014 and recommendations for repairs and maintenance.

A pre-inspection meeting was held on January 13 at the Trolley Barn with City of Tampa and HART representatives. HART maintenance staff described their recurring track maintenance issues including flooding of the trackway south of the Barn and flooded, obsolete switch machines. They reported no significant incidents related to the condition of the trackway and had no problems with ride quality. A current program to retrofit the streetcar vehicles with a new wheel profile is yielding good results, with the vehicles providing a smoother, quieter ride and less binding and wheel-squeal in the tight curves on the alignment. HART's small trackway maintenance staff appears to have a limited formalized inspection program, but performs a daily trackway check before start of revenue operations, knows the maintenance-intensive items and schedules their activities accordingly.

The track inspection was conducted over 2 ½ days by two engineers and, when available, one HART maintenance representative. The inspection team walked the entire track alignment, measuring, photographing and assessing the condition of trackway components including:

- Rail, track slab and rail support systems
- Turnouts and switch components
- CSX track crossing
- At-grade crossings
- Pavement, sidewalks and pedestrian ramps adjacent to and crossing trackway
- Drainage facilities
- Stop platforms including wheelchair loading mechanisms canopies, railings, and trash receptacles

American Public Transportation Association (APTA) inspection standards and tolerances for Class 2 passenger track (defined as operating at less than 30 mph) were used as a guideline for the track inspection.

<u>Narrative of Field Findings – Trackway</u>

The inspection checklist and attached key map divide the track alignment into 73 segments based on track type, geometry and location, starting at Whiting Station and ending at Centennial Park Station in Ybor City. The following is a brief narrative of field observations based on these segments:

- **1-5** All of Phase II embedded track on Franklin St:


Excellent condition for slab, rail, boot, turnouts; turnouts for siding constructed w/o tubs, encapsulated method (need as-builts/shop drawings); gauge is within tolerance; alignment and cross level are okay; platform and bumping post look good; some mud and vegetation in the siding flangeways due to lack of use (not a problem); *concrete cracking around frogs; loose switch point bolts at north turnout – HART has been notified and will fix.*

(See photo points 11, 33, 34, 44)

- **6-14** Phase I embedded double track from Franklin St through Greko Plaza, Old Water St to TBT Forum:


Good condition for slab, rail, boot, Franklin turnout; gauge is within tolerance; alignment and cross level are okay; *switch box at segment 6 is flooded; switch point has excessive vertical play; concrete cracking around switch; guard rail is high and vertically mismatched at curve segment 8 and could be a hazard for pedestrian crossing and bikes; ponding in trackway at west end of HSBC stop; a few tactile pavers are broken and chipped.*

(See photo points 9, 10 32, 43)

- **15-18** Embedded track, east end of TBT Forum to Channelside Drive:

Good condition for slab, rail, guard rail and elastomeric grout embedment; gauge and guard rail wear are within tolerance; alignment and cross level are okay; drainage is good except at bottom of hill; *turnout at segment 15 is in fair to poor condition – poor drainage, flooded switch machine and rail pockets, broken rail at switch point, broken concrete, eroded rail support (approx. ½" vertical movement under load), suspect welds at points, vertical play in points; guard rail at crosswalk in curve segment 18 sits high and presents tripping hazard. HART is aware of turnout condition and is initiating repair.*

(See photo points 21, 31)

- **19-26** Embedded track, Channelside Drive to Port Authority entrance:

Good condition for slab, rail, guard rail and elastomeric grout embedment; guard rail wear is within tolerance; gauge is generally within tolerance; alignment and cross level are okay; *drainage is fair to poor as this is a level track segment, backed up storm drains were observed, possibly influenced by tides; 57 1/4" gauge at one point across from 12th*

St quickly transitions back to 56 ½"; suspect welds (broken) at switch points; turnout infill slabs cracked; concrete chipped and broken around switches, flooded switches and flangeways; ponding (large) at siding; 2 broken rails – in segments 24 and 26; vertical play in switch points. HART is aware of broken rails and is initiating repairs.

(See photo points 8, 29, 30, 37, 42)

- **27-33** Embedded track, Channelside Drive from Port Authority to Cumberland Ave Station:

Good condition for slab, rail, guard rail and elastomeric grout embedment; guard rail wear is within tolerance; gauge is within tolerance; alignment and cross level are okay; Cumberland Ave Station trackway and platform in very good condition; *drainage is fair as this is a relatively level track segment; guard rail in tight curves at roundabout is showing wear and appears to have been hand-ground (possibly to relieve wheel binding); guard rail is high (1" max), elastomer is low and flangeway is wide (3¼" max) at crosswalks creating tripping hazards; some cracking and settling of sidewalk around OCS poles at roundabout probably due to unstable subgrade (poles look good and plumb).*

(See photo points 7, 20, 22)

- **34-51** Ballasted track, Channelside Drive from Cumberland Ave Station to E Harbor St:

This segment includes approximately 400 feet of embedded double track in front of the Port Authority building, all in very good condition; very good condition for rail, guard rail, plates, insulators, rail clips, spikes, turnouts, frogs, switches and switch machines; gauge is within tolerance; alignment and cross level appear to be as designed; prefabricated, tie-borne crossing panels and hardware appear to be in good condition, solid and flat; drainage structures are in good condition although grate elevations are variable; underdrain pipes could not be accessed for assessment; *timber ties are in generally good condition with fewer than 10 (randomly scattered) showing significant checking or rot but still holding spikes; a few (less than 5) clips and insulators were broken or missing in segments 45 and 51; all ballasted turnouts were originally installed without insulating rail pads and rail/clip insulators; ballast is in good condition except at most locations where adjacent paved track crossings drain into it and have, over time, fouled the ballast and ties with debris and vegetation leaving ties in fair to poor condition.*

(See photo points 5, 6, 13, 19, 27, 28, 38, 39, 40)

- **52-58** Embedded track, Channelside Drive from E Harbor St to E 4th Ave:


Good condition for slab, rail, guard rail and boot; gauge is within tolerance; alignment and cross level are okay; *some vertical play in switch tongues; broken, uneven, undermined sidewalk in segment 53 likely due to unstable subgrade and vehicles driving on sidewalk, OCS poles appear to be stable; broken rail embedded in deteriorating concrete near switch point in segment 56; fill slope sloughing and sidewalk undermined in segment 57; ponding across rails at low point in segment 58. HART is addressing broken rail.*

(See photo points 18, 35, 36)

- **58-64** Ballasted track, Channelside/E 4th Ave to E 6th Ave/N 13th St:


Good condition for rail, guard rail, plates, insulators, rail clips, spikes, CSX rail crossing; gauge is within tolerance; alignment and cross level appear to be as designed; prefabricated, tie-borne crossing panels and hardware appear to be in good condition, solid and flat; turnout and upgraded switch machine are in good condition; south of E 5th Ave timber ties, hardware and ballast are in good condition*, ballast is uncontained* *and sloughing away from ties, drainage appears to be adequate; north of E 5th Ave drainage facilities are undersized and the area is a local low point intercepting drainage from the surrounding area, ballast is fouled and ties are partially covered with debris and in fair to poor condition.*

(See photo points 16, 17, 26)

- **65-67** Embedded track, N 13th St from trolley barn to E 8th Ave:

Good condition for slab, rail, guard rail, boot and turnouts; gauge is within tolerance; alignment and cross level are okay; upgraded switch machine is dry and functions well; *old machines are flooded but functional; some vertical play in switch tongues; guardrails at N 13th St/E 8th Ave are uniformly worn from wheel contact and apparent hand grinding but in good condition; minor cracking in turnout infill slabs.*

(See photo points 4, 14, 15, 25)

- **68-73** Embedded track, E 8th Ave from N 13th St to N 20th St (North Terminus):

Good condition for slab, rail, guard rail, boot, elastomeric embedment, turnouts and bumping post; gauge is within tolerance; alignment and cross level are okay; *old switch machines are flooded but functional; vertical play in switch tongues; minor cracking in turnout infill slabs, suspect welds on rail heads near switch points.*

(See photo points 2, 3, 23, 24, 41)

<u>Narrative of Field Findings – Stop Platforms</u>

Stop platforms were visually assessed based on APTA Standard RT-S-003-02. The architectural features of the platforms are similar based on location, including Ybor City, Channelside and Downtown, and the Dick Greco Plaza Transportation Center. In general, the stop platforms and surrounding elements are in satisfactory condition with a few notable exceptions. The following is a brief narrative of field observations based on these general locations:

- Ybor City stations (Centennial Park, Tampa Bay Federal Credit Union, Streetcar Society, Cadrecha Plaza):

Platform concrete and paint is in good condition, fair condition for canopies and wheelchair mechanisms. Each stop had two functional trash receptacles. Signage in good condition. *Moderate to severe washout/undermining at landscaping planters near edges of stations along 8th Avenue, causing uniform sinking of pavers on the station walkway; all canopies show signs of weathering, including chipping paint and deterioration of wooden ties and planks; loose handrails at Centennial Park, Streetcar Society, and Tampa Bay Federal Credit Union stations should be regrouted where the rail has loosened. Historic-style painted wood signs showing slight wear, however other signage exists.*

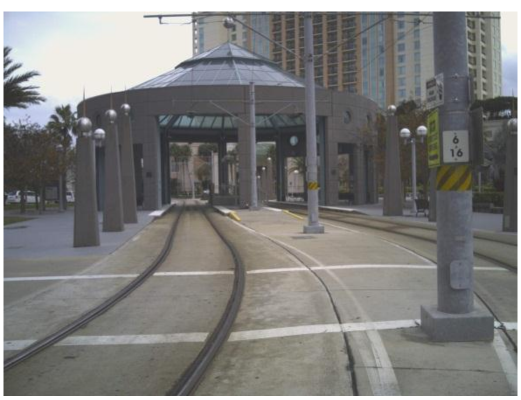
(See photo points 1 - 4)

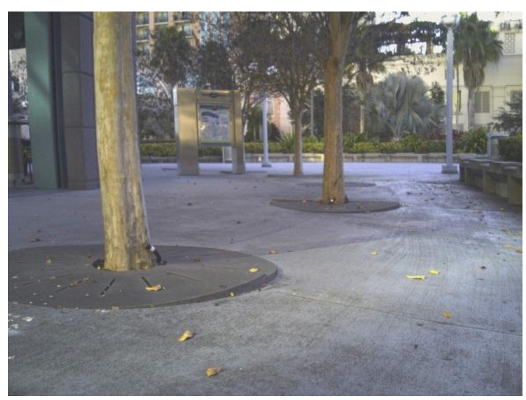
- Channelside and Downtown stations (Port Authority, York Street, Cumberland Avenue, The Tampa Tribune, HSBC, Whiting):

Stop platform concrete, paint, and platforms in fair condition, canopy structures and signage in good condition. Whiting Station was in good condition completely; *loose handrails at Cumberland Avenue, York Street, and The Tampa Tribune stations should be regrouted where the rail has loosened. HSBC station had a missing trash receptacle and loose debris on the roof which appeared to be roofing material. Minor pavement cracking existed at the base of the columns supporting the canopy at the stations along Channelside Drive. Moderate pavement cracking around OCS pole location near the station platform. Broken sign support at Port Authority station.*

(See photo points 5 – 9, 11)

- Dick Greco Plaza Transportation Center:





Good condition for stop platform and canopy; *Leak at one of the downspouts was observed, but cause of the leak was not identified and may have been clogged by debris. Many of the metal tree skirts surrounding the Plaza have been pushed above grade and* *are a tripping hazard to pedestrians. Moderate pavement cracking was observed at OCS pole locations nearby.*

(See photo point 10)

Summary of Findings of Trackway Inspection

Because the scope of the inspection did not include removal of concrete, track components or destructive testing it was necessarily limited to items that could be seen or measured by hand. With that in mind the track elements appear to be in good to very good condition and are in compliance with APTA tolerances for gauge, cross level, rail wear and , visually, alignment. The rail surface shows very little wear and can be expected to provide service for 50 more years at its current level of service if properly maintained. The track slab is generally in good condition with some minor cracking. Ties and ballast are in good to fair condition, providing good rail support and securely holding rail fasteners, but are deteriorating due to drainage conditions and lack of maintenance. Turnouts are in good condition in terms of rail components and frogs. Several embedded turnouts are showing signs of concrete embedment failure, especially around the bolted rail joints. These areas should be closely monitored. The switch machines are obsolete and require a lot of maintenance but are still functional. Lacking drains, most of the machines are under water.

Immediate needs (within two years)

- (4) Broken Rails – HART is addressing these.
- Turnout at TBT Forum – repair or replace
- Missing rail clips and insulators – replace
- Uninsulated ballasted turnouts – install insulators
- Undermined and broken sidewalks - repair
- Guard rails/uneven surfaces in crosswalks – Vicinities of Port, Aquarium and TBT Forum – explore/implement measures to even out and minimize flangeway width.
- Platform tripping hazards - repair
- Platform loose handrails - repair
- Ballast south of CSX crossing – add/condition ballast, check alignment
- Ballasted track and drainage problems south of trolley barn – replace wood ties and ballast with steel ties and fresh ballast, install high capacity drainage facilities and divert flows from offsite.
- Complete wheel replacement program
- Conduct a track geometry and rail ultrasound inspection
- Implement a uniform, regular trackway inspection program.
- Compile a complete set of as-built track detail drawings and specifications including Phase I and II turnouts and old and new wheel profiles, plus switch machine manuals.

Mid-term needs (two to five years)

- Old switch machines – Replace with new Contec water tight switches, and add drains if possible.
- Vertical play in switch points – New machines should help this situation, otherwise determine the cause, and implement improvements.
- Contaminated ballast and ties along Channelside Drive – Divert stormwater from sources outside trackway, clean ballast, implement tie replacement program.
- Drainage issues in ballasted track along Channelside Drive – See above.
- Ponding in turnout areas – Install drains as practicable.

Long-term needs (beyond five years)

- Ballasted track - Implement ballast conditioning and tie replacement program.
- Ponding across rails on track slab – Install drains as practicable.

APPENDIX C – DETAILED COST ESTIMATES FOR CAPITAL EXPENDITURES AND OPERATIONS AND MAINTENANCE EXPENDITURES OF TRACK, TRACTION POWER, AND OCS

TECO Line Streetcar System
Infrastructure Assessment
Capital Expenditure Cost Estimate Table

Item/Work Description		Quantity Immediate < 2 years	Quantity Mid-term 2-5 years	Quantity Long-term 5-20 years	Unit	2014 Unit Cost	Subtotal Immediate < 2 years	Subtotal Mid-term 2-5 years	Subtotal Long-term 6-30 years	Total
Guideway and Trackwork	Steel Ties, Ballast and Drainage South of Barn	1	0	0	LS	$120,000.00	$120,000.00	$0.00	$0.00	$120,000.00
	Replace Wood Ties and Ballast	200	200	500	TF	$200.00	$40,000.00	$46,400.00	$180,000.00	$266,400.00
	Install Water Tight Switch Boxes, 2ea/yr	4	6	5	EA	$16,000.00	$64,000.00	$111,360.00	$144,000.00	$319,360.00
	Add Drain to Track Slab	4	6	11	EA	$10,000.00	$40,000.00	$69,600.00	$198,000.00	$307,600.00
	Allowance for Design and Drafting Services	1	0	0	LS	$50,000.00	$50,000.00	$0.00	$0.00	$50,000.00
	Improve Pedestrian Track Crossing	3	0	0	EA	$8,000.00	$24,000.00	$0.00	$0.00	$24,000.00
	Optional Upgrade to Steel Ties with "e" Clips	200	200	500	TF	$140.00	$28,000.00	$32,480.00	$126,000.00	$186,480.00
	Insulate Ballasted Turnouts	3	0	0	EA	$2,000.00	$6,000.00	$0.00	$0.00	$6,000.00
						Guideway and Trackwork Subtotal:	**$372,000.00**	**$259,840.00**	**$648,000.00**	**$1,279,840.00**
Station and Pedestrian Facilities	Downtown - Undermined and Damaged Concrete Sidewalk Repair along Channelside Dr. (Earthwork and Concrete)	3	0	0	EA	$450.00	$1,350.00	$0.00	$0.00	$1,350.00
	Downtown - Pavm't markings at ped. crossings	3	0	20	EA	$150.00	$450.00	$0.00	$5,400.00	$5,850.00
	Downtown - Additional Signage	10	2	2	EA	$330.00	$3,300.00	$765.60	$1,188.00	$5,253.60
	Ybor - Additional Signage along 8th Avenue	10	2	5	EA	$330.00	$3,300.00	$765.60	$2,970.00	$7,035.60
	Replace Wheelchair Lifts	0	0	16	EA	$5,500.00	$0.00	$0.00	$158,400.00	$158,400.00
						Stations and Pedestrian Facilities Subtotal:	**$8,400.00**	**$1,531.20**	**$167,958.00**	**$177,889.20**
OCS and TP	Purchase New OCS Maintenance Vehicle	1	0	0	LS	$75,000.00	$75,000.00	$0.00	$0.00	$75,000.00
	Update OCS and TP drawings to reflect as-builts	1	0	0	LS	$75,000.00	$75,000.00	$0.00	$0.00	$75,000.00
	Clean cement debris off of OCS poles and support system under OH Bridge	1	0	0	LS	$2,000.00	$2,000.00	$0.00	$0.00	$2,000.00
	Label OCS feeders and sectionalizing switches	1	0	0	LS	$10,000.00	$10,000.00	$0.00	$0.00	$10,000.00
	Spare parts for OCS (insulators, clips, clamps, turnbuckles, etc...)	1	0	0	LS	$50,000.00	$50,000.00	$0.00	$0.00	$50,000.00
	Install cantilever sag braces on utility poles along East 8th Ave.	1	0	0	LS	$75,000.00	$75,000.00	$0.00	$0.00	$75,000.00
	Install OCS pole IDs	1	0	0	LS	$15,000.00	$15,000.00	$0.00	$0.00	$15,000.00
	Fall Protection System in VMF, (For tracks 4 and 5)	1	0	0	LS	$15,000.00	$15,000.00	$0.00	$0.00	$15,000.00
	Install 500kcmil continuity cables at CSX Crossing	1	0	0	LS	$15,000.00	$15,000.00	$0.00	$0.00	$15,000.00
	Install missing insulated boots and insulated rail clips at various locations to prevent stray current issues	1	0	0	LS	$50,000.00	$50,000.00	$0.00	$0.00	$50,000.00
	Provide grounding at all passenger stations	1	0	0	LS	$125,000.00	$125,000.00	$0.00	$0.00	$125,000.00
	Spare parts for TP (battery cells, relays, contacts, metering, breaker, fuse switches, etc…)	1	0	0	LS	$50,000.00	$50,000.00	$0.00	$0.00	$50,000.00
	Upgrade drainage system to prevent stray current issues	1	0	0	LS	$200,000.00	$200,000.00	$0.00	$0.00	$200,000.00
						OCS and TP (Immediate) Subtotal:	**$757,000.00**	**$0.00**	**$0.00**	**$757,000.00**
						Capital Expenditures Total:	**Immediate (<2 Years)**	**Mid-term (2-5 Years)**	**Long-term (6-30 Years)**	**Lifetime (<2-30 Years)**
							$1,137,400.00	**$261,371.20**	**$815,958.00**	**$2,214,729.20**

TECO Line Streetcar System
Infrastructure Assessment
Operations and Maintenance Cost Estimate Table

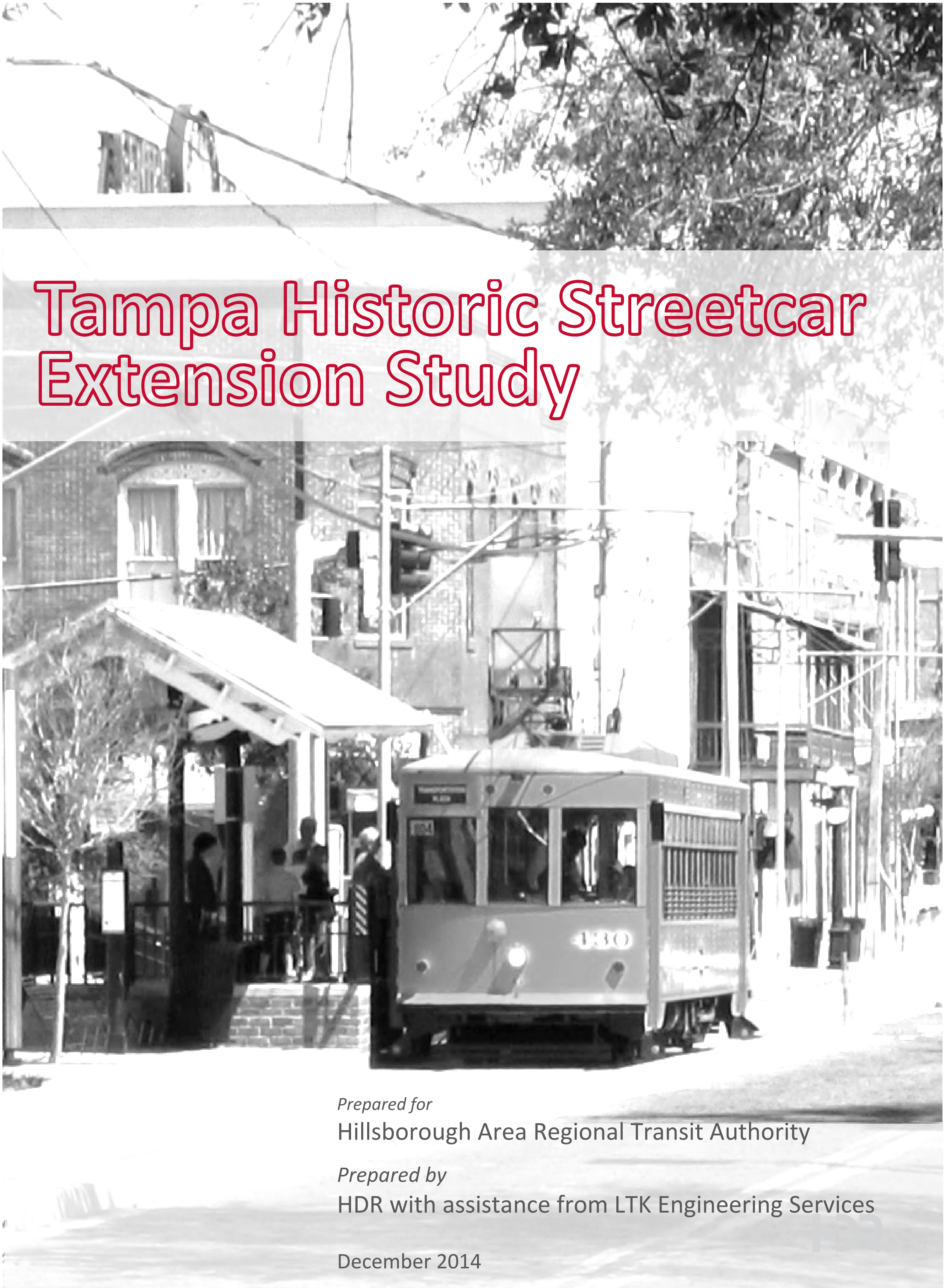
	Item/Work Description	Quantity Immediate < 2 years	Quantity Mid-term 2-5 years	Quantity Long-term 5-20 years	Unit	2014 Unit Cost	Subtotal Immediate < 2 years	Subtotal Mid-term 2-5 years	Subtotal Long-term 6-30 years	Total
Guideway and Trackwork	Ultrasonic Rail Inspection	1	0	1	LS	$5,000.00	$5,000.00	$0.00	$9,000.00	$14,000.00
	Repair Broken Rail	4	2	8	EA	$10,000.00	$40,000.00	$23,200.00	$144,000.00	$207,200.00
	Add Ballast South of CSX Crossing	1	0	1	LS	$3,000.00	$3,000.00	$0.00	$5,400.00	$8,400.00
	Replace Broken Rail Clips in Ballasted Track	1	0	0	LS	$500.00	$500.00	$0.00	$0.00	$500.00
	Guideway and Trackwork Subtotal:						**$48,500.00**	**$23,200.00**	**$158,400.00**	**$230,100.00**
Stations and Pedestrian Facilities	Ybor - Roofing/Architectural Tie Replacement	0	2	2	EA	$12,000.00	$0.00	$27,840.00	$43,200.00	$71,040.00
	Ybor - Station Painting	0	2	2	EA	$2,500.00	$0.00	$5,800.00	$9,000.00	$14,800.00
	Ybor - Concrete/Paver Sidewalk Repair	2	1	1	EA	$500.00	$1,000.00	$580.00	$900.00	$2,480.00
	Downtown - Station Signage	6	10	5	EA	$330.00	$1,980.00	$3,828.00	$2,970.00	$8,778.00
	Downtown - Concrete Sidewalk Repair	3	2	1	EA	$300.00	$900.00	$696.00	$540.00	$2,136.00
	Plaza - Sidewalk Repair per location	1	2	2	EA	$300.00	$300.00	$696.00	$1,080.00	$2,076.00
	Plaza - Landscaping (overgrowth at planters)	0	3	2	EA	$1,000.00	$0.00	$3,480.00	$3,600.00	$7,080.00
	Stations and Pedestrian Facilities Subtotal:						**$4,180.00**	**$42,920.00**	**$61,290.00**	**$108,390.00**
Overhead Contact System (OCS)	Inspect and test OCS pole grounding	1	0	0	LS	$30,000.00	$30,000.00	$0.00	$0.00	$30,000.00
	Replace worn sections of contact wire (5-Yr freq.)	0	1	0	LS	$30,000.00	$0.00	$34,778.22	$0.00	$34,778.22
	Overhaul OCS disconnect switches (5-Yr freq.)	0	1	0	LS	$15,000.00	$0.00	$17,389.11	$0.00	$17,389.11
	Replace insulating rods and align section breaks (3-Yr freq.)	0	1	0	LS	$15,000.00	$0.00	$16,390.91	$0.00	$16,390.91
	Retension contact wire and align with centerline of track, systemwide (5-Yr freq.)	0	1	0	LS	$200,000.00	$0.00	$231,854.81	$0.00	$231,854.81
	Align supports and registration assemblies, systemwide (5-Yr freq.)	0	1	0	LS	$50,000.00	$0.00	$57,963.70	$0.00	$57,963.70
	Clean insulators and rods, systemwide (3-Yr freq.)	0	1	0	LS	$15,000.00	$0.00	$16,390.91	$0.00	$16,390.91
	Megger test OCS for continuity (5-Yr freq.)	0	1	0	LS	$15,000.00	$0.00	$17,389.11	$0.00	$17,389.11
	Insulation test OCS (5-Yr freq.)	0	1	0	LS	$15,000.00	$0.00	$17,389.11	$0.00	$17,389.11
	Replace contact wire on entire 2.7 mile system (30-Yr freq.)	0	0	1	LS	$700,000.00	$0.00	$0.00	$1,699,083.73	$1,699,083.73
	Replace system insulation (20-Yr freq.)	0	0	1	LS	$100,000.00	$0.00	$0.00	$180,611.12	$180,611.12
	Replace clips, clamps, hardware (20-Yr freq.)	0	0	1	LS	$150,000.00	$0.00	$0.00	$270,916.69	$270,916.69
	Replace full feeding jumper and potential equilizing jumpers (10-Yr freq.)	0	0	1	LS	$20,000.00	$0.00	$0.00	$26,878.33	$26,878.33
	Replace OCS manual disconnect switches (pole and wall mounted) (20-Yr freq.)	0	0	1	LS	$75,000.00	$0.00	$0.00	$135,458.34	$135,458.34
	Replace section breaks (10-Yr freq.)	0	0	1	LS	$40,000.00	$0.00	$0.00	$53,756.66	$53,756.66
	Replace section insulators - shop door assemblies (10-Yr freq.)	0	0	1	LS	$20,000.00	$0.00	$0.00	$26,878.33	$26,878.33
	Replace supports and registration assemblies (35-Yr freq.)	0	0	1	LS	$300,000.00	$0.00	$0.00	$844,158.74	$844,158.74
	Replace downguys and backguys (30-Yr freq.)	0	0	1	LS	$30,000.00	$0.00	$0.00	$72,817.87	$72,817.87
	Replace OCS poles, systemwide (30-Yr freq.)	0	0	1	LS	$1,550,000.00	$0.00	$0.00	$3,762,256.83	$3,762,256.83
	Replace OCS pole foundations with anchor bolts and grounding, systemwide (30-Yr freq.)	0	0	1	LS	$2,250,000.00	$0.00	$0.00	$5,461,340.56	$5,461,340.56
	Replace signs, systemwide (10-Yr freq.)	0	0	1	LS	$10,000.00	$0.00	$0.00	$13,439.16	$13,439.16
	Replace single wire pull off assemblies, messenger wire dead end assemblies, contact wire dead end assemblies (30-Yr freq.)	0	0	1	LS	$30,000.00	$0.00	$0.00	$72,817.87	$72,817.87
	Replace two-wire assemblies (30-Yr freq.)	0	0	1	LS	$20,000.00	$0.00	$0.00	$48,545.25	$48,545.25
	Replace cross span assemblies (30-Yr freq.)	0	0	1	LS	$30,000.00	$0.00	$0.00	$72,817.87	$72,817.87
	Replace lightning arrestors (10-Yr freq.)	0	0	1	LS	$10,000.00	$0.00	$0.00	$13,439.16	$13,439.16
	Replace trolley frogs (30-Yr freq.)	0	0	1	LS	$10,000.00	$0.00	$0.00	$24,272.62	$24,272.62
	OCS Subtotal:						**$30,000.00**	**$409,545.88**	**$12,779,489.14**	**$13,219,035.02**

Note: Subtotals escalated by 3% per year.

TECO Line Streetcar System
Infrastructure Assessment
Operations and Maintenance Cost Estimate Table

Item/Work Description		Quantity Immediate < 2 years	Quantity Mid-term 2-5 years	Quantity Long-term 5-20 years	Unit	2014 Unit Cost	Subtotal Immediate < 2 years	Subtotal Mid-term 2-5 years	Subtotal Long-term 6-30 years	Total
Traction Power (TP)	Test electrical continuity jumpers at switch points, frogs and track cross bonding (5-Yr freq.)	0	1	0	LS	$20,000.00	$0.00	$23,185.48	$0.00	$23,185.48
	Test relays at TPSS locations (Manufacturer recommendation)	0	1	0	LS	$20,000.00	$0.00	$20,600.00	$0.00	$20,600.00
	Overhaul AC and DC breakers (5-Yr freq.)	0	1	0	LS	$35,000.00	$0.00	$40,574.59	$0.00	$40,574.59
	Megger test positive feeder cables (5-Yr freq.)	0	1	0	LS	$15,000.00	$0.00	$17,389.11	$0.00	$17,389.11
	Megger test negatvie feeder cables (5-Yr freq.)	0	1	0	LS	$5,000.00	$0.00	$5,796.37	$0.00	$5,796.37
	Test all grounding and bonding (5-Yr freq.)	0	1	0	LS	$5,000.00	$0.00	$5,796.37	$0.00	$5,796.37
	Overhaul HVAC units at TPSS (5-Yr freq.)	0	1	0	LS	$10,000.00	$0.00	$11,592.74	$0.00	$11,592.74
	Clean out manholes (5-Yr freq.)	0	1	0	LS	$5,000.00	$0.00	$5,796.37	$0.00	$5,796.37
	Replace batteries (10-Yr freq.)	0	0	1	LS	$10,000.00	$0.00	$0.00	$13,439.16	$13,439.16
	Replace battery charger (x3) (15-Yr freq.)	0	0	1	LS	$30,000.00	$0.00	$0.00	$40,317.49	$40,317.49
	Upgrade relays (20-Yr freq.)	0	0	1	LS	$30,000.00	$0.00	$0.00	$46,739.02	$46,739.02
	Replace feeder breakers (20-Yr freq.)	0	0	1	LS	$300,000.00	$0.00	$0.00	$541,833.37	$541,833.37
	Replace auxiliary transformer (30-Yr freq.)	0	0	1	LS	$60,000.00	$0.00	$0.00	$145,635.75	$145,635.75
	Replace rectifier transformer (30-Yr freq.)	0	0	1	LS	$80,000.00	$0.00	$0.00	$194,181.00	$194,181.00
	Replace rectifier (30-Yr freq.)	0	0	1	LS	$80,000.00	$0.00	$0.00	$194,181.00	$194,181.00
	Replace feeder cable on entire system (30-Yr freq.)	0	0	1	LS	$1,000,000.00	$0.00	$0.00	$2,427,262.47	$2,427,262.47
	Replace negative return cable (30-Yr freq.)	0	0	1	LS	$100,000.00	$0.00	$0.00	$242,726.25	$242,726.25
	Replace ductbank (30-Yr freq.)	0	0	1	LS	$2,000,000.00	$0.00	$0.00	$4,854,524.94	$4,854,524.94
	Replace entry and fire alarm system (20-Yr freq.)	0	0	1	LS	$50,000.00	$0.00	$0.00	$90,305.56	$90,305.56
	Replace track insulation on system (30-Yr freq.)	0	0	1	LS	$200,000.00	$0.00	$0.00	$485,452.49	$485,452.49
	Replace track continuity jumpers and cross bonding (30-Yr freq.)	0	0	1	LS	$50,000.00	$0.00	$0.00	$121,363.12	$121,363.12
	Replace 120V DC panel boards and breakers (x3) (15-Yr freq.)	0	0	1	LS	$15,000.00	$0.00	$0.00	$23,369.51	$23,369.51
	Replace AC distribution panel and breaker (x3) (15-Yr freq.)	0	0	1	LS	$15,000.00	$0.00	$0.00	$23,369.51	$23,369.51
	Replace substation flourescent lighting fixtures (x2) (10-Yr freq.)	0	0	1	LS	$10,000.00	$0.00	$0.00	$13,439.16	$13,439.16
	Replace emergency lights (15-Yr freq.)	0	0	1	LS	$5,000.00	$0.00	$0.00	$7,789.84	$7,789.84
	Replace test cabinets (20-Yr freq.)	0	0	1	LS	$5,000.00	$0.00	$0.00	$9,030.56	$9,030.56
	Replace telephone cabinet (20-Yr freq.)	0	0	1	LS	$5,000.00	$0.00	$0.00	$9,030.56	$9,030.56
	Replace eye wash station (20-Yr freq.)	0	0	1	LS	$5,000.00	$0.00	$0.00	$9,030.56	$9,030.56
	Replace blue light (15-Yr freq.)	0	0	1	LS	$1,000.00	$0.00	$0.00	$1,557.97	$1,557.97
	Replace exterior light fixtures (15-Yr freq.)	0	0	1	LS	$5,000.00	$0.00	$0.00	$7,789.84	$7,789.84
	Replace substation floor insulation (20-Yr freq.)	0	0	1	LS	$5,000.00	$0.00	$0.00	$9,030.56	$9,030.56
	Replace utility metering equipment (30-Yr freq.)	0	0	1	LS	$10,000.00	$0.00	$0.00	$24,272.62	$24,272.62
	Replace fuse switches and contacts (30-Yr freq.)	0	0	1	LS	$30,000.00	$0.00	$0.00	$72,817.87	$72,817.87
	Repalce substation roof (x2) (20-Yr freq.)	0	0	1	LS	$20,000.00	$0.00	$0.00	$36,122.22	$36,122.22
	Traction Power Subtotal:						**$0.00**	**$130,731.04**	**$9,644,612.41**	**$9,775,343.45**
Operations and Maintenance Expenditures Total:							**Immediate (<2 Years)**	**Mid-term (2-5 Years)**	**Long-term (6-30 Years)**	**Lifetime (<2-30 Years)**
							$82,680.00	**$606,396.92**	**$22,643,791.55**	**$23,332,868.47**

Note: Subtotals escalated by 3% per year.



Tampa Historic Streetcar Extension Study

Prepared for
Hillsborough Area Regional Transit Authority

Prepared by
HDR with assistance from LTK Engineering Services

December 2014

I. INTRODUCTION

The Tampa Historic Streetcar Extension Study is being undertaken by the Hillsborough Area Regional Transit Authority (HART) to explore the general feasibility of constructing a streetcar extension through the heart of downtown Tampa to the Marion Transit Center and to identify improvements required to upgrade the existing system to accommodate modern streetcar or light rail transit vehicles. This study report was prepared on HART's behalf by HDR with assistance from LTK Engineering Services.

For the extension to Marion Transit Center, the study focuses on the physical feasibility and conceptual costs of extending streetcar service from the existing terminus at Franklin and Whiting Streets north along one or a combination of north-south streets—Ashley Drive, Tampa Street-Florida Avenue, Franklin Street, and the Marion Transitway. Extension scenarios were prepared, discussed with key stakeholders, and evaluated to identify benefits, costs, and physical constraints of each. Although potential further extensions of the system to serve destinations to the west, north, or east were discussed during stakeholder meetings, this study is limited to extension alternatives to the vicinity of the Marion Transit Center. An assessment of additional extensions was not undertaken as part of this study.

This study also identifies improvements required to upgrade the existing system to accommodate modern streetcar or light rail vehicles. This portion of the study resulted in the identification of a series of improvements required to support higher capacity transit vehicles, including the reconstruction of several horizontal curves, reconfiguration of stations, upgrade of power sources and overhead power systems, and reconstruction or replacement of the existing maintenance and storage facility.

The study offers a conceptual level assessment of extension and improvement scenarios to support policy-making and provide the basis for more detailed analysis. The study does not include estimates of potential ridership, estimates of operating and maintenance costs, benefit-costs analyses, or other detailed assessments of scenarios. In addition, this study does not result in the selection of a preferred alignment alternative or provide specific recommendations for enhancing streetcar technology. Further evaluation is required to determine the most effective and economical solutions to advance local mobility, livability, and economic development goals.

II. PREVIOUS STUDIES

Several previous studies have evaluated options for fixed rail transit serving Downtown Tampa, including options to make the streetcar system a more vital part of the local and regional transportation network.

Studies completed since revenue service was started on the initial segment of the streetcar line have explored alternatives for the following:

- Extending streetcar into the heart of Downtown and north to the Marion Transit Center;
- Converting the existing system to run higher capacity vehicles and extending the system to destinations in Westshore, the USF Area, and to Ybor City via alignments along Palm Avenue and Nuccio Parkway.
- Introducing regional Commuter Rail or light rail service connecting downtown to regional destinations in Westshore, the USF Area, and Brandon.

The most recent study addressing improvements and extensions to the existing streetcar system is the *Transit Assets and Opportunities Study* completed by the Hillsborough Metropolitan Planning Organization (MPO) in cooperation with the Tampa Downtown Partnership. Completed in September 2014, the study explored opportunities to leverage existing transit assets and focus on the feasibility of using lower cost forms of fixed-guideway transit to serve key activity centers in the region.

The study looked at the potential use of existing freight rail lines, as well as Interstate highway right-of-way specifically reserved for transit, and recommended repurposing the existing streetcar system to make it faster and more effective for day-to-day travel. The study resulted in recommendations to make an improved and expanded streetcar system part of a larger regional system designed to link the three largest job centers in Hillsborough County—Downtown, Westshore, and the USF Area—and ultimately connect Tampa's urban core with the rest of the Tampa Bay region.

The *Transit Assets and Opportunities Study* recommended upgrading the existing streetcar system to accommodate modern streetcar or light rail vehicles, and constructing extensions to the north end of Downtown and eventually to the west to connect to the proposed Westshore Intermodal Center and north along Florida Avenue, Busch Boulevard and 30th Street to serve the USF area.

The *Transit Assets and Opportunities Study* recognized many potential benefits associated with upgrading and extending the existing system, including:

- Improvements to the existing system can better serve existing and planned residential, office, educational, and entertainment destinations along the existing line in Ybor City, the Channel District, South Downtown, and the core of Downtown Tampa.
- An improved and expanded system can serve as the backbone of an expanded urban circulator system connecting existing concentrations of transit-supportive development in greater Downtown Tampa with regional activity centers in Westshore and the USF Area.

- Enhanced transit service can be an attractive and feasible alternative to single-occupancy vehicle travel between downtown, Westshore, and the USF Area and help address projected increases in levels of congestion along key regional corridors
- The potential for incremental improvement and extension to the existing allows for service upgrades and extensions as demand warrants.

III. EXTENSION SCENARIOS

A. Scenario Development

During the course of the study, four scenarios for the northward extension of streetcar service to Marion Transit Center were defined and evaluated. The scenarios, generally following alignments shown in previous studies, explore the potential to extend streetcar from the existing terminus on Franklin Street along Ashley Drive, the Tampa Street and Florida Avenue Pair, Franklin Street, and the Marion Transitway.

Each of the scenarios was developed to meet the general design standards and assumptions presented below:

- ***Use of Existing Vehicles.*** The scenarios assume the existing heritage streetcar vehicles are used on the extension but the extension is designed to allow the introduction of larger vehicle types in the future. Under the scenarios, service on the extension could be introduced without requiring the purchase of new vehicles; upgrades to existing track, stations, or overhead power on all or part of the existing system; or the expansion or replacement of the existing vehicle maintenance and storage facility on 7th Avenue in Ybor City.
- ***Double-Track System.*** To allow for the potential to offer frequent, high capacity service, the scenarios are designed to provide the maximum extent of double-track service feasible given right-of-way constraints and horizontal curvature limits. Double-tracking allows for vehicles to pass along all sections of an alignment, thus avoiding dwell times at stations and passing tracks required in single-track systems, and allows for more frequent service.
- ***Turning Radii for Larger Vehicles.*** The horizontal curve radii of transit tracks shown in each scenario is greater than 66’ (20m) to accommodate the vast majority of modern streetcar vehicle types. Horizontal curve radii of 82’ (25m) were also tested to determine if light rail vehicles could be accommodated. Notes regarding locations where existing right-of-way constraints may impact the use of 82’ (25m) radius horizontal curves are provided in the descriptions of each scenario.
- ***Use of Existing Rights-of-Way.*** The scenarios are designed to maximize the use of existing public rights-of-way and minimize impacts on bike lanes, crosswalks, and sidewalks. Except where noted

below in the scenario descriptions, the scenarios assume new service is located within existing public rights-of-way with limited impact on space dedicated for bicycle and pedestrian use.

- ***Operation in Shared Lanes.*** Each scenario follows an assumption that tracks would be constructed mostly in existing vehicle travel lanes rather than exclusive guideways. Although further study is required to determine the optimal operating context (i.e. running in exclusive guideway vs. mixed traffic), the mixed traffic scenarios allow fixed guideway transit to be introduced without removing, significantly reducing, or encroaching on existing travel lanes, bicycle lanes, on-street parking, driveways, landscaping, and sidewalks. (As shown in Table 1 below, modern streetcar and light rail vehicles widths allow for operation in 11- to 12-foot wide travel lanes.) Further study is required to determine impacts on traffic operations, bike and pedestrian circulation, on-street parking, and driveway access.
- ***Station Improvements.*** For station sites, the scenarios assume stations are located at curb extensions where on-street parking exists or along existing sidewalks where the tracks run along existing curb lines. The level and types of passenger amenities at stations-including shelters, real time passenger information displays, seating, and lighting—is assumed to be similar to what exists at the recently constructed MetroRapid stations along Nebraska Avenue and Fletcher Avenue.
- ***Traction Power System.*** It is also assumed the traction power system for the extension would be designed to support continued use of the existing heritage streetcar vehicles but with the potential to easily convert to an Overhead Contact System (OCS) to run modern streetcar or light rail vehicles with pantographs.
- ***Crossing of CSX Tracks.*** Each scenario assumes it would be feasible to provide at-grade crossings of the CSX tracks along Polk Street. Coordination with CSX regarding the feasibility of these crossings was not completed as part of the study but would be necessary as further study is undertaken. The scenarios also assumed construction of grade-separated crossings is not feasible due to impacts associated with the closing of local streets to accommodate approach ramps and elevated track structures over the CSX tracks in Downtown Tampa.

Table 1. Characteristics of Heritage Streetcar, Modern Streetcar, and Light Rail Vehicles

Vehicle Characteristics	*Heritage Streetcar*	*Modern Streetcar*	*Light Rail*
Passenger Capacity	88 per vehicle	120 per vehicle	125 per car - 4 cars max.
Speed	20mph typ. / 30mph max.	25-35mph typ. / 45mph max.	30-40mph typ. / 55mph max.
Length	46.1’(14.05m)	66-80’ (20-24m)	80-95’ (24.4-per car)
Width	10’ (3.05m)	8.1-8.7’ (2.46-2.65m)	8.7’ (2.65m)
Fit in Travel Lane	12’	11-12’	11-12’
Min. Turning Radius	50’ (15m)	66-82’ (20-25m)	82’(25m)

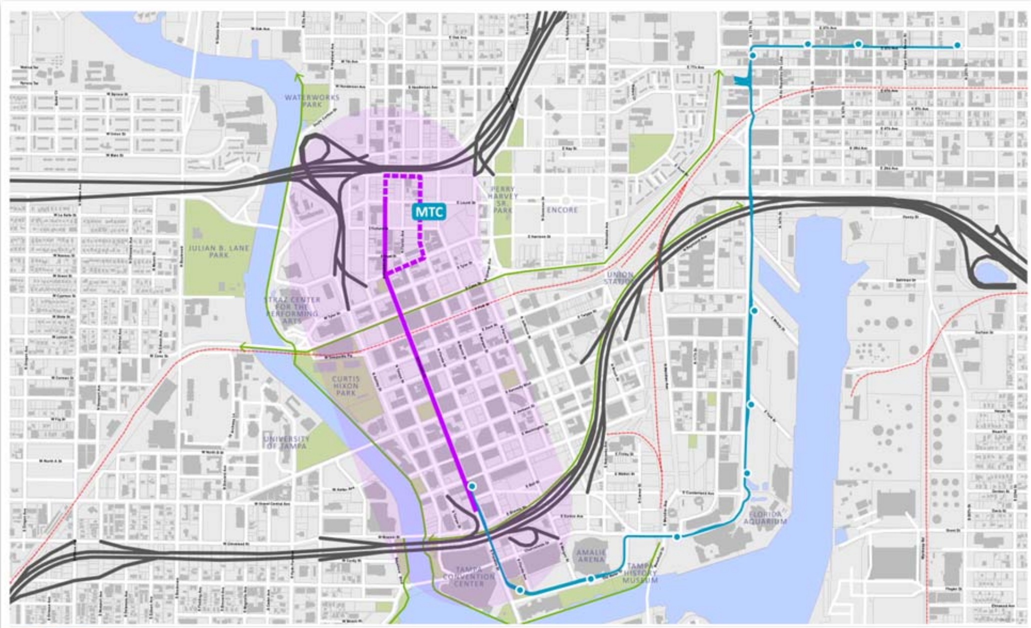
Notes:
Speed is affected by station spacing and operating environment.
All dimensions, drawn from information on transit vehicles operating on systems in the United States, area provided for planning purposes only.

B. Scenario Descriptions

The following section of the report includes text and graphics describing each extension scenario. The section provides a review of each of the four extension scenarios along with information regarding, benefits and challenges, conceptual construction costs, and topics requiring further study. Figures 1 through 4 below illustrate the general alignment and a ¼ mile buffer for each scenario. More detailed plans are provided in the Appendix

Figures 1 and 2: Scenario Maps – Ashley and Tampa-Florida

Figures 3 and 4: Scenario Maps – Franklin and Marion Street Transitway



Ashley Scenario

Alignment Description. From south to north, the Ashley Drive alignment extends from the existing single track at the Whiting Street Station to a median running single track along Whiting Street to Ashley Drive. The single track design in this location is required due to right-of-way constraints at the Franklin Street-Whiting Street and Ashley Drive-Whiting Street intersections. From Whiting Street, a double-track system runs along the outside travel lanes of Ashley Drive to the intersection of Ashley Drive and Tyler Street. From the Ashley Street-Tyler Street intersection, the alignment runs in the center lanes of Tyler Street, turns north onto Marion Street, and runs along Marion Street to a station at the Marion Transit Center.

Under this scenario, it is assumed the existing station at Franklin Street is removed, a replacement station is constructed on the CAMLS block, two pairs of new stations are constructed along Ashley Drive, and one pair of new stations is located along Marion Street at the Marion Transit Center. Further study is required to determine appropriate number, location, and design for stations.

The scenario does not require the acquisition of rights-of-way and may accommodate both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required at the following intersections: Whiting Street-Ashely Drive, Ashely Drive-Tyler Street, and Tyler Street-Marion Street.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of costs between $40.8M and $55.2M. The estimate includes hard and soft costs associated with the construction of improvements.

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The scenario provides the most direct transit connections to entertainment and cultural destinations along Ashley Drive and the Hillsborough River, including Curtis Hixon Park and Kiley Gardens, the Tampa Museum of Art, the Glazer Children's Museum, and the Straz Center for the Performing Arts.
- The single-track section of the alignment along Whiting Street between Ashley Drive and Franklin Street limits the extension's potential capacity, and double-tracking of this segment would require traffic mitigation and potential right-of-way acquisition.
- The alignment's western location is within walking distance of the University of Tampa and but has limited potential to serve existing and potential development east of the Marion Street Transitway.
- The alignment's location within existing rights-of-way likely eliminates the need for property acquisition.

Topics for Future Study. Future studies of the Ashley Scenario should focus on the following:

- Development of operating scenarios that minimize the effect of single-track of the single-track sections on the extension's capacity.
- Assessing ridership potential given the western location of the alignment and distance of stations from key destinations.
- Determining the optimal operating context along Ashley Drive (i.e. fixed guideway versus shared lanes).
- Assessing potential impacts on parking and vehicular, bicycle, and pedestrian mobility.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Tampa-Florida Scenario

Alignment Description. The Tampa Street-Florida Avenue scenario follows a general alignment from Franklin Street to Florida Avenue for northbound tracks and Tampa Street for southbound tracks to Laurel Street. From south to north, the alignment extends from the existing single track on Franklin Street at the Selmon Expressway turns east along the south side of Brorien Street then turns north onto Florida Avenue.

Along Florida Avenue, tracks run along the western most travel lanes to Fortune Street where the line could continue one block north or turn east to provide a direct connection to the Marion Transit Center. From the Marion Transit Center, the tracks turn west along the Laurel Street alignment to Tampa Street and turn to run south along the eastern most travel lanes of Tampa Street. At the Tampa Street-Whiting Street intersection, the scenario includes an option to 1) run east in the center of Whiting Street and turn south to run along the west side of Franklin Street or 2) to continue south along Tampa Street and turn southwest and run the north side of the Selmon Expressway ramp then turn south to run along the west side of Franklin Street. From north of the Franklin Street-Brorien Street intersection, the alignment would continue south along the west side of Franklin Street and cross Franklin Street to connect to the existing tracks in the Dick Greco Plaza Station.

For this scenario, it is assumed four new stations would be constructed along the Tampa Street-Florida Avenue pair and one new station would be located close to the Marion Transit Center. The existing station and tracks between Brorien Street and Whiting Street would remain in place for use for the staging of vehicles during special events or as an alternative northern terminus for service running between the Fort Brooke Garage and locations to along the existing line. Further study is required to determine appropriate number, location, and design for stations.

The scenario requires the acquisition of rights-of-way in two locations, along the Laurel Alignment crossing property controlled by FDOT and along the north side of the Selmon Expressway ramp between Tampa Street and Ashely Street. The scenario accommodates both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required at the following intersections: Fortune Street-Marion Street, Laurel Street-Marion Street, and Whiting Street-Franklin Street.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of costs between $44.4M and $60.1M. The estimate include hard and soft costs associated with the construction of improvements but did not include an estimate of costs for the acquisition of right-of-way controlled by FDOT along the Laurel Street alignment or by private entities along the Selmon Expressway ramp between Tampa Street or Franklin Street.

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The central location of the alignments along Tampa Street and Florida Avenue provide serve to most of downtown and the pair results in a larger area served than the scenarios using single streets.
- The scenario provides the potential for high-capacity, double-track service extending from Dick Greco Plaza to the Marion Transit Center.
- Transit operations may benefit from colocation along Tampa Street and Florida Avenue as these streets are designed to carry high volumes of traffic with favorable signal timing.
- Right-of-way acquisition may result in increased project costs and longer time frames for design and engineering.
- Crossing CSX tracks in two places may constitute a greater challenge and expense than crossing at one location.

Topics for Future Study. Future study of the Tampa-Florida Scenario should focus on the following:

- Determining the optimal operating context along Tampa Street and Florida Avenue (i.e. fixed guideway versus shared lanes).
- Assessing ridership potential given the central location of the alignment and distance of stations from key destinations.
- Determining costs and feasibility of acquiring necessary right-of-way along the Laurel Street alignment and north side of the Selmon Expressway entrance ramp.
- Assessing potential impacts on parking and vehicular, bicycle, and pedestrian mobility.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Franklin Scenario

Alignment Description. The Franklin Street scenario follows an alignment from the existing terminus at the Fort Brooke Garage north along Franklin Street. From north to south, the alignment extends as single track from the existing terminus north through the two-block Esplanade between Whiting Street and Jackson Street then as double-track along Franklin Street to Laurel Street with an optional alignment running east along Harrison Street, north along Marion Street to the Marion Transit Center, and West along Scott Street.

Under this scenario, it is assumed the existing station at Franklin Street is removed, a replacement station is constructed on the CAMLS block, and two pairs of new stations are constructed along Franklin Street or along the alternative loop to the Marion Transit Center. Further study is required to determine appropriate number, location, and design for stations.

The scenario requires the acquisition of rights-of-way along the Esplanade and would require streetscape reconstruction through the Esplanade to accommodate single track and along much of the Franklin Street right-of-way to accommodate double-track. The scenario accommodates both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required along the alternative loop at the following intersections: Harrison Street-Marion Street, Scott Street-Marion Street, and Scott Street-Franklin Street.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of costs between $37.8M and $40.2M. The estimate includes hard and soft costs associated with the construction of improvements but does not include costs for the acquisition of right-of-way controlled by private entities along the Esplanade. (According to City of Tampa representatives, the City controls a pedestrian easement through the Esplanade between Whiting Street and Jackson Street but does not have rights to construct transit in the easement.)

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The Franklin Street scenario provides the most direct alignment alternative and its central position provides direct service to hotel, office, and residential properties in the heart of downtown.
- The single track section of the alignment through the Esplanade limits the extension's potential capacity, and double-tracking would require significant reconstruction of plaza improvements and acquisition of additional right-of-way.
- Streetscape reconstruction could have a negative impact on the emerging concentration of retail and restaurant businesses along Franklin Street.

- Right-of-way acquisition may result in increased project costs and longer project delivery time frames.

Topics for Future Study. Future studies of this scenario should focus on the following:

- Determining the optimal operating context along Franklin Street (i.e. fixed guideway versus shared lanes).
- Determining costs and feasibility of acquiring necessary right-of-way along the Esplanade.
- Assessing ridership potential given the central location of the alignment and distance of stations from key destinations.
- Assessing potential impacts on parking and vehicular, bicycle, and pedestrian mobility.
- Assessing the impact on existing retail and restaurants along Franklin Street.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Marion Scenario

Alignment Description. The Marion Street scenario follows an alignment from Franklin east to Whiting Street then north along the Marion Street Transitway and Marion Street to the Marion Transit Center. North to south, the alignment begins south of the existing terminus and extends the double track section to Whiting Street, then turns north on the Marion Street Transitway and extends to the Marion Transit Center. The scenario includes an option to extend the southbound track on the west side of Franklin Street from Whiting Street to Dick Greco Plaza, thus allowing for a double track system from the Plaza to Marion Transit Center.

Under this scenario, it is assumed the existing station at Franklin Street is removed, a replacement station is constructed on the CAMLS block, two pairs of new stations are constructed along Marion Street, and one pair is constructed at the Marion Transit Center. For stations locations along the Marion Street Transitway, the study assumes the transit way would be widened to allow buses to streetcar stations along curb lines with center lanes allowing buses to pass the stations. Further study is required to determine appropriate number, location, and design for stations.

The scenario does not require the acquisition of rights-of-way and is designed to accommodate both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required at the following intersections: Whiting Street-Franklin Drive and Whiting Street-Marion Street Transitway.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of between $37.8M and $51.1M. The estimate includes hard and soft costs associated with the construction of improvements as well as costs for the reconstruction of streetscapes where stations are proposed along the Marion Street Transitway. The estimate does not include costs associated with extending the southbound tracks to Dick Greco Plaza.

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The Marion Street scenario provides direct service to the Marion Transit Center but its eastern location is the furthest away from destinations along the Riverwalk and Ashley Drive.
- Adjustments to the tracks in Franklin Street to provide for a double track extension would allow for high capacity service between Franklin Street and the Marion Transit Center.
- The project has the potential to be integrated with a project to improve bus operations along the Marion Street Transitway.

Topics for Future Study. Future studies of this scenario should focus on the following:

- Determining the optimal operating context along Marion Street north of the Marion Street Transitway (i.e. fixed guideway versus shared lanes).
- Assessing ridership potential given the eastern location of the alignment and distance of stations from key destinations along the Hillsborough River.
- Assessing potential impacts on traffic operations, bus transit operations, and pedestrian mobility.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Summary of Costs

The construction costs estimates for each scenario were based on a conceptual level of planning and design and were developed using available data regarding costs incurred for recently completed transit system projects in the United States. As future design and engineering efforts are undertaken and more detailed investigation occurs regarding such matters as utility conflicts, alignment alternatives, and right-of-way and property acquisition requirements, project estimates would be updated to account for conditions and design details not typically addressed at this high level of study. Table 2 below provides the range of potential costs for each scenario.

Table 2: Capital Cost Ranges for Extension Scenarios

Scenario	Conceptual Costs (2014)		Notes
	Low Range	High Range	
Ashley	$40,800,000	$55,200,000	• Includes costs for relocation of Whiting Street Station.
Tampa-Florida	$44,400,000	$60,100,000	• Includes cost for southbound track on Franklin to the Dick Greco Plaza. • Does not include costs for right-of-way for alignment along Selmon Expressway ramp between South Tampa Street and South Franklin Street.
Franklin	$37,800,000	$40,200,000	• Does not include costs for right-of-way through the Esplanade between Whiting Street and Jackson Street.
Marion	$37,800,000	$51,100,000	• Does not include cost for optional southbound track on Franklin to the Dick Greco Plaza.

Notes:
Estimate assumes extension uses existing heritage streetcar vehicles and maintenance and storage facility.
The estimate includes hard costs, soft costs, and contingencies.
The estimate does not include costs for right-of-way acquisition.

IV. EXISTING SYSTEM UPGRADE

This study also assessed the potential to upgrade the existing system to operate modern streetcar and/or light rail vehicles. The assessment focused on defining conceptual level costs for purchasing new vehicles, reconstructing horizontal curves, upgrading power sources and systems, adjusting stations, and expanding the existing Maintenance and Storage Facility or constructing a new one to service and store larger vehicles.

A review of requirements to upgrade the system is provided by topic below.

Modern Streetcar Vehicle Procurement

This study identified requirements if the system operator were to acquire modern streetcar vehicles that fall in the range of those either in operation or under consideration for procurement by streetcar systems around the country. Some typical dimensions and geometric constraints of these cars are listed in Table 3 below

Table 3. Modern Streetcar Vehicle Characteristics and Requirements

Vehicle Characteristic	*Design Requirement*
Length	66-80’ (20-24m)
Width	8.1-8.7’ (2.46-2.65m)
Minimum Horizontal Curve Radius	65-82’ (20-25m)
Minimum Vertical Curve Radius, Crest	800-1,200’ (250-350m)
Minimum Vertical Curve Radius, Sag	800-1,200’ (250-350m)
Minimum Frog Number	4
Track Gauge	4’8.5” (1435mm)
Average Track Superelevation	1” (25mm)
Maximum Track Superelevation	3” (75mm)
Maximum Gradient	9%
Reverse Vertical Curves	Either a crest and sag of 800’ (250m) separated by a tangent section of 7.5m or a crest and sag of 1,200’ (350m) separated by no tangent track
Compound Curves	A 60-82’ (18-20m) horizontal curve superimposed on a 1,500 (450m) vertical crest or sag
Current Collector	Pantograph

As stated above, new track on any extension should be designed within these parameters, while the track in the existing line at several locations would require reconstruction to meet horizontal curvature requirements for new vehicles. If all forms of modern streetcars in operation and being purchased in the US are to be considered, then all curves should be designed with a minimum radius of 82’ (25m). This high end of the range is typical for light rail vehicles, including the Siemens Short S70, which has been promoted for use in streetcar service and, in fact, is the vehicle purchased for the Atlanta Streetcar. Siemens has indicated that, with some minor modification, this vehicle can negotiate 65’ (20m) curves. Therefore, it is suggested that this value be assumed as the minimum for the existing section and the new extension. Larger radius curves are desired wherever possible to reduce or eliminate the possibility of wheel squeal.

Based on recent orders for new streetcars in small quantities, a cost of $4M each is assumed for the purchase of modern streetcar vehicles and it is likely that at least 8 vehicles would need to be purchased to support service on the existing system plus an extension to Marion Transitway. (Further study is required to determine the appropriate number vehicles to support planned levels of service.) The cost of the new streetcars may be offset somewhat by the salvage value from liquidating the existing Gomaco cars. It is assumed that the existing cars were purchased in 2002 for a unit price of about $565,000. Absent a condition inspection and assessment, and information regarding major overhauls, a depreciated value estimate using several methodologies resulted in a range of value per liquidated Gomaco car of between $226,000 and $485,000. As there have been no recent sales of similar used cars, it is difficult to determine a true market value.

Additional study is required to determine the appropriate vehicle type, number of vehicles required to support planned levels of service, the estimated cost for procurement and purchase of tools, spare parts, and testing equipment, and the number and market value of existing vehicles to be taken out of service.

Track Upgrades

Although the gauge and profile of tracks on the existing system can accommodate modern streetcar and light rail vehicles, the horizontal curve radius of the track in several locations is too small to meet turning radius requirements for larger vehicles. As mentioned previously, 66' (20m) is considered the minimum turning radius to accommodate modern streetcar vehicles and 82' (25m) is considered the minimum required to accommodate light rail vehicles.

The existing system includes several locations where the horizontal curvature of tracks falls below the 82' (25m) minimum radius for light rail vehicles and five of these locations fall below the 66' (20m) minimum radius for modern streetcar vehicles. The locations with inadequate horizontal curvatures include the following turns:

- The intersection of Old Water Street and Channelside Drive (curve 1025/50' radius);
- The turns to the south and north of the roundabout at Channelside Drive and Cumberland Avenue (curve 1042 - 50' radius and curve 1045 - 65' radius);
- The turns at the "S" curve at the crossing of the CSX Tracks (curve 1093 - 50' radius and curve 1094 - 80' radius);
- The turn at the intersection of 13th Street and 8th Avenue (curve 1102 – 50' radius).
- The turns into and out of the existing maintenance and storage facility.

To support the use of larger vehicles at these locations, new tracks, track bed, and overhead power would need to be constructed. In addition, these upgrades may require street and streetscape reconstruction and right-of-way acquisition, especially in constrained locations such as the roundabout on Channelside Drive and the turns in Ybor City.

The conceptual cost estimate for upgrading the existing system includes costs for the new tracks, track bed, and overhead power as well as the removal of existing tracks and street reconstruction but does not account for other costs which may be incurred, including the costs for right-of-way acquisition or major intersection reconfiguration as may be required at the roundabout or near the CSX crossing.

Station Upgrades

To support larger vehicles, significant improvements to existing stations would be required. These improvements, reflected in the cost estimate for the upgrade, include the removal of the high block platform for ADA access to the existing high floor vehicles and the potential for platform raising and lengthening to serve longer vehicles. Detailed design requirements can not be defined until a specific vehicle type is selected so the conceptual cost estimates include a preliminary cost per station to account for a range of potential upgrades.

Traction Power System Upgrade

Existing System. The existing traction power system on the existing line consists of two 1,500kW substations, traction power substation (TPSS) North and TPSS South, that operate at a nominal 600Vdc. TPSS North is located under the Selmon Expressway near East Adamo Street, and TPPS South is situated in the north end of the parking lot between Channelside Drive and East York Street. The substations are arranged so that each feeds one power section. The substations and respective power sections are electrically isolated from each other using a section insulator and a normally open isolating switch. In the event of an outage of one substation, the sections may be tied together by closing the isolating switch, essentially reconfiguring the entire traction power system as one large power section drawing from the one operating substation.

The distribution system consists of a single 4/0 overhead contact wire for each direction of travel running the entire length of the streetcar line through both single and double track sections. There is a parallel cable from near Cumberland Avenue to the yard area which is run in a duct bank tapped to the overhead system at varying intervals. The contact wires for each direction of travel are also tapped frequently to permit current sharing between the conductors. In the single track areas, both 4/0 contact wires are supported side-by-side in the same plane and centered above the track. The trolley car operates with a trolley pole and shoe so it will track along the contact wire uniformly throughout the single track areas.

Power Systems Upgrade. For the existing line, the assumed improvement would be to increase the size of the contact wire from 4/0 to 350kcmil on the existing overhead catenary system (OCS) and to develop a power section layout that would take advantage of the benefit of having two substations feeding a power section whenever possible. This would involve moving the section insulator from between the two substations to out in front of them.

In addition, as there are several types of modern streetcar vehicles in service throughout the US and it is not yet known which type would be selected, it is difficult to precisely quantify the vehicle's impact on the existing traction power system. The rating of the 1,500kW substations likely would not be an issue for supplying adequate power. Rather, the concern with the existing system would be how the traction power system performs during a substation outage scenario where the distance from the existing substation to the end of the line would reach at least 1.6 miles. This distance, coupled with the increased current demand of the modern streetcar, is likely to strain the OCS and would result in a voltage drop and a weaker train voltage profile. Therefore, the addition of another substation cannot be ruled out, and smaller (500kW) substations may be required to strengthen the existing section.

Overhead Contact System Upgrade. The OCS on the existing system consists of simple trolley wire mounted on brackets over the centerline of track. The hardware that clamps to the contact wire and keeps it in position is designed for operation with trolley pole current collectors. These are rollers or 'shoes' at the end of spring loaded poles mounted to the roofs of the streetcars. The trolley poles only operate in one direction, angled toward the rear of the car in the direction of travel. Therefore, for bi-directional operation, each Gomaco car is equipped with two trolley poles.

Modern streetcars are equipped with a pantograph, which can operate in either direction. This device consists of a bar of carbon-based conducting material that is mounted on a frame that is attached to a hinged tube assembly. The assembly is spring-loaded and presses the 'carbon' up against the overhead wire. A typical pantograph frame is about 5'6" wide with ends tapered downward.

To upgrading the existing system to support modern streetcar vehicles, the existing trolley overhead system for trolley collector poles would be converted to an OCS for pantograph operations. Doing so requires changing out the trolley wire positioning devices (called 'registrations') and supports, replacing all the existing trolley special work (frogs and crossings) with OCS contact wire bridges or knuckles, making minor modifications to pull-off wires, or 'guys', at turns, and possibly re-tensioning the conductor wire.

With regard to registrations/supports, virtually every trolley wire 'ear' (contact wire clamp) would need to be replaced. This should not be a problem because the change to an OCS steady arm can be phased incrementally over time, without affecting existing trolley operations. This is accomplished by using OCS steady arms with slidable (adjustable) trolley ears. Trolley ears are perfectly suitable for pantograph operations. Initially, at any registration, the steady arm would be installed to clear the pantograph clearance envelope, but the trolley ear would be set to the existing stagger so that trolley poles can continue to operate. Then, during an overnight service closure, all of the trolley ears would be slid to a stagger scheme developed in an OCS upgrade design. From then on only pantographs can operate. The wire is staggered side to side off the centerline of track from pole to pole to allow the overhead wire to sweep across the pantograph carbon, enabling for uniform wear of this material.

Pantographs can operate over most designs of special work at very slow speed without the need for special carry-under skids. These are short runners that keep the pantograph away from hardware in the air they should not touch. However, if skids are considered absolutely necessary, they can be used, but would need to be checked for alignment daily. For the conversion, each individual piece of special work would need to be changed out for a corresponding OCS design, with these OCS assemblies installed following the conclusion of all trolley pole operations. Once the conversion is accomplished, guy-networks can be simplified and conductor re-tensioning may be necessary.

At this stage of the planning, it is assumed any extension to the system would likely be configured differently to the existing installation and would employ a different style of OCS to cater to the heavier power demands of the anticipated new streetcars as well as the pole types and pole spacing that would best fit the selected alignment alternative. The upgraded OCS would need an increased copper cross-section as one option, either employing a low-profile catenary or, as a minimum, a 350kcmil contact wire.

Further study and modeling is required to determine the preferred technical solution to design an appropriate traction power system for the extension and complete power upgrades and conversion to OCS for the existing line. Such analysis would include load flow modeling of the entire system and a detailed investigation existing hardware.

Maintenance and Storage Facility

Based on an initial evaluation, it appears the existing maintenance and storage facility on 7th Avenue in Ybor City would need to be expanded or replaced to serve larger transit vehicles. The existing facility, including both the enclosed building with service bays and outdoor yard and tracks, was designed to support general maintenance, repair, cleaning, and storage of the existing heritage streetcar vehicles. The existing vehicles are less than 50’ in length and require only 50’ turning radii while modern streetcar and light rail vehicles can be as long as 100’ in length per vehicle and require 82’ radii for turns. Consequently, an assessment of options for renovations, expansion, or replacement can not be performed until a preferred vehicle type is determined and decisions are made regarding the optimal number vehicles to maintained planned levels of service.

As requirements for a maintenance and storage facility cannot be defined until further planning is complete, the conceptual estimate for the system upgrade includes a very preliminary cost for facility renovations or replacement. And as the study does not address potential locations for a new facility or costs for property acquisition, real estate costs and the additional track feet and power to access a new facility are not included.

Summary of Costs

The following table provides a summary of conceptual construction costs for upgrades to the existing system to accommodate modern streetcar vehicles. The estimate was based on a conceptual level of planning and design and was developed using available data regarding costs incurred for recently completed transit system projects in the United States. As future design and engineering efforts are undertaken and more detailed investigation occurs regarding such matters as vehicle types and right-of-way and property acquisition requirements, project estimates would be updated to account for conditions and design details not typically addressed at this high level of study. Table 4 below provides the estimate of potential costs for the upgrades.

Table 4: Capital Costs for Upgrades to Accommodate Modern Streetcar Vehicles

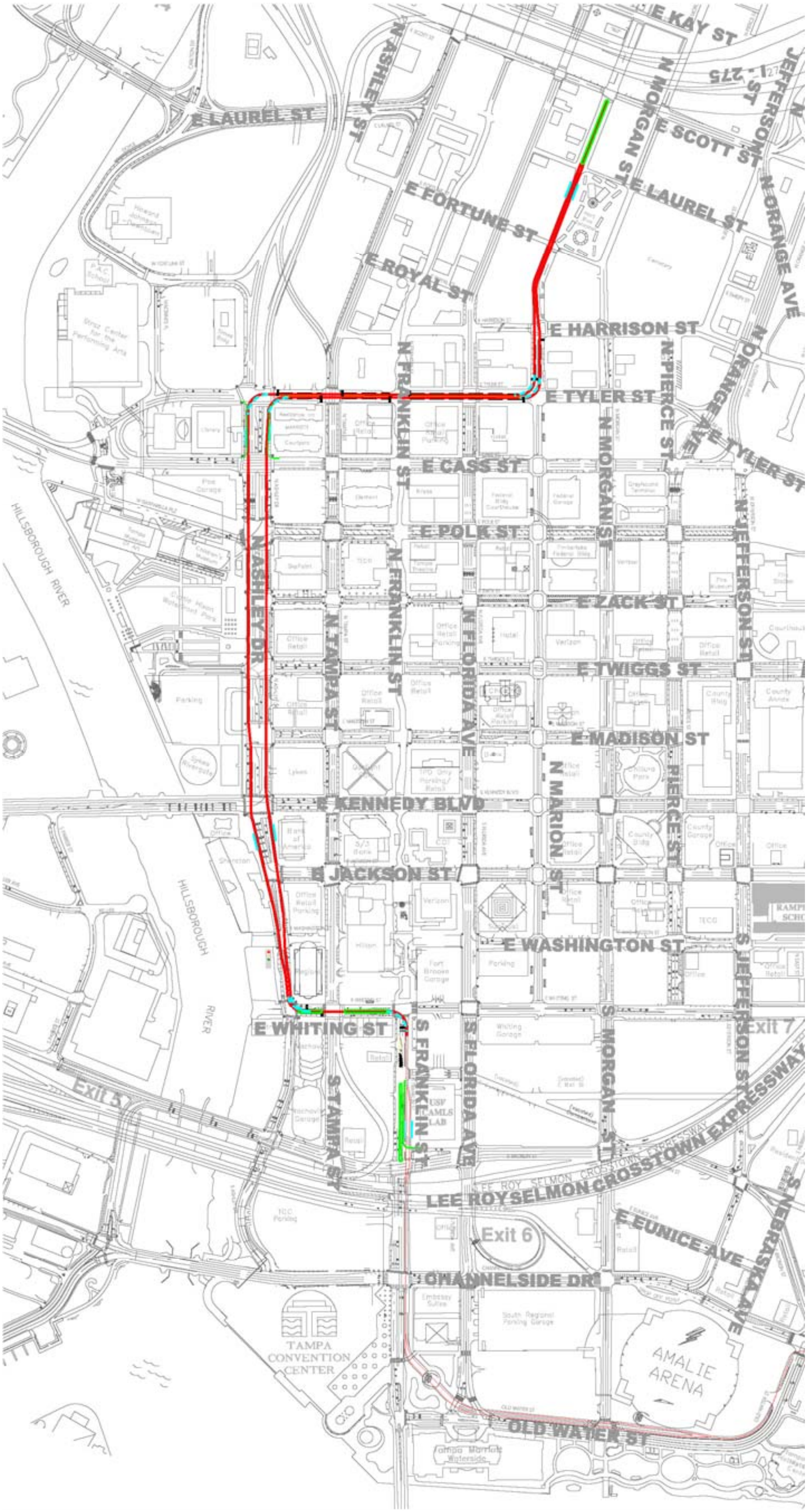
Improvement	Capital Cost (2014)	Notes
Track and Power Upgrades	$18,400,000	• Includes costs for reconstructing curves and upgrading the existing traction power system.
Modern Streetcar Vehicles (8)	$32,000,000	• Includes cost of acquisition of eight new modern streetcar vehicles but is not discounted to account for the potential sale of existing vehicles.
Maintenance and Storage Facility	$11,200,000	• Includes costs for renovation of the existing facility or construction of a new facility but does not include costs for land acquisition or tracks and power to access a new facility.
Total	**$61,600,000**	

Notes: .

1. The estimate includes hard costs, soft costs, and contingencies.

2. The estimate does not include costs for right-of-way acquisition.

Appendix: Conceptual Plans for Extension Scenarios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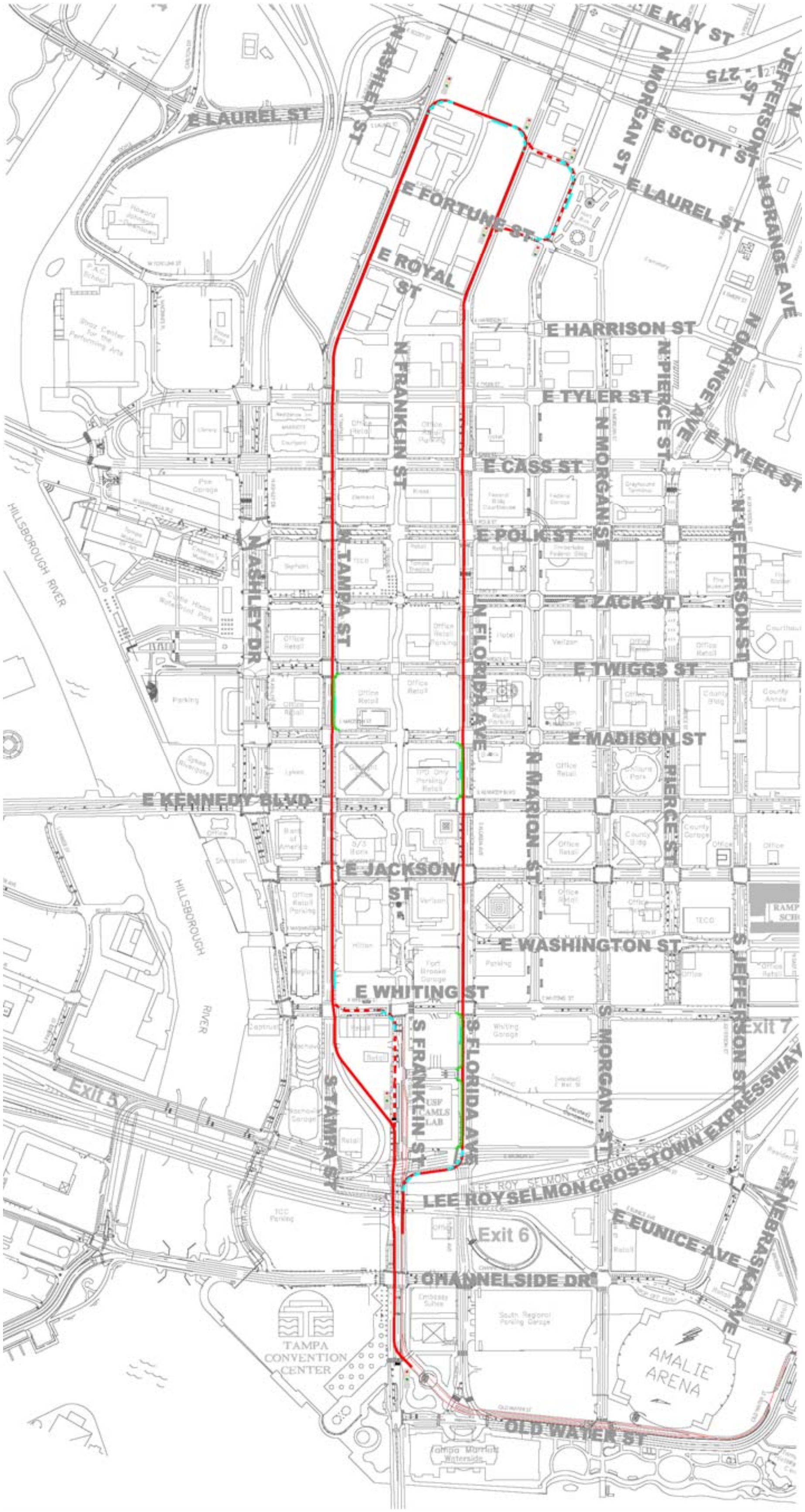
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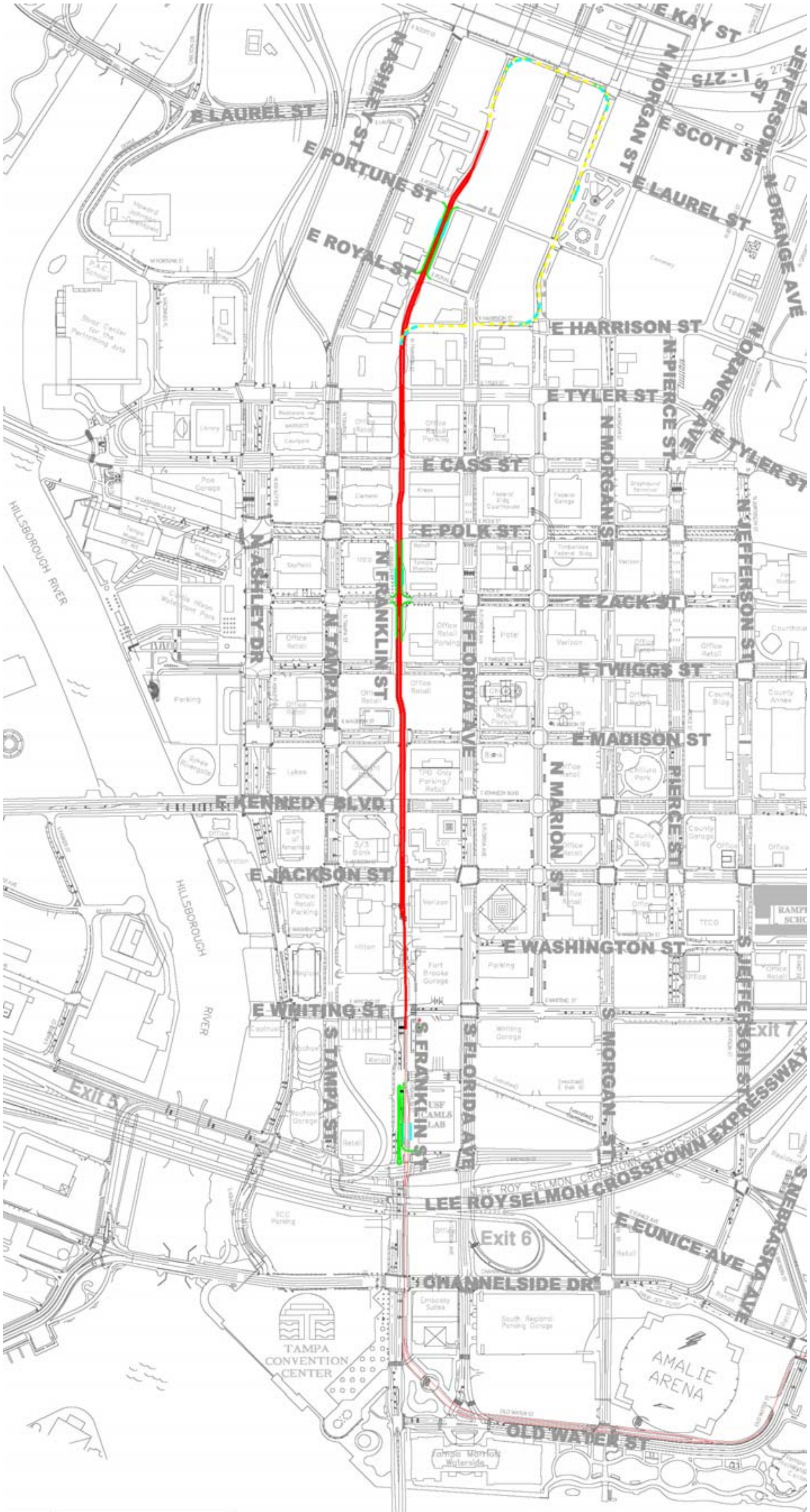
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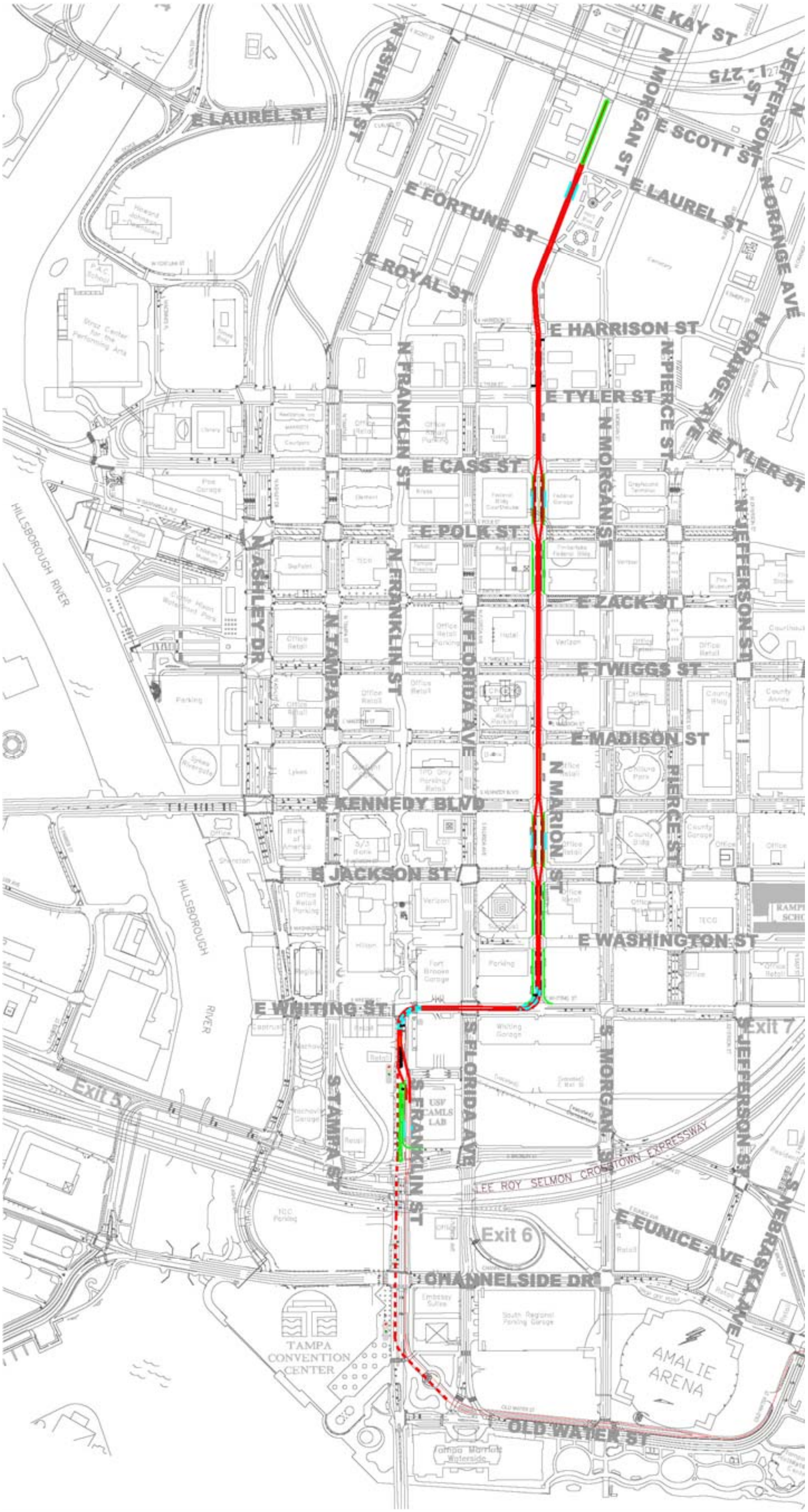
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Streetcar Extension and Modernization
Feasibility Study
City of Tamp RFQ 16-D-00002

Supplemental Information:

http://www.planhillsborough.org/downtown-transit-assets-study/

http://www.invisiontampa.com/Center_City_Vision_Plan.html